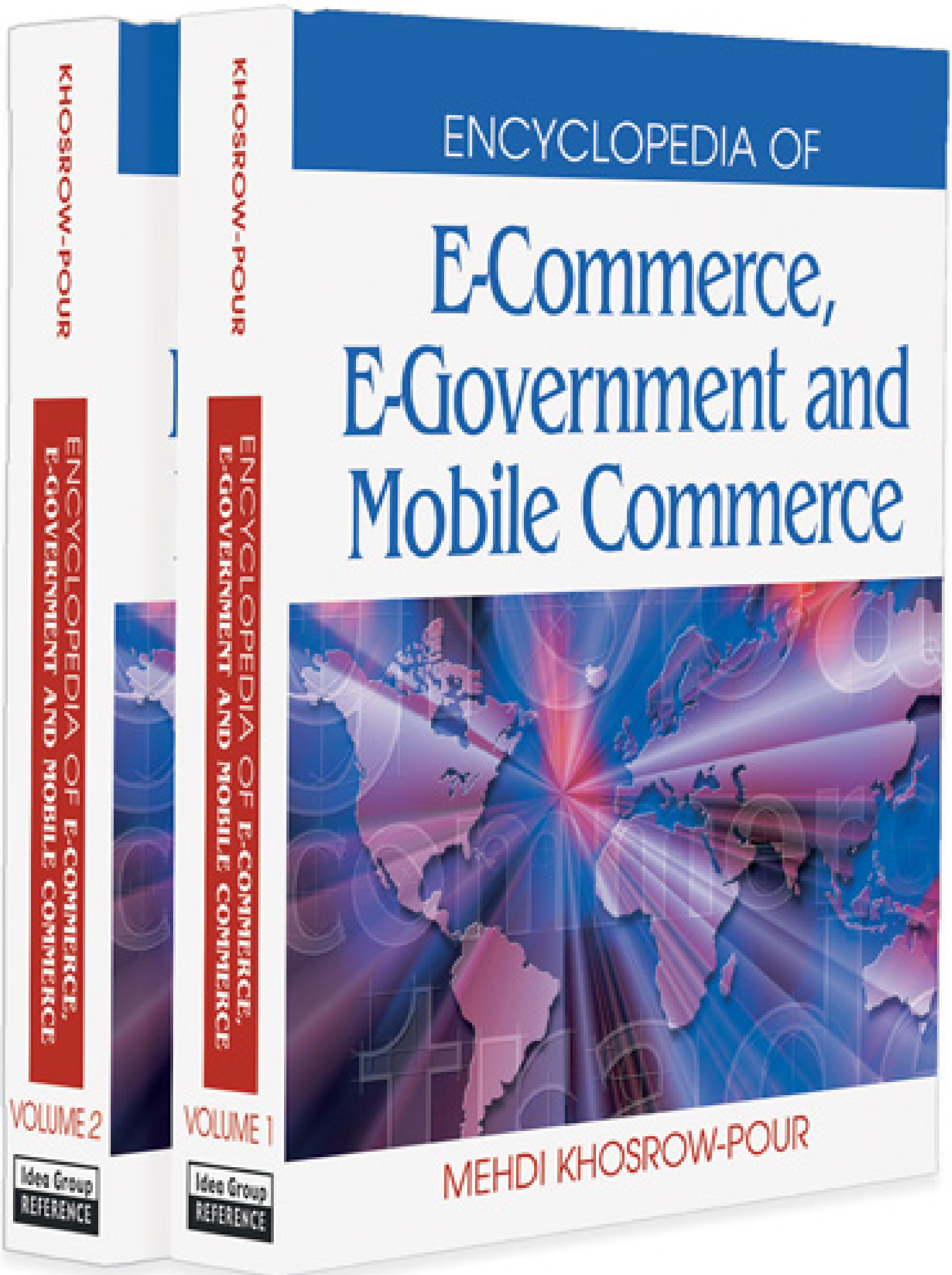
ENCYCLOPEDIA OF
E-Commerce,
E-Government and
Mobile Commerce
MEHDI KHOSROW-POUR
KHOSROW-POUR
ENCYCLOPEDIA OF E-COMMERCE, E-GOVERNMENT AND MOBILE COMMERCE
VOLUME 1
Idea Group REFERENCE
KHOSROW-POUR
ENCYCLOPEDIA OF E-COMMERCE, E-GOVERNMENT AND MOBILE COMMERCE
VOLUME 2
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Encyclopedia of E-Commerce, E-Government, and Mobile Commerce

Mehdi Khosrow-Pour
Information Resources Management Association, USA

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Preface

Since the early 1990s, the world has observed a technological revolution of similar magnitude to the industrial revolution of the early 20th century. This modern revolution has provided organizations and societies worldwide with an innovative medium of communication entirely new to humankind. Researchers made the discovery that through the use of integrated computer-based telecommunication networks, information of all types and forms could be disseminated throughout the world, utilizing existing computer and communication technologies. As a result, to supplement the telephone, fax, and mail, a new medium of communication was born and is known today as the Internet.

This phenomena actually grew out of a project knows as ARPANET, funded by the U.S. Department of Defense. The primary objective of this project was to study how researchers could share research data in the case of nuclear attack. The project was later transferred to the National Science Foundation (NSF) and became known as the "Internet," initially to be used by university scholars and researchers. Subsequently, the invention of the Internet led itself to the World Wide Web (WWW), fueled by the technological advancement of computer and communication technologies combining to create a new set of technologies, better know today as Web-enabled technologies or e-technologies.

During the early days of the WWW, this medium was primarily utilized by both public and private organizations to disseminate information about the organizations' products, services, and news. As a result, organizations of all types and sizes worldwide began establishing their presence on the WWW by having their own Web sites filled with all kinds of information about their organizations. Consequently, many organizations began expanding their presence on the WWW by developing new technologies and applications to allow customers and suppliers to conduct business transactions. They discovered that through the use of this technology, customers could do business with the organization electronically, and this led to the birth of "electronic commerce," sometimes known as "e-commerce" or the abbreviated term of "EC." Then came the establishment of a new breed of e-commerce-based businesses, such as Amazon.com and eBay.com, as part of the more than one trillion dollars-a-year industry worldwide.

The innovations achieved through the use of EC during the early days of Web-enabled technologies led to the discovery of "electronic government," otherwise known as "e-government" or "eGov," where governmental organizations began using these technologies to develop various applications to serve and govern their constituencies in a fashion that was not possible a decade earlier. Today, e-government applications have allowed many government-based agencies around the globe to reach and serve their citizens in a much more timely, efficient and less costly manner.

As telecommunication technologies further advanced, they introduced new mobile technologies, also known as wireless technologies, for the need of individuals and organizations to conduct electronic transactions and communications through the use of Web-enabled technologies known as "mobile commerce," "m-commerce," or "MC." In recent years, consumers and organizations have benefited from many of the features of m-commerce technologies through numerous applications, such as conducting financial transactions, supply chain operations, advertising, portal access points, information and news services, entertainment and games, and education and training. As individuals and organizations become more mobile and virtual, it is expected that the number of m-commerce-related applications will increase significantly.

In less than two decades, Web-enabled technologies have provided organizations all over the world with tremendous new and innovative opportunities to expand their business horizons in ways that, until a decade ago, were unimaginable. Incredible cost savings have come from conducting operations electronically. Furthermore, these technologies have paved the way for the development of many other indirect applications and uses, such as the creation of virtual communities and enterprises, e-collaboration, distance learning, Web portals, and Web services. In addition, however, Web-enabled technologies have not been free of criticism and problematic issues, ranging from security, privacy, fraud, digital divide, cyber crime and terrorisms, and system incompatibilities.

To better understand the components, applications, and managerial and organizational issues of e-technologies for students, faculty, researchers, managers, public administrators and policy makers, editing an encyclopedia became an important and necessary goal. Therefore, the primary objective of the *Encyclopedia of E-Commerce, E-Government, and M-Commerce* is to provide the most inclusive and up-to-date coverage of e-technologies by compiling quality contributions that highlight current concepts, trends, challenges, applications, and experiences related to e-commerce, e-government, and mobile commerce technologies.

To provide the most comprehensive, in-depth, and up-to-date coverage of issues, technologies, and applications of e-commerce, e-government, and m-commerce, the many essential and important topics and aspects of these technologies were selected for this encyclopedia project, including: E-Collaboration Technologies and Applications, E-Commerce Technologies and Applications, E-Commerce Management and Social Issues, E-Government Technologies and Applications, E-Government Management and Social Issues, E-Healthcare Technologies and Applications, E-learning Technologies and Applications, E-Technologies Security and Privacy, Mobile Commerce Technologies and Applications, Mobile Commerce Management and Social Issues, Virtual Communities and Enterprises, Web Portals and Services.

To present applied research and coverage, submissions for this encyclopedia were grouped into three categories:

- **Concepts, Trends, and Challenges:** Entries under this category deal with the fundamental and emerging concepts related to e-commerce, e-government, and mobile commerce. Entries in this category provide coverage of current and emerging trends, challenges, problems, and solutions related to these technologies. Furthermore, the entries in this category include 7-10 technical and managerial key terms with full definitions.
- **Applications of E-Technologies:** Entries under this category describe different applications of e-commerce, e-government, and mobile commerce in business or organizational settings. These entries describe how different e-technology-based applications have been developed in support of different business or organizational functions or activities.
- **Dot-Com Experiences:** Entries under this category illustrate various dot-com businesses that either failed or succeeded. These entries describe how the dot-com entity started (history), what kind of services/products it offered (purpose), how it was directed (management), how it failed/succeeded (failure/success factor), and what lessons may be learned from these experiences.

Researchers from all over the world were invited to submit proposals describing their proposed coverage and the contribution of such coverage to the overall theme of the *Encyclopedia of E-Commerce, E-Government, and Mobile Commerce.* All proposals were carefully reviewed by the editor-in-chief in light of their suitability, researchers' knowledge on the proposed topic, and the quality of the submitted proposal. Authors of accepted proposals were notified regarding the acceptance of their proposals and were provided with a copy of the "Manuscript Organization and Submission Guidelines" for the authors to use in preparing their full submissions. Upon the receipt of full entry submissions, each submission was forwarded to at least three expert, external reviewers for a double-blind, peer review. In many cases, the review process was repeated for those manuscripts that were recommended for revision by reviewers. Only submissions with strong and favorable reviews were chosen as entries for the *Encyclopedia of E-Commerce, E-Government, and Mobile Commerce*.

Subsequently, the two-volume *Encyclopedia of E-Commerce, E-Government, and Mobile Commerce* includes more than 200 entries highlighting current concepts, applications, technologies, opportunities, issues, challenges, solutions, and future trends. More than 1,400 technical and managerial key terms with 5-50-word definitions compliment these entries and provide the readers of this comprehensive reference publication with the basic definition and description of these key terms. Furthermore, a total of more than 475 tables and figures contribute to the comprehensiveness of this publication. In addition, this two-volume encyclopedia offers a thorough reference section with over 4,400 additional research sources for the further investigations of scholars, researchers, educators, students, managers, and administrators.

To provide the best entry organization to assist readers in navigating and identifying entries in this publication, this two-volume encyclopedia is organized by listing all entries in alphabetical order by title throughout the publication, and by including the entries' titles and authors' names and affiliations in a regular "Table of Contents" in the beginning of each volume. All entries are also organized under their prospective topic area category in a second "Table of Contents by Topic," allowing readers to identify entries related to their research areas and interests. In addition, the first page of each entry consists of a labels describing the submission category. Furthermore, the first comprehensive and easy-to-navigate index of this encyclopedia assists readers in locating full descriptions and definitions of all technical and managerial terms included, and the second comprehensive index helps readers in identifying any key terms as identified by the authors.

To compliment the print version of the *Encyclopedia of E-Commerce, E-Government, and Mobile Commerce,* this publication will also be available in an online version with very easy-to-use search capabilities. As with all reference titles of Idea Group Reference, a complimentary unlimited access to the online version of this publication is provided to libraries that purchase a copy of the print version. However, for those libraries that are not interested in purchasing the print version, online subscriptions are available for a reduced price. Access to the online version will allow students, faculty, researchers, corporate managers, and public administrators to also have access to recently added entries to the first edition of this encyclopedia, allowing users to keep up with the latest coverage of emerging technologies and issues related to the coverage if this encyclopedia.

The world has witnessed fundamental change in the way people worldwide communicate with each other and share information. Alexander Graham Bell's invention of the telephone introduced a completely new means for people to communicate with each other. However, the introduction of the Internet, followed by subsequent, innovative e-technologies, has brought a completely new kind of revolution in the areas of communication and information dissemination. E-commerce, e-government, and mobile commerce technologies, in addition to a wide range of applications, have allowed the world to convert into electronic virtual communities where members may communicate, share information and knowledge, do business, obtain services, and conduct educational programs and even religious activities in ways totally unthinkable several years ago. Many researchers claim that e-technology innovations the world currently witnesses are just the beginning of a far more expansive digital revolution ahead of us, and that future generations will be the beneficiaries of these emerging technologies. It is my heartfelt hope that this encyclopedia, with its comprehensive coverage of e-technologies, will assist scholars, researchers, educators, students, managers, and administrators in learning about the current status of these technologies and also facilitate the discovery of future innovative technologies.

Mehdi Khosrow-Pour, D.B.A.
Editor-In-Chief

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Adaptive Virtual Reality Shopping Malls

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INTRODUCTION

Firms and organizations are increasingly exploiting electronic channels to reach their customers and create new business opportunities. To this end, electronic shops have been developed, either offering products from a single firm or encompassing multiple individual electronic stores, comprising thus electronic shopping malls. Besides development activities, electronic shopping has attracted the attention of researchers, who have studied various perspectives, including user attitude, critical success factors, security, technical aspects, and so forth (e.g., Fang & Salvendy, 2003; Wang, Makaroff, & Edwards, 2003).

Two main concerns for e-commerce are personalization and enhancement of user experience. Personalization addresses the ability to offer content tailored to the preferences of each user (Anupam, Hull, & Kumar, 2001) or user group (Wang et al., 2003). Preferences may be explicitly declared by the user, or derived by the system through inspecting user interaction; if the system dynamically reacts to changes of visitor behavior, it is termed as *adaptive*. Personalization allows customers to focus on the items they are interested in, and enables electronic shops to make targeted suggestions and send promotions to customers (Lekakos & Giaglis, 2005).

Enhancement of user experience is another major issue in e-commerce, given that 2D images and texts on the screen are not sufficient to provide information on product aspects such as physical dimensions, textures, and manipulation feedback (Park & Woohun, 2004). Major e-commerce categories that could benefit from giving a more accurate and/or complete view of the products include real estate brokers who could present detailed models of properties, furniture stores that could allow their customers to view how certain pieces would fit in the target place (Hughes, Brusilovsky, & Lewis, 2002), and clothing shops that could provide a virtual fitting room with customizable avatars (Compucloz Corporation, 2003). Multimedia presentations can also be used as a means for "information acceleration" for promoting "really new" products (Urban et al., 1997). Enhancement of user experience may finally compensate for the loss of the pleasure associated with a visit to a shopping mall (Laskaridis, Vassilakis, Lepouras, & Rouvas, 2001).

Nowadays, the technological potential of Internet systems provides adequate means for building online multimedia applications that can help e-commerce sites attract e-shoppers. Applications can be built to adapt to the user's profile and provide the user with a suitable set of information in the most efficient way. Virtual reality (VR) technologies are also now mature enough to be used for the wide public, offering vivid and highly interactive environments, allowing users to view synthetic worlds within which they can visualize and manipulate artifacts. This article aims to specify a system that exploits capabilities offered by adaptation and VR technologies to offer e-shoppers personalized and enhanced experiences, while addressing challenges related to the cost, complexity, and effort of building and maintaining such a system.

BACKGROUND

E-commerce sites nowadays expose variable degrees of sophistication, functionality, and complexity. Most e-commerce sites offer lists of available products, usually organized in categories. For each product, a brief description, the price, and possibly an image are made available to e-customers; more information items may be included depending on the e-commerce domain (e.g., customer reviews for books and music). A basic e-commerce site offers the same content to all its visitors.

The first step towards offering services tailored to the user needs is the categorization of users into groups and serving each group with specifically selected content (e.g., Arlitt, Krishnamurthy, & Rolia, 2001). Personalization provides a finer granularity for tailored content delivery, because content formulation is based on the preferences and behavior of individual users, rather than aggregate data from user groups. Preferences may be declared through *static profiling* (Datta, Dutta, VanderMeer, Ramamritham, & Navathe, 2001) where users declare their preferences through profile definition pages; dynamic profiles extend their static counterparts by incorporating information collected from user activities during the interaction sessions.

On the other hand, 3D objects and VR can greatly enhance user experience within an electronic shop. Since 3D environments are inherently more complex as compared to 2D interfaces, the issue of navigation within such an environment is important. Chittaro and Coppola (2000) discuss the use of animated products as a navigation aid for e-commerce. Hughes et al. (2002) examine the integration of ideal viewing parameters with navigation, to assist the navigation procedure. Park and Woohun (2004) present a prototype augmented reality system, enabling users to "put and feel a product" in order to find the match in the real environment.

Although adaptation and VR technologies seem promising for e-commerce, their adoption is currently hindered due to a number of challenges, mainly related to the technologies themselves. The first major challenge is *content creation*: for each item in the VR-mall, the respective representations have to be created. The virtual space for the mall must also be designed, and stands and shelves on which items will be placed must be inserted. Finally, interaction methods for each item need to be designed. These may vary from item to item depending on the type of digital representations (e.g., 3D models may be rotated; videos may be played, paused, and continued; photographs may be only viewed), and the nature and semantics of the item (e.g., for a 3D model of a camera, interaction may be provided to illustrate change of lenses, while a 3D model of a vase can be only rotated). This is a cumbersome, time consuming, and costly process (Lepouras, Charitos, Vassilakis, Charissi, & Halatsi, 2001).

A second major challenge is the overall system complexity, stemming from the diversity of its components, structures, and interactions (European Center for Virtual Reality, 2004). The system must include provisions for user profile modeling (both static and dynamic parts), selection of the items that best fit the current user profile, dynamic creation of virtual worlds (VR-worlds) in which the selected items must be placed, coupled with proper interaction methods.

A final challenge is the overall size of the VR-mall description. VR-worlds tend to be of large size, and thus their download time can be considerable. Constructing thus a single world representing the whole VR-mall will result in long waiting times, which may lead users to navigate away from the VR-mall. A more prominent approach would be the formulation of smaller VR-worlds, each one containing a subset of the VR-mall merchandise. These worlds may be interconnected using gates, teleports, or any other suitable means (when a user reaches an interconnection item, they are transferred to another VR-world constructed and downloaded at that time; thus waiting times are broken down into small portions). The proposed architecture adopts this approach, which additionally provides the opportunity to populate each VR-world with the merchandise that best fits the user interests, as this can be determined by the user activities observed so far. The details of this process are analyzed in the next section.

THE VR-MALL ARCHITECTURE

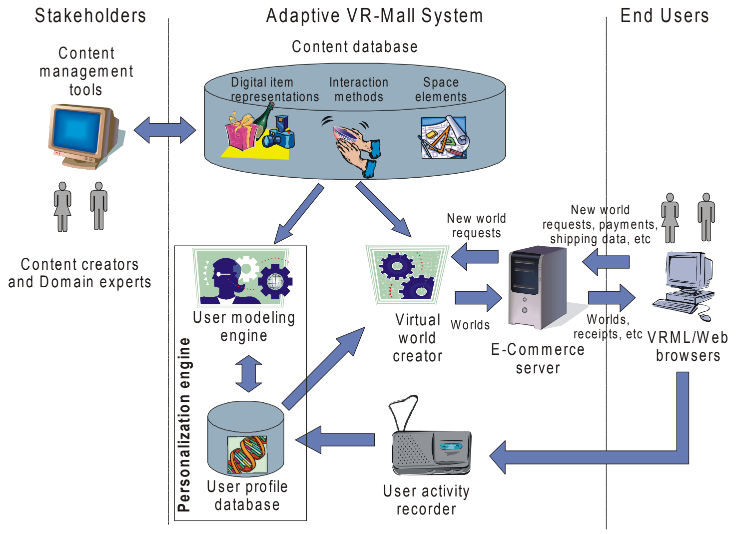
The proposed architecture provides a generic framework for building an adaptive VR-mall, undertaking the tasks related to user profiling and monitoring, selection of the items best suited to the user profile, association of the relevant interaction methods, and dynamic formulation of the VR-worlds. In this sense, the tasks that need to be performed by the VR-mall maintainers are limited to the provision of the content—that is, the digital representations of the items merchandised through the VR-mall. The proposed architecture is depicted in Figure 1.

Defining the VR-Mall Content

In the proposed system, creation and maintenance of the adaptive VR-mall is undertaken by two stakeholder groups, namely content creators and domain experts, who perform their tasks using specially crafted *content management tools*. Content creators provide the digital forms of the VR-mall merchandise in the appropriate form (pictures, 3D models, sounds, videos, etc.). Content creators additionally design the space elements that are used within the VR-mall, including rooms, halls, corridors, shelves, display cases, and stands. Space elements generally contain *merchandise placeholders*, which are replaced by appropriate merchandise items or navigation aids when an instance of the VR-mall is created. For example, shelves may contain placeholders indicating where products will be placed, whereas a placeholder within a corridor may be replaced by a sign listing the merchandise categories along the corridor. All resources can be provided in multiple *levels of detail.* High levels of detail are used for e-shoppers with broadband connections and when e-shoppers explicitly request highly detailed images of items; low levels of detail are used to reduce download times, because the size of the digital representation in low levels of detail is significantly smaller.

To enable the selection of the most suitable items for each user, the adaptive VR-mall system needs to possess certain information regarding each item, such as the item category (e.g., furniture, electric appliance, holiday pack), target age group, shopping season, and so forth. This information is provided in the form of *property-value*

Figure 1. System architecture



pairs by *domain experts*—that is, VR-mall stakeholders who have significant expertise on the merchandise. This information is stored alongside the digital representations of the merchandise and is exploited by the VR-world generator in the process of selecting the items that are considered to best match the interests of the current e-shopper.

Personalization and Adaptation

Central to the proposed architecture is the *VR-mall personalization engine*, comprising the *user profiles database* and the *user-modeling engine*. The user profiles database stores information regarding the profiles of individual users, and associations between user profiles and specific items or item properties. This information is utilized in the process of VR-mall creation to include in the mall the merchandise that most closely matches the interests of the current e-shopper. For each e-shopper, the user profiles database hosts both *static* and *dynamic* information. Static information reflects characteristics that remain constant, at least in the context of the current visit (e.g. preferred language, connection speed, age, etc.). This information is either entered by the user (e.g., a response to a "Language selection" prompt) or deduced by the system (e.g., connection speed is estimated by measuring the download time for an image of known size). Dynamic information pertains to the interaction of the user with the virtual environment and is collected by the *user activity recorder*. This information describes certain actions that the e-shopper has performed in the VR-mall, including moving close to an item and moving away from it, start and end of item manipulation, resetting activities (probably due to disorientation problems), acquiring and losing visibility for items, requesting specific resources or resource types, and so forth. This information is collected within the user browser, and communicated to the user activity recorder periodically. When the user activity recorder receives a group of event information, it first arranges to combine "activity beginning—activity end" records, to compute the duration of each activity. For events that are instantaneous by nature (e.g., request for an image of a product), only the count of these events is computed. The combined information is inserted into the user profiles database, and the user-modeling engine is invoked to update the profile of the user.

The user-modeling engine is a separate architectural module that examines the user activities observed within the virtual environment, and deduces the preferences of the user towards certain items or item categories. Upon invocation, the user modeling engine extracts from the user profiles database the records that describe activities of the current user and processes them as follows:

1. Items that have come into visibility are assigned a grade in the range of (-5) to (10), depending on the time that they have attracted the visitor's attention (-5 = not at all, 10 = very long).
2. If for some item some resources have been explicitly requested (e.g., 3D models, detailed text, images), an extra amount is added to the item's interest grade (1 to 3, depending on the time the extra resource was viewed).

3. Items that have not come into visibility are not assigned any grade, as the user may ignore altogether that the items were present in the VR-world.

The final grade for each item is computed by multiplying the above computed grade with an *aging factor*, which ranges from 1.0 (for recent activities) and 0.1 (for activities that occurred a long time ago). This step effectively assigns a greater importance to recent activities, allowing for modeling of *changing user interests* (Kilfoil, Ghorbani, Xing, Lei, Lu, Zhang, et al., 2003).

The last phase of the user profile update procedure is the mapping of the grades computed in the previous step to preferences towards item categories, or—more generally—*item properties*. To this end, the semantic information associated with the items (in the form of *property-value* pairs) is extracted from the digital items representation repository. For each property-value pair retrieved, the grades of all items associated with it are summed up to form the score of the specific property-value pair. This information is finally inserted into the user profile database. Similar algorithms are used to deduce user preferences towards specific media types and interaction methods.

Generating Virtual Worlds

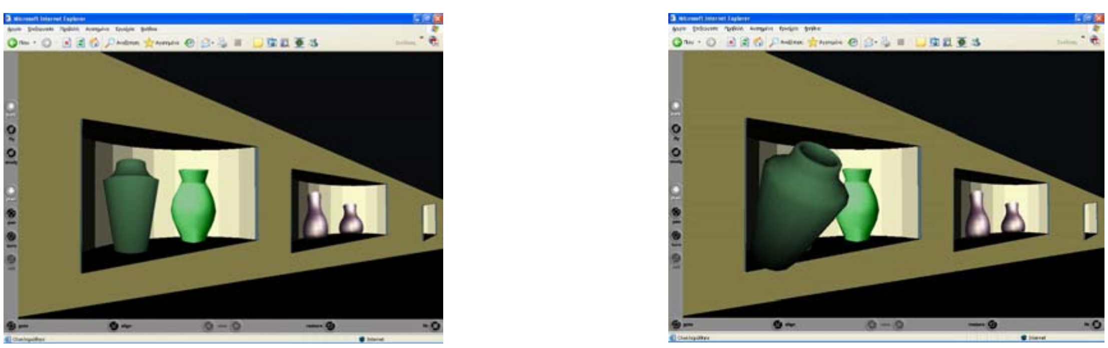
When a user reaches a "VR-world interconnection" point (gate, teleport, etc.), a request is issued to the VR-world generator, which will create the next "portion" of the VR-mall to be sent to the user. This request contains the user identity and—possibly—expressly stated user preferences (e.g., "I want a high-quality environment" or "I am interested in velvet textiles"). The VR-world generator additionally retrieves from the user profile database the preferences and information for the specific user (either statically stated or deduced by the VR-mall personalization engine). Afterwards, the VR-world generator accesses the content database to extract the items that will be placed in the new VR-world. The initial list of the items to be placed in the new VR-world is formulated in either of the following two ways: (a) the user selects to visit an "e-mall department" (e.g., furniture, clothing etc.), in which case the items belonging to the selected department are chosen; or (b) the user requests to see "matching items" to some designated merchandise (items within the shopping cart or some explicitly specified), in which case the items having common properties with the designated merchandise are chosen. The initial item list is sorted in descending order of the sum of scores corresponding to the property-value pairs within each item. The VR-world generator has also an upper limit regarding the number of items that will be placed in a VR-world, and another upper limit pertaining to the download size; if either limit is exceeded, items are removed from the list until the restrictions are met. When the item list has been determined, a proper space element is selected from the content database (one with enough placeholders for the selected items and matching the user preferences), and the items are positioned at the placeholder locations, arranging for "similar" items to be placed in clusters (Lepouras, 2004). At this point, the VR-world has been fully created and can be sent to the user.

Figure 2 presents two screenshots from the VR-mall. The first one illustrates movement along an isle, while in the second screenshot an object has been "grabbed" and is examined.

FUTURE TRENDS

New technologies offer to e-commerce sites the possibility of creating enhanced and highly personalized user experiences, increasing the site potential to attract more e-shoppers. One issue that has to be settled in this context is the *time to adapt*—that is, how much time elapses from the instant that some user behavior is observed to the

Figure 2. The VR-mall environment: (a) moving along an isle with vases; (b) examining a specific vase



a. *b.*

instant that the system changes the user environment. In the proposed architecture, the environment will change only when a new VR-world is requested. Some users may find this reaction delayed; most users, however, have been found to react negatively to constant changes in their environment (e.g., items disappear to be replaced ones considered to be more interesting to the user (Schneidermann, 1997)). A viable approach to a more timely reaction would be use of *navigation clues* that will direct users to an interconnection point (where change of environment *is* expected); navigation clues may appear when the system decides that the user's environment should be changed. In order to support either form of a more timely reaction, certain portions of adaptability mechanisms have to be executed at the client side, eliminating the requirement for creation and transmission of new content. The use of more sophisticated methods for item selection, with possible integration of AI techniques, is also an interesting research direction. Finally, the possibility of allowing multiple users to simultaneously enter a VR-mall and interact with each other while shopping will be investigated.

CONCLUSION

The architecture proposed in this article allows e-commerce sites to benefit from the advantages of adaptive and VR technologies, and simultaneously addresses a number of challenges usually associated with such systems. The proposed system incorporates modules that undertake user monitoring, deduction of preferences, selection of the most prominent items, and dynamic formulation of the VR-world, limiting the tasks that the e-commerce site stakeholders need to perform to content provision and the semantic tagging, which are performed via specifically crafted content management tools. Effectively, this architecture limits the cost and effort associated with the creation and operation of an adaptive VR-mall, opening up the potential to more e-commerce sites to offer their customers vivid, lifelike, and personalized experiences.

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KEY TERMS

Activity Recorder: Software that monitors important user activities within the virtual environment and records this information into a database for later perusal.

Adaptive VR-Mall System: An e-commerce site that offers an immersive or semi-immersive environment for e-shoppers to navigate in, and tailors the content delivered taking into account the individual e-shopper preferences and interests.

Digital Item Representations: Multimedia content related to the merchandise of the VR-mall, coupled with semantic information that describes and categorizes each item.

Interaction Methods: The ways that an e-shopper can manipulate items within the VR-mall. The interaction methods may vary, depending on the type of item representation (video, 3D model, photograph), the item semantics, and the preferences or expertise of the user.

Personalization Engine: A system component that exploits information regarding user activities to derive user preferences and interests, and to tailor the content to be delivered according to these.

Space Elements: Halls, corridors, shelves, and other items representing physical shopping mall components, which are used together with the multimedia representation of the merchandise to formulate the VR-mall worlds.

Virtual World Generator: A system component that uses space elements and digital item representations to dynamically create a virtual environment, which is sent to the user.

Application Service Providers

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INTRODUCTION

Technological changes within the last decade have dramatically changed the business climate. The use of Internet by firms has lead to global production, consumption, and competition. Electronic commerce, or e-commerce, "is a modern business methodology that addresses the needs of organizations, merchants, and consumers to cut costs while improving the quality of goods and services and increasing the speed of service delivery" (Kalakota & Whinston, 1996, p. 1). The benefits of e-commerce include cost savings, direct and quick interaction with the (potential) customer, competitive advantage through business intelligence, digital production sales and distribution, collaborative development with partners, new product development, direct sales, marketing and advertising, publicity, customer service and enhanced customer relationship, and communication.

Small businesses play an important role in the nation's economy. They are the fastest growing segment of all business types. The importance of small businesses to the U.S. economy can be gauged from the following statistics provided by U.S. Small Business Administration (SBA):

- Small businesses represent 99.7% of all employers, employ 50% of all private sector employees and account for 44.3% of total U.S. private payroll;
- Small businesses generate 60 to 80% of net new jobs annually; and
- Small businesses are employers of 39% of high-tech workers.

Researchers have argued that the use of Internet has created a level playing field whereby a small business can compete effectively against larger competitors. Studies have shown that larger firms have made significant progress in e-commerce. But, the same cannot be said of small businesses. In a 2001 report, SBA noted that less than 2% of Internet use is directed at e-commerce. The lack of progress in e-commerce adoption by small businesses has been cited in several studies (Mathiyalakan, 2002, 2004).

Small businesses face numerous e-commerce technology adoption barriers and as a result the pace of adoption has been slow. In addition to capital and access to latest technology, employees' knowledge, expertise, and experience is an important determinant of technology adoption (Kwon & Zmud, 1987; Rogers, 1983). To overcome the technological and skill limitations identified above, several strategic options are available for small businesses. These include the use of external consultants, outsourcing, and the use of ASP amongst others. The focus of this article is on examining issues related to the use of ASP by small businesses. This article is organized in terms of five sections. After this introduction, we provide a background to ASP. Thereafter, we identify and discuss issues that are pertinent to the use of ASP by small business. This is followed by a discussion on future trends and our concluding remarks.

BACKGROUND TO APPLICATION SERVICE PROVIDERS

The roots of ASP go back to the concept of "time sharing." A review of literature on ASP definition (see Table 1) indicates that there exists a multitude of definitions of ASP. Although all researchers agree that ASP provide software applications and services exist, a consensus does not exist on other key features of ASP. Although some have stressed that ASP is akin to a rental agency (ASPstreet.com, 2005; Bennett & Timbrell, 2000), others advocate a broader and management oriented role (Deloitte Research, 1999; Webopedia.com). A common theme across many of the definitions is the use of the Internet to distribute the software applications (ASPstreet.com, 2005; Bennett & Timbrell, 2000, p. 196; Brian, 2005; Kern et al., 2002) who reviewed other definitions of ASP in an attempt to distinguish them from outsourcing note "it is difficult to distinguish a modern ASP from the 1963 Payroll Bureau Service provided by Ross Perot's Electronic Data Systems to Frito Lay and Blue Cross."

The ASP uses the Internet to make applications available to firms. It is essentially delivers and manages the applications and services through the Internet and other networks. Examples of applications that can be used through ASP are payroll, travel and expense accounting, desktop productivity, messaging & collaboration services, information distribution, e-commerce, product configuration, sales force automation, manufacturing, logistics, and supply chain management.

Table 1. Definitions of ASP

Source	Definition
Benett and Timbrell (2000)	A form of selective outsourcing where a third-party organization rents generally available packaged software applications and related services.
Kern, Kreijger, Willcocks (2002)	These are service firms that provide on contractual basis, rental based or 'pay-as you-use' access to centrally managed applications made available to multiple users from a shared data center over the Internet or other networks.
Smith and Kumar (2004)	A single point of contact for all telecommunications, hardware, software, and consulting services necessary to deploy, run, and maintain hosted applications remotely.
ASPstreet.com	Offer individuals or enterprises access to software applications and related support services over the Internet.
Brian (2005)	Companies that supply software applications and /or software-related services over the Internet.
Deloitte Research	A service firm that deploys, hosts, and manages application solutions for rent to businesses residential customers.
Information Technology Association of America	An Application Service Provider, or ASP, is any company that delivers and manages applications and computer services to subscribers/clients remotely via the Internet or a private network.
Webopedia.com	A third-party entity that manages and distributes software-based services and solutions to customers across a wide area network from a central data center.

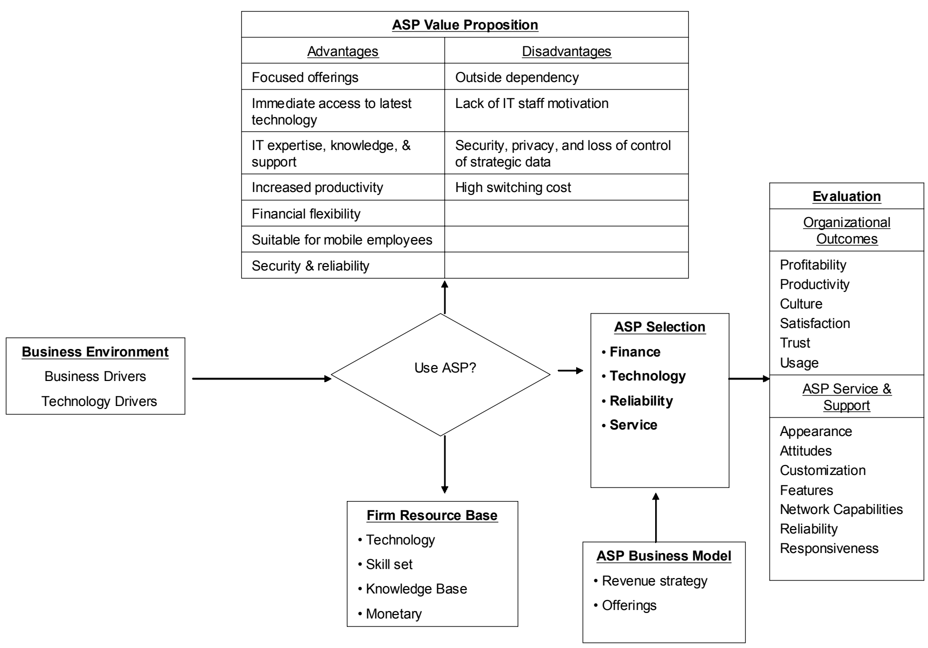
ISSUES IN THE USE OF ASP BY SMALL BUSINESS

In Figure 1, we present our framework. We use this framework to identify issues of concern to both academics and small business managers. The noteworthy features of our framework are: (a) drivers within the business environment that precipitate the need for the use of ASP, (b) firm resource base, (c) ASP value proposition, (d) ASP business model, (e) ASP selection, and (f) Organizational outcomes and ASP evaluation. Next, we discuss each of these issues in detail.

Drivers Present in the Business Environment

Rapid developments in the global marketplace, including technological advances, mushrooming consumer de-

Figure 1. Model for ASP selection, use, and evaluation



mands, new products, escalating globalization, and the implications of corporate reengineering and the restructuring, have fundamentally transformed the contemporary business climate. To compete in this changing business and technology environment, small businesses are constantly revising strategies to better manage their businesses. ASP are seen as a way for a small business to overcome its technology, knowledge, and monetary limitations and compete with much larger firms.

Firm Resource Base: Why Use ASP?

Larger businesses have a greater access to capital (money, material, employees, technology, and knowledge) and have greater freedom to engage in new technology adoption. Larger firms can easily overcome their technical expertise limitations by hiring additional staff, using consultants, or using third-party vendors. Small businesses are different from large businesses in many areas such as capital availability, access to capital markets, technical capabilities and availability of professionals. In small businesses, very few people or possibly an individual may function as the IT staff. Premkumar and Roberts (1999) asserted that firms without the required employee skills may not be aware of new technological innovations or may fear the risk associated with adoption of such technology within their organization.

Lack of access to education and training within small business may affect their willingness to adopt new technology (Fariselli, Oughton, Picory, & Sugden, 1999). Hiring suitably qualified personnel or motivating them to work within a small business setting may be a daunting task for a small business decision maker. For developing a home page or for other less knowledge and/or capital-intensive task, a small business may make use of off the shelf books, software, and tutorials. Small businesses with restricted technical expertise may require the use of external expertise or personnel in the form of consultants, vendor support, outsourcing, or the use of ASP.

ASP Value Proposition: Advantages and Disadvantages of Using ASP

Prior to using ASP, a small business decision maker who faces technical and skilled personnel limitations needs to decide on whether to use ASP to avail the opportunities in the marketplace. Both the advantages and disadvantages must be carefully considered and evaluated prior the decision on ASP use is made. The advantages of using ASP are as follows:

- ASPs are aimed primarily at small business (Paraskevas & Buhalis, 2002) and thus the ASP can have more focused offerings.
- A small business (or a startup) can have immediate access to the latest technology.
- A small business has the access to the same technology that their large counterparts have and thereby levels the playing field.
- ASP provides IT expertise and eliminates the need for a large and technically capable IT department to deal with support, maintenance, and upgrades.
- By using ASP, small businesses can focus on using the applications immediately to support their business activities and eliminate the learning curve and the time and cost associated with installing and managing applications. A small business does not have to expend time and money in software development and thereby the small business can increase its IT productivity.
- Rather than purchasing hardware and software, and acquiring relevant personnel (new or trained) which necessitates in capital outlay, small businesses can “rent” ASP and thereby decrease initial capital requirements, lower the total cost of ownership, and provide financial flexibility. Further, as managing and supporting the applications and services falls within the purview of the ASP, small businesses do not have to provide extensive IT staff training.
- ASP provides viable solutions for a small business with mobile and or distributed employees as the applications are hosted on remote servers.
- There is a reduced risk for technology obsolescence as small businesses are renting the applications.
- There is a greater provision of security and reliability.

The disadvantages of using ASP are as follows:

- By depending on outside parties, small businesses face the risk of high switching costs, access to organizational strategic asset by external parties, lack of security and privacy, and potential collapse or downfall of their ASP.
- By depending on external IT staff, small businesses face the risk of alienating internal IT personnel who may feel that they are relegated to performing routine mundane tasks with no avenue for career advancement or for learning new technology.
- A small business decision maker may fear that perhaps due to their lack of or limited IT knowledge ASP may pursue their own agenda (Yao, DeSouza, & Watson, 2004).

ASP Business Models

A business model specifies how a firm will generate money to sustain its operations and to generate the desired rate of return. Business models usually specify how the firm will generate revenue and the specific tactics it will use to operate within the industry. An ASP generates a revenue stream either through monthly fees or through per user fees. Based on target markets and products, ASP may be classified into Enterprise ASP, Local/ Regional ASP, Specialist ASP, Vertical Market ASP, and Volume Business ASP (ASPnews.com). Enterprise ASP deliver high-end business applications such as enterprise resource planning software, e-commerce applications and supply chain management applications. Local/Regional ASP supply wide variety of application services for smaller businesses in a local area. Specialist ASP provides applications for a specific need, such as Web site services, human resources, customer-relationship management software. Vertical Market ASP provides support to a specific industry, such as healthcare, finance etc. Volume Business ASP supply general small and medium-sized businesses with prepackaged application services in volume.

ASP Selection

It is important that ASPs are selected after a careful study of the needs and requirements and the capabilities. A small business decision maker must carefully consider issues related monetary, technological, reliability, and service during the section of the ASP. Focacci, Mockler, Gartenfeld, and Dologite (2003) provide 10 guidelines that can form the basis for ASP selection. These 10 guidelines deal with business strengths of the ASP, capabilities and certification of ASP personnel, architecture, data center and infrastructure analysis, recovery and backup plans, security, service and support, scalability, pricing, guarantees on system availability. Grover, Teng, and Cheon (1998) suggested that as ASP possess more technical knowledge than a typical small business manager they may play a dominant role during negotiations leading to a lower degree of control by the small business. Such a loss of control could result in incomplete or inflexible contracts (Kern et al., 2002). Yao et al. (2004) pointed out that such a lack of control could lead to ASP pursuing its own agenda.

Organizational Outcomes and ASP Evaluation

It is important that periodic evaluation be made both of the organizational outcomes and services and support provided by the ASP. Given the newness of the ASP concept, there exists a dearth of studies that have as their primary focus the evaluation of services and support provided by the ASP (Ma, Pearson, & Tadisina, 2005). There is also no agreement among researchers on the ways to define and operationalize quality (Reeves & Bednar, 1994). However, a good starting point is the study of Ma et al. (2005) who identified seven dimensions (features, availability, reliability, assurance, empathy, conformance, and security) for evaluating the service quality of ASP. Trust is also an issue that may affect ASP choice and usage (Seltsikas, Currie, & Tebbourne, 2002). The task of a small business decision maker is to ensure that the use of the ASP results in net positive outcomes. In addition to quantitative factors such as performance, productivity and usage, we argue that a small business decision maker must use nonquantifiable measures such as culture, satisfaction (with both the process and outcomes) and trust to assess the impact of the ASP.

FUTURE TRENDS

The research firm of IDC expects the ASP market to by 92% over the 5-year period 1999 to 2004 to an estimated $7.8B in 2004[1]. However, this forecast represents a drastic reduction from the earlier estimate of Gartner Research Group, who predicted that the market would be around $22B (Mears, 2003). While there are many different estimates on ASP spending, it should be noted that all of them have revised their estimate downward from the projections made in late 1990s.

A possible reason for the downward revision of ASP spending could be due to the crash of many dot-com firms in early 2000. In late 1990s, many firms entered the ASP market with a lot of fanfare and with the expectation that the premise behind their business model of customers renting software applications over the Internet would hold true. However, the collapse of the dot-com firms in part has lead to the demise of many ASP. Those that do remain can be considered as the survivors. This second generation ASP have altered their business model and have changed their tactics to provide more and high quality offerings and superior service.

CONCLUSION

Small businesses face resource limitations. Both academics and practitioners have suggested that ASP can be used to overcome financial and technical limitations experienced by small businesses. However, it should be noted that ASP should not be thought of as panacea for all the problems experienced by small businesses. A small business decision maker must carefully consider the value proposition offered by the ASP prior to engaging its services. Performance requirements must be carefully specified prior to the start of the contract and constant monitoring and evaluation is necessary. In this study, we presented a framework that may be of use to both academics and practitioners in identifying issues and considerations in use of ASP by small businesses.

There are several opportunities for additional research. It would be interesting to develop a profile of firms that use ASP and the applications they use. Information, education, training, and supplier incentives have a positive effect on adoption (Deeter-Schmelz, Bizzari, Graham, & Howdyshell, 2001) and thus studies should also focus on how the small business decision maker characteristics impacts ASP use.

Studies should focus on identifying ASP usage barriers. Mathiyalakan (2004) found that as the size of the firm increases, the knowledge about ASP also increases. But this knowledge does not get translated into use of ASP possibly suggesting the existence of barriers other than knowledge. There may be several reasons for the lack of use of ASP by small businesses (Mathiyalakan, 2004). First, a small business decision maker may be concerned with security, privacy, and loss of control associated with ASP usage. Second, a small business decision maker may fear that perhaps due to their lack of or limited IT knowledge, ASP may pursue their own agenda (Yao et al., 2004). Third, a small business decision maker may not believe in an ASP's value proposition as evidenced by Roberts (1998), who found that many small businesses have problems in using computers and translating IT investments into business value. Therefore, future research should focus on whether additional barriers to ASP usage exist and the ways to overcome such barriers. We also note that there is a need for research that is longitudinal in nature as technology adoption and implementation is often an ongoing process.

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KEY TERMS

Application Service Providers: "These are service firms that provide on contractual basis, rental based or 'pay-as you-use' access to centrally managed applications made available to multiple users from a shared data centre over the Internet or other networks" (Kern, Kreijger, & Willcocks, 2002, p. 154).

E-Commerce: "Is a modern business methodology that addresses the needs of organizations, merchants, and consumers to cut costs while improving the quality of goods and services and increasing the speed of service delivery" (Kalakota & Whinston, 1996, p. 1).

Enterprise ASP: Deliver high-end business applications such as enterprise resource planning software, e-commerce applications and supply chain management applications (Wainwright, 2001).

Local/Regional ASP: Supply wide variety of application services for smaller businesses in a local area (Wainwright, 2001).

Specialist ASP: Provides applications for a specific need, such as Web site services, human resources, and customer relationship management software (Wainwright, 2001).

Vertical Market ASP: Provides support to a specific industry, such as health care, finance, and so forth (Wainwright, 2001).

Volume Business ASP: Supply general small- and medium-sized businesses with prepackaged application services in volume (Wainwright, 2001).

ENDNOTE

[1] http://www.itaa.org/asp/about.htm

Auto-Personalization WAP Portal

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INTRODUCTION

WAP (wireless application protocol) has failed to take off exponentially as anticipated by industry players over the last few years with the slow acceptance by the consumers. The big players of WAP mobile phone manufacturers and mobile operators had over-hyped the advantages of using WAP to access the Internet ubiquitously. This had led to a mismatch in the consumers' expectations when they eventually realized that user experience in surfing the Internet with WAP phones was not what was perceived earlier. The perceived experience was equated with that of surfing the Internet with desktop personal computers, browsing Web sites with rich multimedia contents. The reality is, WAP phones have limited screen real estate, and these came with monochrome displays initially. Thus, WAP contents have to be specially coded to suit the small screens for browsing. WAP phones with color displays were only available in quantity and variety since late 2002. Much of the WAP content available has not yet redesigned to take advantage of the new color displays.

The attainable bandwidth for WAP surfing is only a small fraction when compared to broadband access. The bandwidth attainable by surfing WAP over GPRS (General Packet Radio Service, a 2.5-generation GSM packet data technology) is between 20 kbps to 40 kbps, whereas it is 256 kbps to 1,024 kbps for broadband. Prior to the availability of GPRS, WAP was carried over CSD (GSM Circuit Switch Data) and had an attainable bandwidth of merely 9.6 kbps. With these limiting factors, rich multimedia contents are simply not applicable to WAP at the moment (Gehlen & Bergs, 2004; Bai, Chou, Yen, & Lin, 2005). The limited screen real estate of WAP phones has also created navigation problems which involved many selections and too many moves between cards for consumers to achieve their goals. It was said that WAP is the "Wrong Approach to Portability," and it is a technology designed *by* techies *for* techies, without the best interests of the consumer at heart (George & Sarch, 2001). Others said that WAP's days were numbered and soon it would R.I.P. (rest in peace) (Saymour et al., 2001). It is certain that some amount of guidance is required for the less techie consumers during their initial encounters with WAP. Nevertheless, WAP is a good technology that allows one to access handy information in a timely fashion and ubiquitously. Like it or not, WAP will be around for some time, but much improvement is needed to make WAP surfing a less painful experience for consumers (Mahmoud, 2004; Sriskanthan, Meher, Ng, & Heng, 2004; Yeo, Hui, & Lee, 2004; Ma & Irvine, 2004; Radhamani & Siddiqi, 2004; Hung & Chang, 2005; Albastaki & Alajeeli, 2005; Gilbert & Han, 2005).

Mobile Internet browsing using WAP phones has created unique problems of its kind. One of the challenges that consumers faced is that they are only equipped with a small screen for browsing WAP contents. This makes navigating to WAP sites of interest on WAP portals a hassle. WAP portals served as consumers' gateway to the WAP sites offered by third-party content providers. These portals usually organize the list of WAP sites into a multilevel tree hierarchy structure. Consumers are required to navigate deep down the tree to access their favorite sites. This article proposes methods for making WAP portals adaptive. Such portals reduce time spent by consumers in navigation, hence there is more time for content browsing. The proposed methods do not require explicit consumers' input for adaptation, but rather they implicitly track consumers' navigation activities among WAP sites and use this input to form the basis of consumers' preferences for adaptation. The methods had also taken into account possible drift of consumers' interests over time, and weighted computation is used to achieve adaptation that will be of relevance to consumers at any point of time. Preliminary experiments with mobile users have yielded promising results.

DESCRIPTION OF THE SYSTEM

Personalization refers to the process of creating a customized consumer experience that is unique to each target consumer by making use of the preferences of these consumers as inputs to the process. Much research has been done in this area (Quah & Yong, 2002; Jelekaninen, 2004; Saleh, Avery, & Siddiqui, 2004; Wu, Chung, & Moonesinghe, 2004; Lin, Wang, & Liu, 2005; Yin & Leung, 2005; Ezeife & Lu, 2005; Tee, 2005; Ueno, Ishikawa, Suzuki, Sumino, & Takahashi, 2005) to devise methods that will be efficient in delivering the customized consumer experience.

In order to relieve consumers of the hassle of customization, an adaptive WAP portal is proposed. The adaptive WAP portal requires no explicit consumer input. Its adaptation is enabled by examining consumers' history of WAP site access. Adaptation is achieved by the following means:

- adaptive link sorting,
- adaptive recommendation, and
- navigation shortcuts.

Consumers' usage data or access history is acquired implicitly by tracking the WAP sites that are accessed during each WAP portal navigation session. The data collected for each access consists of consumer's mobile number, identification number of WAP site accessed, timestamp of access, session identification number, and optionally the duration of visit to the site (in minutes).

Information on the duration of visits to the sites is gathered from the WAP gateway of the mobile operator of the Adaptive WAP portal. It is the best node to retrieve such information since WAP gateway proxies all the requests from WAP phones to the WAP sites requested. The usage of "duration of visits" information is an optional feature, as in some implementation this information is difficult to retrieve. Commercially deployed WAP gateways usually store logs of the WAP sites that were accessed by consumers for charging purposes. In system implementations with the absence of the "duration of visits" information, the number of hits to WAP sites is used. The rationale of using "duration of visits" information is to produce adaptations that closely reflect consumers' WAP browsing behaviors. WAP sites where consumers' frequently spent more time browsing should be made easily for the consumer to revisit in the future.

Preferences or interests of consumers can be inferred over time, based on the collected usage data that will be used to adapt consumers' WAP surfing experiences. Consumers' interests tend to drift over time. This behavior has been taken into account in the proposed adaptation methods by introducing temporal weights which influence the relevance of a site accessed in the past. What this essentially means is that a site accessed in the past has less influence in the adaptation as compared to those sites that were accessed recently.

Temporal weights are calculated with respect to each of the past WAP portal navigation sessions. The adaptation methods will take into consideration usage data of a target consumer for the last N sessions, where N is predefined by the mobile operator of the adaptive WAP portal. Having identified the last N sessions used for adaptation, the proposed methods will calculate the temporal weights of each of these sessions using Equation 1:

$$W_S = \frac{1 + Timegap_{oldest} - Timegap_s}{Timegap_{oldest}}$$

(Equation 1)

Adaptive Link Sorting

This method reorganizes the tree structure by sorting the links according to individual consumer's past accesses to these links. Specifically, the method will enable links in a category that are accessed by a consumer to be sorted based on the consumer's preference model that was generated using usage data in the past sessions. The original order of the links within the category accessed is overridden. The motivation behind adaptive link sorting is to reduce the number of scrolling (upwards and downwards directions) that is needed on the limited screen real estate of WAP phones. These phones typically can only display three to four lines of text within the display area of the screen.

The algorithm will use the target consumer's usage data (similar to that of Figure 2) of the last N sessions for computing the access scores of each link.

The algorithm used by the method is presented as follows.

Let ***L ε {links in category X}*** where X is the category that is accessed by a target consumer and the links in this category are to be re-sorted. The algorithm will use the target consumer's usage data (similar to that of Figure 2) of the last N sessions for computing the access scores of each link L denoted by $\mathbf{Score_L}$.

Let ***S ε {last N sessions}***. N is a configurable input parameter to the algorithm that is decided by the mobile operator of the WAP portal.

For each ***L ε {links in category X}***, the respective access scores will be computed using Equation 2:

$$\mathbf{Score_L} = \sum_{S=1}^{N} W_S \cdot A_{LS}$$

(Equation 2)

$\mathbf{W_S}$ denotes the temporal weights as presented in Equation 1.

$\mathbf{A_{LS}}$ denotes the total duration of visits to link L in the S^{th} session. In implementations where information on duration of visits is not available, $\mathbf{A_{LS}}$ will then denote the total number of access (i.e., clicks) to link L in the S^{th} session.

Upon computing the access scores, $\mathbf{Score}_L$ for each ***L ε {links in category X}*** over the span of the last N sessions, the links in category **X** will then be sorted according to these scores in descending order.

Adaptive Recommendation

This method generates an adapted list of recommended WAP sites that are popularly accessed by target consumers. Content-based filtering technique is the recommendation mechanism implemented which uses the target consumer's usage data of WAP sites that were accessed in the past as the basis for making recommendations for similar sites.

The algorithm will then compute the access scores to these categories in the last N sessions using the target consumer's usage data. The access scores of the predefined categories are computed by taking into account the past accesses to the WAP sites that are the descendants to these recommended categories.

The algorithm used by the method is presented as follows:

Let ***C ε {predefined recommended categories}***. The algorithm will then compute the access scores to these categories denoted by $\mathbf{Score}_C$ in the last N sessions using the target consumer's usage data. The access scores of the predefined categories are computed by taking into account the past accesses to the WAP sites that are the descendants to these recommended categories.

Let ***S ε {last N sessions}***. N is a configurable input parameter to the algorithm that is decided by the mobile operator of the WAP portal.

For each ***C ε {predefined recommended categories}***, the respective access scores will be computed by using Equation 3:

$$\mathbf{Score}_C = \sum_{S=1}^{N} W_S \cdot A_{CS}$$

(Equation 3)

$\mathbf{W}_S$ denotes the temporal weights as presented in Equation 1, which yields weights that favor descendant sites of the predefined recommended category C that are accessed in the last N sessions. This will help to capture the consumer's drift of interest over time and used it as the basis to recommend undiscovered WAP sites of the same genre.

$\mathbf{A}_{CS}$ denotes the total duration of visits to descendant WAP sites of the predefined recommended category C in the S^{th} session. In implementations where information on duration of visits is not available, $\mathbf{A}_{CS}$ will then denote the total number of access (i.e., clicks) to the descendant WAP sites of the predefined recommended category C in the S^{th} session.

Apart from specifying the predefined recommended categories, mobile operators will also need to define the maximum number of link recommendations to be generated by the algorithm. Let **M** denote the maximum number of WAP site recommendations to be made. This list is a mixture of sites that are the descendants of each of the predefined recommended categories. Prior to the generation of this list, the algorithm will move on to compute the number of WAP sites that are to be recommended from each of the predefined recommended categories.

Thus, for each ***C ε {predefined recommended categories}***, the number of links to be recommended denoted by $\mathbf{TotalLinks}_C$ will be computed as follows (Equation 4):

$$\mathbf{TotalLinks}_C = \left\lceil \frac{Score_c \times M}{TotalScore} \right\rceil$$

(Equation 4)

TotalScore denotes the sum of all access scores, $\mathbf{Score}_C$ for all the recommended categories. With the $\mathbf{TotalLinks}_C$ computed for each ***C ε {predefined recommended categories}***, the list of WAP sites will be generated accordingly to form the recommendation list. The decision on which WAP sites to recommend within a predefined recommended category is bases on their age since launch (newest descendant sites in that category will be recommended). Recommended sites are picked from those that have yet to be discovered by the target consumer.

Navigation Shortcuts

This method produces shortcuts to WAP sites that are frequently accessed by a target consumer. These shortcuts are placed at the very top level of the WAP portal. The motivation behind *navigation shortcuts* is to reduce the number of click-throughs needed for consumers to access their favorite WAP sites. WAP surfing is usually goal oriented. That is to say, most of the time consumers who surf WAP wish to accomplish certain tasks such as reading e-mails, viewing the latest stock prices, weather and traffic condition updates, and so forth. These tasks are usually executed repeatedly over time, thus it makes sense to provide *navigation shortcuts* to these frequently visited WAP sites upfront.

The algorithm used by the method is presented as follows:

Let ***L ε {Distinct sites accessed by target consumer}***. The algorithm will use the target consumer's usage data of the last N sessions to compute the access scores of each L denoted by $\mathbf{Score}_L$.

Let $S \in$ ***{last N sessions}***. N is a configurable input parameter to the algorithm which is decided by the mobile operator of the WAP portal.

For each $L \in$ ***{Distinct sites accessed by target consumer}***, the respective access scores will be computed using Equation 5:

$$\textbf{Score}_L = \sum_{S=1}^{N} W_S \cdot A_{LS}$$

(Equation 5)

$\mathbf{W_S}$ denotes the temporal weights as presented in Equation 1, which yields weights that help to reduce the influence of sites that were accessed in the past compared to the present accesses.

$\mathbf{A_{LS}}$ denotes the total duration of visits to a site L for the S^{th} session. In implementations where information on duration of visits is not available, $\mathbf{A_{LS}}$ will then denote the total number of accesses (i.e., clicks) to the site L for the S^{th} session.

Upon computing the access scores, $\mathbf{Score_L}$ for each $L \in$ ***{Distinct sites accessed by target consumer}*** over the span of the last N sessions, the *navigation shortcuts* will be generated, with these sites sorted according to their respective scores in descending order. The number of such shortcuts to be generated is a configurable input to the algorithm. This is decided by the mobile operator of the WAP portal.

IMPACT OF APPLICATION ON MOBILE USERS

It was discussed in the previous sections that temporal weights $\mathbf{W_S}$ reduces the relevance of sites accessed in the past and focuses on recently accessed sites. Therefore, it is important that the algorithm deployed by the proposed methods will not overreact to consumers' usage data of WAP sites in the recent past. Various ways could be implemented to maintain the stability and adequate sensitivity of the proposed methods.

The variable **A** in Equations 2, 3, and 5 are calculated by summing up the duration of visits to WAP sites for past sessions of interest. This approach takes into consideration the time spent by the consumers equating to their level of interests in these sites. In addition, it is more accurate than the approach where the number of clicks made to access these WAP sites for the past sessions of interest are used in computation (i.e., the number of times a WAP site is accessed in a single session). This is to prevent an excessive number of unintended clicks to WAP sites that would affect the computation of the proposed methods thereby generating inaccurate adaptations.

A series of experiments was conducted with five consumers over a one-week period to evaluate the effectiveness of all the proposed adaptation methods implemented in the IntelliPortal prototype. These consumers are familiar with WAP and have been using WAP for more than a year. The experiments effectively demonstrated the following adaptive features of the prototype:

- Creation of *navigation shortcuts* containing a list of WAP sites that were frequently accessed by the consumers.
- Recommendation of WAP sites of similar genre to those that were accessed by the consumers in the past.
- Reordering of the links on the directory pages such that these links are presented in decreasing order of frequency-of-access.

RESULTS

The objective of the navigation shortcut experiment was to measure the reduction in the click distance with the use of *navigation shortcuts*. Five consumers were asked to access IntelliPortal over a period of one week to build up their respective list of *navigation shortcuts*. The click distance to consumers' favorite WAP sites using *navigation shortcuts* is always "1" since the shortcuts are located upfront under the homepage of IntelliPortal.

An analysis of the *navigation shortcuts* experiment is shown in Table 1. The savings in terms of total click distance reduction with the use of *navigation shortcuts* were computed. Total click distance refers to the number of clicks between menu pages that are needed to navigate to all the consumers' favorite WAP sites via the IntelliPortal. It was shown that consumers were able to save an average of 53.95% on the total click distance. Thus, with the significant amount of navigation time saved (as a result of click distance savings), consumers were able to spend more time browsing the actual contents found on their favorite WAP sites.

The objective of the *adaptive recommendation* experiment was to measure the effectiveness of the adaptive recommendations made to the same group of five consumers. The effectiveness of adaptive recommendation was measured by tracking the number of recommended WAP sites that were visited by these consumers. The recommended WAP sites for the consumers were similar to those that were accessed in the past. An analysis of the *adaptive recommendation* experiment is shown in Table 2. The total number of recommended WAP sites varied between each consumer since these were made based on their respective access history. "Total Visited" accounted for the number of recommended WAP sites that were repeatedly visited (more than three repeated visits within

Table 1. An analysis of navigation shortcuts experiment

	Consumer A	Consumer B	Consumer C	Consumer D	Consumer E	Average
Total Click Distance (without shortcuts)	14	15	15	17	15	15.2
Total Click Distance (with shortcuts)	7	7	6	8	7	7
% Savings	50%	53.33%	60%	47.06%	52.94%	53.95%

Table 2. An analysis of the adaptive recommendation experiment

	Consumer A	Consumer B	Consumer C	Consumer D	Consumer E	Average
Total Recommended WAP Sites	8	8	3	8	7	6.8
Total Visited	5	4	2	3	4	3.6
% Effectiveness of Recommendation	62.5%	50%	66.67%	37.5%	57.14%	54.76%

Table 3. An analysis of the adaptive link sorting experiment

	Consumer A	Consumer B	Consumer C	Consumer D	Consumer E	Average
No. of Scrolling Before Re-sorting	22	11	13	19	15	16
No. of Scrolling After Re-sorting	6	2	2	4	4	3.6
% Reduction of Scrolling	72.73%	81.82%	84.62%	78.95%	73.33%	77.5%

the one-week experiment period) by these consumers upon recommendation.

The effectiveness of *adaptive recommendation* made for each consumer was computed. It was shown that an average of 54.76% of the recommended WAP sites were repeatedly visited by the consumers upon recommendation. The result is encouraging, as it showed that *adaptive recommendation* is an effective avenue for mobile operators to expose yet-to-be-discovered WAP sites that could be of interest to the consumers, thereby increasing the latter's usage.

The objective of the *adaptive link sorting* experiment was to measure the effectiveness of the *adaptive link sorting* made to the same group of five consumers. Five WAP links were tracked for each consumer and the number of *downward scrolling* that was needed to access these links before and after *adaptive link sorting* was recorded. Downward scrolling refers to the action of pressing a scroll key to move the cursor downwards to highlight the desired WAP link on the microbrowser. For example, a total of three downward scrollings are needed to highlight the WAP link "Digital Look." The first link of any menu page is usually highlighted by the microbrowser. The effectiveness of *adaptive link sorting* was measured by computing the percentage of reduction in the number of downward scrollings needed before and after the re-sorting. An analysis of the *adaptive link sorting* experiment is shown in Table 3.

It was shown that with *adaptive link sorting*, consumers were able to reduce the number of downward scrollings by an average of 77.5%. This was a significant reduction, as the WAP links accessed by these consumers were made more accessible to them. Thus, the amount of time saved could be well spent in content browsing.

CONCLUSION

The previous chapters have presented methods that were designed to make WAP portals more usable for consumers. Mobile phones are deemed to be of relatively small size to ensure consumers' convenience in carrying these devices everywhere they go. It is unlikely that screens of these phones will get larger in the future, while still keeping the phones pocket size; further, navigation within the WAP portal will continue to be a pain for consumers if these portals are to remain as they are today.

Therefore, it is critical that these portals should adapt to the changing needs of the consumers without requiring them to state their preferences explicitly. By doing so, the WAP surfing experience will be significantly improved. This has been shown with the experimental evaluation of the proposed adaptive methods implemented on the prototype. Adaptive link sorting was able to reduce an average of 77.5% of downward scrollings. Adaptive recommendation was able to encourage repeated visits to an average of 41.18% of the recommended WAP sites. Navigation shortcuts provided an average of 54.55% savings in the total click distance needed to access consumers' favorite WAP sites.

With the encouraging results shown in the evaluation, it is hopeful that new consumers' take-up rate for WAP services will improve and encourage multiple repeated visits. Financially, this means that mobile operators of adaptive WAP portals will benefit with the increase of ARPU (average revenue per consumer) and reduce the chance of consumer churn by building consumer loyalty.

The proposed adaptive recommendation method uses content-based filtering as the recommendation mechanism. It would be interesting to make recommendations based on a collaborative filtering technique where consumers could be asked to rate the WAP sites that they had visited. Consumers could be grouped and WAP sites recommended based on the similarity in the ratings.

Current WAP portals organized WAP sites in multilevel hierarchical tree structures as discussed in this article. Apart from the adaptive methods proposed in this research project, research work could be carried out to explore new grounds to break the hierarchical organization of these WAP sites with some innovative methods, where relevant content information from certain WAP sites could be presented to consumers up front without having them to navigate to these sites.

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KEY TERMS

Access History: Navigation path taken by a user as he/she surfs a WAP site.

Access Link: Web page address used for navigation purposes.

Auto-Personalization: Self-adaptive features of WAP applications.

Link Sorting: Reordering the pointers to various WAP pages.

Navigation: Movement from WAP page to WAP page (surfing).

Portal: The entry-node of the navigation semantic units of a WAP site.

Shortcuts: Direct access mechanism for accessing a particular WAP page.

Category: Applications of E-Technologies

Auto-Personalization Web Pages

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INTRODUCTION

This project experiments with the designing of a Web site that has the self-adaptive feature of generating and adapting the site contents dynamically to match visitors' tastes based on their activities on the site. No explicit inputs are required from visitors. Instead a visitor's clickstream on the site will be implicitly monitored, logged, and analyzed. Based on the information gathered, the Web site would then generate Web contents that contain items that have certain relatedness to items that were previously browsed by the visitor. The relatedness rules will have multidimensional aspects in order to produce cross-mapping between items.

The Internet has become a place where a vast amount of information can be deposited and also retrieved by hundreds of millions of people scattered around the globe. With such an ability to reach out to this large pool of people, we have seen the expulsion of companies plunging into conducting business over the Internet (e-commerce). This has made the competition for consumers' dollars fiercely stiff. It is now insufficient to just place information of products onto the Internet and expect customers to browse through the Web pages. Instead, e-commerce Web site designing is undergoing a significant revolution. It has become an important strategy to design Web sites that are able to generate contents that are matched to the customer's taste or preference. In fact a survey done in 1998 (GVU, 1998) shows that around 23% of online shoppers actually reported a dissatisfying experience with Web sites that are confusing or disorganized. Personalization features on the Web would likely reverse this dissatisfaction and increase the likelihood of attracting and retaining visitors.

Having personalization or an adaptive site can bring the following benefits:

1. Attract and maintain visitors with adaptive contents that are tailored to their taste.
2. Target Web contents correspondingly to their respective audience, thus reducing information that is of no interest to the audience.
3. Advertise and promote products through marketing campaigns targeting the correct audience.
4. Enable the site to intelligently direct information to a selective or respective audience.

Currently, most Web personalization or adaptive features employ data mining or collaborative filtering techniques (Herlocker, Konstan, Borchers, & Riedl, 1999; Mobasher, Cooley, & Srivastava, 1999; Mobasher, Jain, Han, & Srivastava, 1997; Spiliopoulou, Faulstich, & Winkler, 1999) which often use past historical (static) data (e.g., previous purchases or server logs). The deployment of data mining often involves significant resources (large storage space and computing power) and complicated rules or algorithms. A vast amount of data is required in order to be able to form recommendations that made sense and are meaningful in general (Claypool et al., 1999; Basu, Hirsh, & Cohen, 1998).

While the main idea of Web personalization is to increase the 'stickiness' of a portal, with the proven presumption that the number of times a shopper returns to a shop has a direct relationship to the likelihood of resulting in business transactions, the method of achieving the goal varies. The methods range from user clustering and time framed navigation sessions analysis (Kim et al., 2005; Wang & Shao, 2004), analyzing relationship between customers and products (Wang, Chuang, Hsu, & Keh, 2004), performing collaborative filtering and data mining on transaction data (Cho & Kim, 2002, 2004; Uchyigit & Clark, 2002; Jung, Jung, & Lee, 2003), deploying statistical methods for finding relationships (Kim & Yum, 2005), and performing recommendations bases on similarity with known user groups (Yu, Liu, & Li, 2005), to tracking shopping behavior over time as well as over the taxonomy of products. Our implementation works on the premise that each user has his own preferences and needs, and these interests drift over time (Cho, Cho, & Kim, 2005). Therefore, besides identifying users' needs, the system should also be sensitive to changes in tastes. Finally, a truly useful system should not only be recommending items in which a user had shown interest, but also related items that may be of relevance to the user (e.g., buying a pet => recommend some suitable pet foods for the pet, as well as suggesting some accessories that may be useful, such as fur brush, nail clipper, etc.). In this aspect, we borrow the concept of 'category management' use in the retailing industry to perform classification as well as linking the categories using shared characteristics. These linkages provide the bridge for cross-category recommendations.

DESCRIPTION OF SYSTEM

In this article, we seek to provide an adaptive feature using a fast and cost-effective means. The aim is to provide adaptiveness in the sense that when a visitor selects the next link or a new page, the contents of the page generated will have relatedness to previous pages' contents. This adaptive feature will be immediate and will not experience delay or repetitive computational filtering problems, as compared to using mining or collaborative filtering (Claypool et al., 1999; Basu et al., 1998).

The rules-based technique offers an excellent and flexible mechanism to specify rules that map categories that exhibit relatedness among themselves (IBM, 2000). Adding new product lines is simple, by just adding new sets of rules to map the new products accordingly. For direct item-to-item relatedness mapping, it is not so scalable and feasible to implement through use of the rules-based technique. Instead we will use content-based filtering for generating direct item-to-item mappings. The content-based technique (Claypool et al., 1999; Basu et al., 1998) allows item-to-item mapping to be implemented in a scalable manner by just defining the item's attribute, and the recommendation engine will automatically generate or match items of same attribute without involving user efforts (Basu et al., 1998).

In order to facilitate the deployment of these recommendation techniques, the Web domain is structured into their respective categories that exhibit relatedness among them. For example, pet dog would have relatedness to books on dogs. Each of the categories is given a unique ID value. The relatedness rules make use of these IDs to generate recommendations. The Web site domain is structured into supernodes (SA, SB…) which branch into child nodes (A1,A2…An;…K1,K2…Kn). These supernodes are a representation of products on the Web site, and the child nodes are used to represent the breakdown of the products into categories. Below each of the child nodes are the sub-child nodes (Aa1,…Axm,…Ka1,Ka2,…Kxm) that represent the items. Each of the child nodes (A1,A2…An;…K1,K2…Kn) is identified with its corresponding ID value. With this structure, rules-based mapping can be easily identified and applied among the child nodes by defining the IDs that will result into a recommended page.

The syntax of a relatedness rule is:

IDa:IDb:…=>Target page

The entries IDx represent the IDs of Web pages that have relatedness and thus can be mapped directly to the Web page (link) identified as target page. A rule is considered matched when any of the Web page IDs in the rule is also found to exist in the selector's list (visitor's profile). The selector's list is compared against all the rules in the rule file. Only one of the rules will be used, and that is the rule that has the most number of IDx elements matching the selector's list. In the event of tie, the rule which matches with selector entry that carries the higher points will be used, or if they still tie, then precedence of rule entry in the rule file will be used to determine the final rule to use.

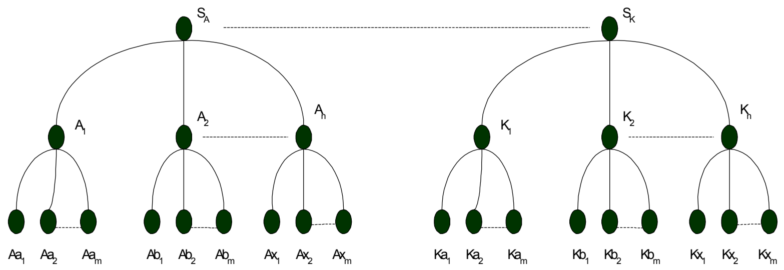
Mappings across sub-child nodes are done based on their attributes (content based). A file will be used to define the list of items (or contents) of each Web page (at category level) and also any of attributes for each of the items. The syntax for this item list file is:

Idxa:idxb:…:attra:attrb=>display.html

The entries idxx are indexes to the html page that contains all the information regarding the item. An example of these indexes could be the type of pet. The information about each type of pet is found in the corresponding html file. An item sorter engine will, at startup, sort out the indexes and their corresponding html files. This will allow the page contents to be arranged or displayed based on any of these indexes. The other set of entries attrx define the attributes of the item. When the visitor selects any of the items for browsing, the corresponding attrx will be tracked. Whenever the visitor browses a new page, the recommendation engine will check for items that have the same attrx and automatically include the corresponding html file for display (see Figure 1).

Our prototype system also incorporates means of generating a dynamic profile that changes as the visitor browses through the Web site. Implicit tracking does not require any explicit inputs or intervention by the visitor. Conventionally this is done either through use of user authorization, hidden form fields, URL rewriting, or cookies (Hunter et al., 2002). Although cookies offer an elegant

Figure 1. Web domain structure



solution to the stateless HTTP protocol when compared to the other three, it is also frowned upon by some visitors and as such are disabled (Mobasher et al., 1999; Cooley, Mobasher, & Srivastava, 1999). Instead, the tracking of visitors' activities is implemented through use of a session object on the server side (Hunter et al., 2002). This object will be used to record all the Web pages (tagged with IDs on the server side) browsed by the visitor during the current session, hence obtaining the profile of the visitor. However, a cookies mechanism is still implemented to provide the "remember" feature, in the sense that if the cookies feature is enabled on the visitor's browser, the activities on the Web site from the most recent visit will be available (and retrieved) during the next visit. This allows the system to build the visitor's profile immediately. Hence we are able to combine the static profiling (from cookies) with the dynamic one (tracked by session object) to build a profile that can "remember" a visitor's previous preferences and dynamically change itself as the visitor continues browsing the Web site.

In order to give priority to activities that occur more often and recent, a point system is used whereby the current session log is given heavier weight than those retrieved from the cookies so that the current activities will be more likely to be nominated into the visitor's latest profile. The activities log tracked by the session object will be given higher consideration during profiling in order for the system adaptiveness to be reflected accordingly and immediately to the changes in the visitor browsing behavior. In this design, a total of three activities logs are used (two from cookies if available, and the remaining one is from the current session object that tracks the current activities).

In order to demonstrate the adaptiveness feature, the Web site domain should consist items or products that have the following characteristics:

1. Products that can be easily categorized.
2. Selection of items or products should be able to reflect the taste or preference of visitor.
3. Certain form of relatedness between the products.

With the above considerations taken into the account, we implemented a Web portal using an online shop named My-Pet that sells the following products:

1. Pets
2. Books on pets
3. Accessories for pets
4. Food for pets

To demonstrate how the system functions, we selected the following list of categories:

Pets:	Bird, Dog, Cat, Hamster, Fish
Books:	How to care…, Diseases of…, Nutrition for …
Accessories:	Pet wears, Toys, Restraints
Foods:	Meals, Snacks, Supplements

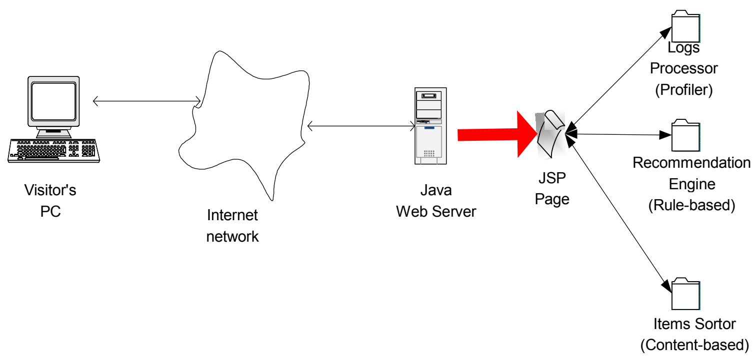
The My-Pet recommendation engine is based on the relatedness determination among its products. The relatedness determination for My-Pet is defined at three levels:

1. Relatedness between categories across products (e.g., pet dog and dog food and books on dogs);
2. Relatedness between categories in the same product (e.g., books on how to care for dogs and books on diseases of dogs and books on nutrition for healthy dogs); and
3. Relatedness at items level across products (e.g., food and accessory items from the same company/brand).

Items (1) and (2) are achieved based on the rules-base technique, while content-based filtering is used for item (3).

The server software architecture is decomposed into independent modules that have very similar structure. Each product has its own module that is responsible for presenting and generating its dynamic Web page con-

Figure 2. Software architecture



tents. The development platform chosen is Java Server Pages (JSP), which offers object-oriented components deployment. By developing the whole Web program in JSP and Java, the server program is OS-platform independent.

Each module is made up of the following components:

- JSP Page
- Logs Processor (JavaBean)
- Recommendation Engine (JavaBean)
- Item Sorter (JavaBean)

The JSP page is responsible for delegating the tasks to the respective components, and at the end presenting the results into HTML format for viewing by the visitor.

The Logs Processor component serves to log all the activities by the visitor and process the activities logs before submitting to the Recommendation Engine. It plays the role of profiling the visitor's activities. The Recommendation Engine is mainly used for determining product-to-product mapping based on the selector's list (profile) generated by the Logs Processor. The Items Sorter's main function is to read the list of product items and sort them such that they can be retrieved via means of indexing or key. This component is also used to retrieve an item attribute that is used for Content-Based filtering, based on the input determined by the Logs Processor component (see Figure 2).

IMPACT OF SYSTEM

The prototype system is implemented using a Java Server from JRUN which provides the container for running JSP and JavaBeans classes. The database stores all external data inputs. The Web server PC is installed with JRUN and the Web application. Customers can access the Web site using any Web browser.

To illustrate the effectiveness of this system in providing dynamic content generation, a series of user inputs and the subsequent system responses are tabulated.

From the trial run results obtained, it was observed that the system behaved as expected, providing the adaptive feature of generating Web contents based on users' activities on the Web site (see Table 1).Browsing Activities Web Content Generated

The system is able to demonstrate the following adaptiveness features:

Table 1. Results obtained from trial runs

Browsing Activities	Web Content Generated
Customer initially selects Dog category under the Pet section and chooses from the choice of displaying dogs based on the friendliness/loyalty. The customer then chooses Cat category under Pet section.	The system automatically displays the choices of cats for selection. The cats are displayed based on the degree of friendliness/loyalty to owners.
In continuation from above, the customer then selects the choice of displaying Cats based on feeding habits. User then re-selects the Dog category.	The system automatically switches from presenting cats to presenting dogs based on their feeding habits.
Customer selects Dog category under the Pet section. Customer then chooses Book product.	The system automatically presents books that are related to dogs.
Customer selects Supplements category under Food section. Visitor then selects Petsfriend (from the list of brands) and clicks the item "Best Choice Dog Cookies". Customer then chooses Book product.	The system automatically brings the customer to Nutrition category under the Book section and also displays the option for viewing book titles related to dog nutrition from Petsfriend.
Customer selects Dog category under Accessories product and then chooses Dog category under Books as well. Customer subsequently closes the browser before restarting again to browse the Web site again, but this time around selecting the Food product instead.	The system automatically forwards the visitor to the Dog category when the Food product was selected in this new browsing session.

1. the ability to automatically present the choice of viewing items in a page (e.g., what type of pets) based on visitor's previous preference;
2. the ability to automatically present Web contents that display the category that exhibits relatedness (as defined in Rule Files) to other products' categories browsed by the visitor previously;
3. the ability to generate an option to view list of items that has relatedness to other items that the visitor has visited or selected; and
4. the ability to generate a recommendation based on cookies retrieved from the visitor's PC.

CONCLUSION

We have developed a system that can adapt its Web contents based on visitors' activities on the Web site through combining rule-based with content-based filtering techniques—resulting in an implementation that is both flexible and can rapidly adjust its recommendations. Rule-based structure offers cross-product mapping. Content-based filtering takes the items' attributes into account when generating recommendations. The system transparently and seamlessly tracks the visitor on the server side and does not require explicit inputs (ratings or purchases or login account) to determine the visitor's profile dynamically.

My-Pet's system design utilizes the concept of category management, which is widely practiced in brick-and-mortar shop fronts and maps product taxonomy into a cyberspace virtual environment. The key to using category management is that it makes system expansion systematic and easy. In our illustration, we included a handful of products and categories. However, the system architecture provides a structure that allows more products or categories to be added easily. Sub-categories can also be added as long as each of them is given a unique ID page. A new set of relatedness rules can then be defined for these newly added elements. This is in fact a strength of rule-based implementation, where new linkages between product categories and subcategories can be added and removed as need arises. Rules may also carry different precedence values.

Such a highly adaptive system does have a weakness—it has taken away some navigation control from the user. It was noted in a 1998 survey (GVU, 1998) that 17% of Web users experience difficulty in returning to pages visited before. A system with an auto-recommendation feature is likely to fair worse in this aspect. Therefore, for future improvement to the system, a feature could be added to the system whereby a link page is created and this page contains all links to pages that were previously browsed by the user.

In addition, a search option can also be included. This search option indirectly provides a way for the visitor to tell the system his/her taste or preference. This serves as an excellent and accurate input in building a profile that even more closely reflects the visitor's preferences. Hence the system will be able to use a more accurate visitor's profile when generating recommendations.

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KEY TERMS

Category Management: Classify and manage items based on some predetermined categories.

Clickstream: A sequence of mouse clicks.

Collaborative Filtering: Unveiling general patterns through "sniffing" through user's past activities.

Personalization: Customization to individual user's preferences and needs.

Portal: The entry node/point of navigation semantic unit for a Web site.

Profiling: Capturing individual user's interests and needs.

Self-Adaptive: Ability of a Web portal to automatically adjust its presentations to perceived user's preferences.

Session Object: Information items that capture characteristics and activities of a user during a Web session.

B2B E-Business

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INTRODUCTION

Every organization can be viewed from two perspectives. There are external processes such as procurement and sales, and internal processes such as management and operations, finance, marketing, and human resources.

This article primarily focuses on external, commercial e-business processes. B2B (business-to-business) e-business is the sale of products or services, or information exchange, among two or more businesses through electronic technology, usually involving the Internet, through a public or private exchange. The following background section gives a very brief general overview of B2B e-business history. In the main thrust of this article, we discuss making the B2B decision by examining key B2B business requirements and benefits, as well as describing basic approaches to B2B e-business implementation. In the subsequent section, the article provides a future outlook for e-business.

BACKGROUND

During the technological explosion of the late 1990s, virtually every company in the world was talking about B2B. The concept was sound and the possibilities were endless, so many companies rushed into implementing something, anything that would make them part of this new business revolution. As often happens when concepts are implemented, many unforeseen problems arise during the early stages of their application. Although the development of B2B e-business has provided opportunities for organizations to improve their purchasing systems and so enhance performance and profitability, it is not the magic solution once believed, but rather just another useful business tool when implemented under the right circumstances.

Despite the burst of the dot.com bubble and the global recession, online B2B trading exchanges continue to expand. Online B2B e-marketplaces have remained resilient by providing valuable advantages over off-line transactions, including lower costs for buyers, greater access to customers for suppliers, and increased transparency throughout the supply chain for all participants (Krell, 2002). For example, members of the WorldWide Retail Exchange, an online B2B exchange, have saved over $1 billion since 2000 when the exchange was founded ("Survey," 2004).

Internet-based B2B e-business tools help companies master a multitude of objectives, ranging from reducing raw material, process, and transaction costs as well as cycle times, error rates, and inventory, and it improves transparency (Hartman, Salehi, & Vallerien, 2003).

In 2001, B2B e-business represented about one third of all e-business volume on the Internet, but it was expected to grow at an accelerated rate and eventually become the largest segment of e-business.

MAIN THRUST OF THE ARTICLE

Before the appropriate B2B e-business implementation approach can be determined, a company needs to identify key business requirements and benefits. Once this has been established, the company can then choose from various implementation approaches the one that fits the determined requirements and benefits. The B2B implementation approaches discussed in this article have been derived from researching thoroughly company experiences as well as theoretical studies. Based on these experiences and studies, the ways companies have targeted their B2B implementation endeavors can be grouped into four basic approaches, which will be discussed later in this section.

Identifying Key Business Requirements and Benefits

Planning is the first step to the successful application of any e-business strategy. A company needs to identify key or core business processes in its specific company situation, and the benefits to be derived from e-business B2B applications within these key processes. A well-designed B2B e-business system can be extremely valuable in achieving basic strategic management objectives in many different areas of profit-generating enterprises including increasing efficiency and reducing costs, improving management control, and expanding revenues.

Improve Purchasing Efficiency and Reduce Procurement Costs

This was initially and continues to be a major application area for B2B. Procurement in its conventional form is a costly, labor-intensive, paper-based process. Purchasing personnel often complain that a high percentage of their time is spent on non-value-added activities such as data entry, correcting paperwork errors, expediting delivery, or solving quality problems. Managing supply chains through public or private online B2B exchanges enables companies to (a) directly improve their order-to-fulfillment cycle by streamlining work-flow and business processes so as to achieve better order processing and tracking, (b) better leverage company spending and increase return on investment, and (c) ultimately optimize overall procurement efficiency. This can literally save a company millions of dollars.

For example, Unilever, a major consumer-products company, was able to cut $902 million in procurement costs over a 2-year period, and by the end of 2002, was expected to have achieved more than $1.58 billion in total savings from procurement efficiencies with its new B2B system. These improvements were achieved through Unilever's replacement of a hodgepodge of procurement systems in use across dozens of product divisions with standardized e-procurement, online-auction purchasing management, and demand-planning systems (Hicks, 2002).

Improve Overall Controls

The information exchanged among companies and their suppliers through B2B portals creates a strategic partnership environment that identifies and builds partnerships with new suppliers worldwide, strengthens relationships and streamlines sourcing processes with current business partners, and rapidly distributes information and specifications to business partners. Internet-based buy sites enable companies to manage inventory levels more efficiently by providing access to demand levels through B2B portals. Through B2B exchanges, companies can receive rapid responses, shorten fulfillment cycles, and implement just-in-time procurement strategies, which help reduce lag times and allow companies to more effectively control inventory levels and so carry less inventory reserves on hand.

A good example of this is Cisco Systems. The sharing of information between Cisco Systems, a large Internet product provider company, and its suppliers on customer demand, product defect rates, and engineering reportedly enabled them to substantially reduce manufacturing recycle times and build better products (Corbitt, 2002).

Expand Revenues

The public exchange of information provided through B2B exchanges has allowed many companies that sell to other companies to reach a greater number of potential commercial buyers of their products, which has lead to increased sales. It also provides greater visibility between customers and suppliers. Web exchanges enable customers and suppliers to peer into one another's operations via a secure Internet connection, and decrease the suppliers' time to market with new products. Also, sellers gain instant access to global buyers, with over $1 billion in purchasing power.

B2B E-Business Implementation Approaches

There are four general B2B implementation approaches in use. The first is independent B2B marketplaces, such as Commerce One, Ariba, and Freemarkets. The second approach discussed is the private B2B approach, such as the one found at Unilever and Cisco. A third commonly encountered B2B implementation approach involves consortiums, as have been formed in the auto, aviation, chemical and petroleum, building-materials, aerospace, and retailing industries. There is a fourth, transitional approach that was implemented by GE (General Electric), for example.

Independent B2B Marketplaces

The first approach discussed, which involves an existing company finding an independent B2B marketplace (e-marketplace), is a commonly encountered one. Many companies begin the B2B integration process by focusing on the purchasing cycle. Obtaining goods from suppliers using independent B2B marketplaces very often is the fastest and most economical way to acquire B2B capabilities. This is done by selecting an independent B2B provider, such as Commerce One, Ariba, or Freemarkets, to come in and integrate the company's internal systems with the selected independent market exchanges (e-marketplace).

An independent B2B marketplace or e-marketplace is an Internet destination where businesses from around the world can come together to buy and sell goods and services in an auction format. The destination and the auction are controlled and managed by the independent B2B provider. Buyers prepare bidding-project information and post them on the site. Suppliers then download the project information and submit their bids. Buyers evaluate the suppliers' bids and may negotiate electronically to achieve the best deal. The buyer then accepts the bid of the supplier that best meets their requirements, and the sale is finalized. Purchasers and suppliers can either pay a general fee, a per-transaction fee, or a combination of the two to the B2B provider, otherwise known as the Web host. Each one of these B2B providers has its own software applications and host Web sites.

For example, Commerce One uses its trademarked Enterprise Buyer proprietary software to link companies to all e-marketplaces of the Global Trading Web community on its Web site CommerceOne.net. Commerce One's Global Trading Web is the world's largest B2B trading community and provides unprecedented economies of scale for buyer organizations (http://www.commerceone.com/company/global_trading.html). This software can be purchased and installed by an existing company in order to obtain access to the Global Trading Web community that enables commercial transactions to take place between e-marketplaces.

Private B2B Exchanges

The second approach discussed is private B2B exchanges. A private B2B exchange is an e-marketplace created by a single company to provide e-business capabilities to its business units and preferred trading partners (http://www.commerceone.com/company/global_trading.html). In 2000, in the early stages of e-business development, many companies trying to be ahead of the curve jumped into public B2B marketplaces usually run by third parties. They soon discovered that there were many inherent problems. Although at times they were obtaining better prices, many times the diminished quality and increased rate of defects in the products were hurting their bottom-line gain. There were also problems in returning defective items, receiving orders when promised, and maintaining continuity in the supply chain (Prince, 2001).

Today, more and more businesses with the necessary resources are developing their own private exchanges. The e-market focus of some companies, such as Wal-Mart, has turned away from public exchanges because finance, supply chain, purchasing, and IT managers realized that, in many cases, their systems and employees were ill-equipped to handle the technical and procedural requirements of large public exchanges (Krell, 2002). Wal-Mart has invested in middleware or enterprise application integration (EAI) technology to link its internal applications together and to a few (up to 12) critical suppliers in the supply-chain process. The real value of e-procurement, e-billing, and electronic supply-chain initiatives is realized through real-time, hard-coded integration (Krell).

Other companies, such as Siemens AG, have turned to private exchanges in order to limit access to procurement information (Konicki, 2001). Siemens prefers a private exchange because it does not want its competitors to have access to its production plans. Private exchanges are gaining momentum because, for those companies that have the resources to develop them, they are able to deliver the capabilities many public e-marketplaces promised but have not delivered: the ability to centrally manage procurement across many business units, the ability to enable real-time design collaboration and integration with back-end systems, and the linkage of production-, inventory-, warehouse-, and order-management systems.

Consortium

The third B2B implementation approach discussed is a consortium: a quasipublic online marketplace approach. A consortium is a group of companies within a particular industry establishing an exchange connecting each of them and their suppliers. Today, there is a consortium exchange in almost every industry. Consortium members fund most of these exchanges.

One example of a consortium is found in the auto industry. Ford, General Motors, and DaimlerChrysler together established Covisint.com as a global, independent e-business exchange. Covisint is the central hub where original equipment manufacturers (OEMs) and suppliers come together to do business in a single business environment using the same tools and interface. Covisint enables companies to compress planning cycles and enhance supply-chain planning (http://www.covisint.com/about/). In February 2002, Covisint was handling 100 million supply-chain procurement transactions per month. These transactions take place between the exchange's members and more than 2,000 of their suppliers (Krell, 2002). In 2004, however, Covisint experienced some major problems that led to the acquisition of the company by two other firms, Compuware Corp and Freemarkets, Inc. (Sullivan & Dunn, 2004).

Transitional

The fourth approach involves an existing company moving from a private B2B exchange to an independent, external marketplace venture. A good example of this would be General Electric (http://www.gegxs.com/gxs/about). General Electric, given its vast capital resources and diversity across many industries, decided to develop and establish its own B2B software and private B2B operations. Subsequently, it used this experience to set up its own external, independent B2B exchange (called GE Global eXchange Services) to compete with the likes of Commerce One and Ariba in the B2B provider market. This type of approach would require a large amount of resources and is therefore not practical for many smaller businesses. Even for businesses the size of GE, the resources necessary to maintain such an exchange can become cost prohibitive (Barlas, 2002).

FUTURE TRENDS

B2B e-business experienced an initial boom based on unrealistic projections and expectations, followed by a few years of gloom based on the process of a new technology outgrowing its adolescent phase of development.

Recent projections by *Standard & Poor's*, however, indicate that the future of B2B e-business looks bright. The growth of B2B e-business is forecasted to reach $3.6 trillion in 2005, $4.9 trillion in 2006, and $6.4 trillion in 2007 (Kessler, 2004).

One of the more successful B2B implementation approaches for the future seems to be that of large, private exchanges, such as Ariba and Freemarkets. According to Ordanini, Micelli, and Di Maria (2004), large, private B2B exchanges especially represent a promising phenomenon and offer superior capabilities of generating higher turnovers than smaller niche exchanges.

Electronic B2B transactions, as shown earlier, are already improving the competitiveness of enterprises through sinking costs, faster information, and enhanced flexibility, among other benefits. In the future, however, B2B will be not only the application of technologies, but also a motor of change for economic processes and industry structures: B2B applications have an enormous potential for the alteration of economic processes in the direction of the knowledge society (Schedl & Sülzle, 2004).

In the B2B e-business arena, increased activity through mergers and acquisitions is expected to continue into the future, not only in the middle market among small- and medium-sized competitors, but also among the larger B2B exchanges ("M&A Outlook," 2005).

In the near future, more and more companies, especially finance and investment firms, will be adding multilingual dimensions to their B2B e-business strategies ("IndyMac Bank," 2004).

Manoj Nigam, president of Micro-D, predicts that in 2005, we will see leading retailers and manufacturers "completing the implementation of what we define as a 'full-circle' B2B" (Carroll, 2004). Nigam describes this as a sales and transaction process that begins with accurate and standardized electronic catalogs from manufacturers and flows through to purchase orders and PO acknowledgments.

Because of these and other trends not mentioned here, B2B e-business seems to be on the path to a healthy recovery, ensuring a profitable marketplace for its many competitors.

CONCLUSION

The recent economic downturn has forced companies, with reduced budgets and shrinking bottom lines, to perform internal analysis in order to determine which B2B implementation approach, if any, to select and integrate in order to achieve the maximum benefits of e-business. Especially in light of the upcoming B2B e-business recovery and the positive future trends in this industry, as indicated above, a company should carefully select and integrate B2B e-business into their existing business in a way that is most appropriate for the company's current situation, which makes this process a situational, contingency-based one. Organizations should be aware that although e-business may provide many benefits and the future looks bright, it is not the magic solution it was once assumed to be but rather just another potential business tool to be implemented under the right circumstances.

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KEY TERMS

Back-End System: The support components of a computer system. It typically refers to the database-management system (DBMS), which is the storehouse for the data.

Business-to-Business (B2B) E-Business: The sale of products or services, or an information exchange, among two or more businesses through electronic technology, usually involving the Internet, through a public or private exchange.

Consortium: A group of companies within a particular industry establishing an exchange connecting each of them and their suppliers.

E-Business (Electronic Business): The administration of conducting business via the Internet. This would include the buying and selling of goods and services, along with providing technical or customer support through the Internet. E-business is a term often used in conjunction with e-commerce, but it includes services in addition to the sale of goods.

Enterprise Application Integration (EAI): The process of coordinating the operations of various applications across an enterprise so they can perform as an integrated, enterprise-wide system. This term also refers to the set of commercial applications designed to facilitate this process.

E-Procurement: E-procurement is the business-to-business purchase and sale of supplies and services over the Internet. An important part of many B2B sites, e-procurement is also sometimes referred to by other terms, such as supplier exchange. Typically, e-procurement Web sites allow qualified and registered users to look for buyers or sellers of goods and services. Depending on the approach, buyers or sellers may specify prices or invite bids. Transactions can be initiated and completed. Ongoing purchases may qualify customers for volume discounts or special offers. E-procurement software may make it possible to automate some buying and selling. Companies participating expect to be able to control parts inventories more effectively, reduce purchasing agent overhead, and improve manufacturing cycles. E-procurement is expected to be integrated with the trend toward computerized supply-chain management.

Independent B2B Marketplace (or E-Marketplace): An Internet destination where businesses from around the world can come together to buy and sell goods and services in an auction format.

Middleware: Software that sits between two or more types of software and translates information between them. Middleware can cover a broad spectrum of software and generally sits between an application and an operating system, a network operating system, or a database-management system.

Private B2B Exchange: An e-marketplace created by a single company to provide e-business capabilities to its business units and preferred trading partners.

B2C Success at Wishlist.com

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BACKGROUND OF THE BUSINESS

This article explains how and why, during and through the dot.com bubble that was built and burst, one new economy company in Australia survived and prospered. The challenges were severe. The infrastructure, funding for development, and consumer behavior were key challenges that had to be overcome.

Between 1999 and 2000, around 190 Australian companies evolved selling something over the Web. In early 2000, local e-tailers such as Dstore, ShopFast, ChaosMusic, TheSpot.com, and Wishlist.com.au were being discussed as shining examples of a new way of retailing: smart, aggressive companies that were showing traditional retailers how to operate in the new economy (Kirby, 2000). Then it all started going wrong. Examples are as follows:

- ChaosMusic's shares, issued at $1.40 in December 1999, finished from 1999 to 2000 at $0.28 as the online music retailer slashed its marketing budget and staff.
- The share price of Australia's other online music retailer, Sanity.com, peaked at $2.05 soon after the company was listed in December 1999; on June 30, 2000, it was $0.44.
- On June 29, 2000, Australia witnessed its first major e-tailing failure when the department-store retailer David Jones acquired the assets of TheSpot.com, a toy and health and beauty products e-tailer that ran out of money after spending $12 million in 14 months.

Later in the same year, on November 28, 2000, the founders of Wishlist.com.au, Huy Truong and his sister Jardin Truong, accepted an award at the Australian Internet Awards ceremony for the most entrepreneurial Internet site, an award given for an Australian Internet-related achievement that is innovative, provides strong current or future financial returns, and demonstrates rapid business expansion via a unique business strategy. The site also won as the best e-commerce site on the Web. The head judge said, "Wishlist didn't follow the standard supermarket model on the Internet. It's an adaption of a gift store buying presents for other people not just for yourself."

He said the judges were impressed with the novelty of the delivery model, whereby Wishlist.com.au had arranged with the oil company BP to deliver parcels to BP service stations that can be picked up by customers at anytime (Lindsay, 2000). Huy Truong was also awarded *B&T Weekly's* 2000 e-Marketer of the Year Award.

Golden, Hughes, and Gallagher (2003) conducted a descriptive study that examined the key success factors related to e-business in the retail sector of Ireland. Through their postal survey, they found that the early adoption of Internet technologies and information systems expertise were important factors in contributing to success. Loane (2004) has suggested that there is now significant evidence that many new firms are embracing the use of the Internet from their inception. This is clearly the case with Wishlist.com. They suggest that the Internet is not just an improvement tool but a core capability, including IT competency.

Global Reviews, Australia's online retail performance and reliability gauge for e-consumers, in December 2001 stated that Wishlist.com.au was the standout Australian online retailer, achieving an overall score of 97%, with a perfect rating in four of the five evaluation categories: fulfillment, site usability, security, products, and customer service.

DESCRIPTION OF THE BUSINESS

According to cofounder Huy Truong (personal communication, September 15, 2003), Wishlist has succeeded because it is "[n]ot just a Web site you go to for a discount. We are building an online shopping experience around important events in people's lives."

Wishlist also provided a convenient corporate gift-giving service, which proved popular. Companies can give employees and customers goods and services, which might often be seen as nice indulgences, purchased as gifts from Wishlist.

The Truong Family

Jardin Truong and her brother Huy were young when they arrived in Australia in 1978 after escaping Vietnam in a leaking fishing boat with their parents, younger sister Dinh, younger brother Cameron, and five other families.

Getting Started

Jardin Truong dreamt up the idea for a business that could take orders for gifts using the Web, making sure that deliveries met deadlines. Wishlist was founded in late 1998 to realise this idea.

Gift giving was an opportunity that was already being exploited in the United States, but Jardin and Huy recognized that people did not always find it a fun and enjoyable process, sometimes forgetting special occasions and finding themselves in the pressured situation of trying to get the right gift in a short amount of time. They thought they could "[p]ut the fun back where it ought to be, which is in the giving of the gift, and then for everything else before that [they would] use technology" (Huy Truong, personal communication, September 15, 2003).

The idea captured the imagination of the cofounders, including Huy Truong and his wife, who is a management consultant and e-commerce expert with Price Waterhouse Coopers, and their brother-in-law David Pope, a multimedia expert, who would design the site.

The business plan was developed in January 1999, and the cofounders left their jobs in March and April 1999 to start work on its implementation. Between them, they invested around $80,000 along with free labor, and worked from a room in North Melbourne with a weekly rent of $35. They also gained seed funding of around $1.25 million.

Money was successfully raised on the basis of their business plan, which predicted that profitability would be achieved in 4 years, by 2003, and of the high-calibre team that would be managing the venture.

The Wishlist.com.au Web site was first launched in July 1999. At around the same time, the team undertook a further round of capital raising to get the funds that would enable them to rebuild and scale up the site, and to launch a campaign for Christmas 1999.

The site had 50,000 to 60,000 people visiting each month in its first 3 months of operation, and by Christmas 1999, Wishlist.com.au was delivering gifts to around 30,000 homes.

In April 2000, they successfully raised a further $15 million in capital to scale up the business, making investments in online ordering and fulfillment operations in terms of staffing and infrastructure, followed by another $10 million to buy out the failing Dstore 18% shareholding in Wishlist.

The founders have evolved their business model through various alliances and acquisitions, and through the development of other services and reward programs for partners.

According to Huy Truong (personal communication, September 15, 2003):

What we are doing is a totally new industry with few established rules—we have had to invent it as we have gone along. Although we had access to capital markets, technology and customers like any other business, it is how we have harnessed it to benefit the company and customers. There is no "corporate DNA" which defines why and how we do things—we are in the process of creating our own.

Truong (personal communication, September 15, 2003) also said, "You must have a strategy—not a 100 point plan. The sustainable competitive advantage is being able to change—the environment today is different to when we started. Strategy evolves."

Developing a Customer Base

Huy and Jardin decided that there were two options for their online retail business: Be really product driven or build a business around a consumer need. They thought that the latter would be a higher risk but was more sustainable in the long run.

From the outset they counted on two revenue streams: corporate gifts and individual gifts for customers located mainly on the eastern seaboard of Australia. Another distinct customer segment also emerged when orders started arriving from Australians overseas who wanted a gift delivered to friends or family in Australia in their absence.

Getting Traffic

Wishlist had to compete for consumer attention at a time when competitors like Dstore were spending big dollars, believing that a large marketing budget would generate sales growth that would then lead to profit. From June 1999 to June 2000, Dstore reportedly spent $4 million on media advertising, with 40% of it spent on television, resulting in unprompted customer awareness of 20%, but apparently only resulting in $250,000 in sales (Howarth, 2000).

The Truongs preferred to take a less costly approach to building their brand, believing that there were much smarter ways to drive revenue and attract and keep a loyal customer base. They implemented a number of coordinated strategies that provided discount incentives to get customers online and ordering from them, and believed that combining this with a superior shopping experience and customer service would give them the best chance of getting customers back again without the discount incentives.

They launched an associate program in September 1999 giving small Internet service providers and other Web sites the right to use the Wishlist logo and earn 15% commission on any sales they generated. With a goal of 1,000 associates by Christmas 1999, within days of the announcement, 30 associates had joined up. This campaign was combined with a customer offer of a $10 voucher for all purchases over $30 to create pull from the other direction.

The Truongs view was that spending big on marketing would not only add to their costs, it would also take their focus off the main game, preventing them from investing in the core of the business: the technology, the people, and automation. They preferred to build slowly and steadily from the ground up, managing growth so that the customer experience would not be compromised. The key issue would then be how to retain customers.

The concept of membership was developed to offer a number of benefits to those that signed up, including the following:

- Member discounts on products in every department
- A gift reminder service where members receive e-mails to remind them of special occasions
- The ability to save gift ideas for friends and family so that they are easy to find again and can be purchased later
- An account summary that lets customers track past purchases and current orders, as well as change membership details
- A gift registry that customers can set up to let friends and family see it from anywhere in the world and order gifts from them
- A newsletter letting members know about the latest news and gift ideas

Membership would allow them to collect data on how their site was being used, which could be used as input to site and service upgrades.

One of Wishlist's unique features in the early days was the site itself: clean, uncluttered, and easy to use, with a sophisticated search function to search by age, relationship, interests, occasion, price range, and personality type to help customers find what they are looking for, and a simple, user-friendly payment process that stores customer details so that they do not have to be reentered when ordering again. Drop-down boxes clearly tell the customer what he or she will have to pay for delivery and when to expect the item to arrive, and also give an express-delivery option for an extra charge.

This was vastly different from many other e-tail sites at the time, which were cluttered, difficult to navigate, and consequently plagued by "abandoned shopping trolleys": half-made customer transactions that just got too hard to complete.

Developing the Technology

According to Huy Truong (personal communication, September 15, 2003), much of Wishlist's success rests on creativity and ideas, and then on implementation and execution:

Whilst there are lots of amazing ideas to do with the Internet and technology there is a tension between being innovative and just getting on with it and with balancing what's an investment and what's an ongoing part of the business. You need to pick 1 or 2 of the best ideas and run with them.

As Huy Truong (personal communication, September 15, 2003) put it, "Wishlist wants to be leading edge, not bleeding edge." In an era when the technology and its possibilities were and are very enticing, Wishlist has remained very pragmatic about not letting technology run the business when the business' case does not actually justify it, although everyone in Wishlist is still expected to know how to use the technology.

The company uses technology to gear up the whole business around unparalleled service levels instead of competing primarily on price, even though they often sell at 5 or 10% below retail. This explains to a large extent why much of the process, including most technology and design work, is retained in house.

Some of the failures of the "tech wreck" were attributed to businesses that had searched for a new business model in order to try and take advantage of the new technology, presuming that just because e-tailing was technically possible, it would also be successful, and that through rapidly building a customer base and revenues, profits would follow. The problems arose because the cost of acquiring customers was greater than the revenues that could be generated (Bartholomeusz, 2001).

Others tried to use e-commerce technology to automate existing business, another approach that has not worked very well, especially in terms of the logistics of fulfillment (Kirby, 2000). Traditional retailers were finding it difficult to implement a successful e-tailing site, according to Huy Truong (Needham, 2000), because "they're no good at web development; their distribution is geared to in-store sales and the behaviour of on-line consumers is foreign to them."

Wishlist, on the other hand, has consistently worked with a clear business plan, and while technology is central to the business model, it is used as a means to an end. It has mastered the technology and online selling so well that it now helps other retailers build areas within Wishlist and is providing them with the fulfillment infrastructure as well as helping them to understand online consumer behavior.

Taking Control of the Consumer Experience

Rowley and Slack (2001) have considered the important factors required to better understand both theoretical and practical issues in e-retailing and distribution. They argue that the critical factors to better understand are the following.

- Cognition, which relates to how consumers respond to the e-interface
- Customerization, which refers to the personalization of the Web site
- Accumulation, which looks at the overall and cumulating effect of consumer behavior and context, and analyses the relativities between the old and new that economy retailing offers

Ishikawa, Ohta, Yokoyama, Nakayama, and Katayama (2002) suggest that the complexity of Web sites can be a limiting factor in their effectiveness; elements such as ill-structured design or indeed having too many pages can detract from the effectiveness of this channel of communication and sale. To deliver on its promise of a superior customer-service experience, Wishlist recognized that it needed to have control over the whole end-to-end consumer experience, at least to start with, because in the beginning its success would be determined by its ability to convert consumers from traditional shoppers to online shoppers.

A shopper's first experience would be a critical determinant of whether he or she would return. Once customer confidence had been achieved, the company would be able to look at the efficiency side of the business to control costs, but above and beyond all was the belief that it was the consumer experience that mattered, not the cost.

The Consumer Experience

The consumer-experience concept is a core guiding principle for Wishlist, and timely delivery with a product looking like it was supposed to was central to this.

After visiting various warehouses that packed clothing or technology parts for businesses, Huy found that their staff and operations were so focused on cost and efficiency that they would find it difficult to change their approach for dispatching Wishlist orders. Whilst competitors like Dstore were saying that there was no way any e-tailer could make the economics of fulfillment and logistics work if it did it on its own (Howarth, 2000), Huy Truong disagreed, seeing control over fulfillment as essential to ensuring customer satisfaction and being able to develop a loyal customer base.

Huy decided that Wishlist would fill its own orders and allocate the cost of packing and delivery to its marketing budget. Over the Christmas period in 1999, 120 students were recruited for presentation skills to work in the warehouse. They were responsible for writing dictated messages on cards accompanying gifts, as well as packaging the gift in the wrapping paper selected by the customer and tying the bows.

At this time, Wishlist used Australia Post to pick up parcels and deliver, but late deliveries at Christmas prompted the need for faster delivery, and they changed to TNT, primarily a business-to-business courier, who could offer three pickups a day, although at the time they primarily operated in the business-to-business market and did not offer after-hours delivery.

Automation is a key part of Wishlist's strategy for fulfillment, too. In October 2000, Wishlist upgraded its warehouse to speed up its distribution process, with new conveyor belts and robotic machinery installed, enabling it to handle 40,000 transactions a week.

Getting Over the "Last Mile" Problem

Ping and Chang (2004) propose a model of e-business strategy in which they argue for a holistic dynamic and dialectical properties. They argue for the use of strategic alliances and for the e-business approach to be connected to the business' overall strategy and business model. Wishlist has done this with its alliances with oil retailer BP, airline Qantas, and numerous other companies that enhance its marketing and distribution capabilities and reach.

Perhaps the most innovative move made by Wishlist was when it announced its strategic alliance with BP in August 2001, creating a delivery network initially of 250 inner city BP petrol stations, operating 24 hours a day, 7 days a week. With 1,200 BP outlets Australia-wide, Wishlist will eventually have after-hours delivery to most parts of Australia, and customers will have a much better delivery service, being advised via their mobile phones that their gifts have been delivered and are available for collection. Leonard and Cronan (2003) have pointed to the importance of supply chain management in electronic commerce and also in EDI (electronic data interchange) aspects of distributor-retail relationships. They point to the required core capabilities in replenishment as being critical to e-business success in both retailing and industrial procurement.

Exclusivity was an important component of being able to integrate technology systems and enable the tracking of products once they had left the Wishlist warehouse. This is what Wishlist refers to as the "last mile" of fulfillment, in which most of the problems associated with delivery occur and where e-tailers were failing to deliver on their promise to customers. As Huy Truong (personal communication, September 15, 2003) said on the announcement of the alliance,

Australian customers have embraced the convenience of purchasing online but the issue of controlling the "last mile" (delivery into the hands of the customer) has been a challenge for the whole e-tailing industry since day one. I believe this alliance will provide the ideal solution for our customers.

Indeed, around 30% of all of Wishlist's customers now use the BP-Wishlist service, making it the most widely used delivery system that Wishlist operates.

The Right People

Wishlist is the brainchild of Jardin Truong, but much of the success of the business can be attributed to the whole family, in particular the working relationship of Huy and Jardin. For Huy and Jardin, working together has been an experience. When they first started, they found that the family relationship was an enormous benefit because there was an established trust and a single focus that allowed them to start building the business.

Wishlist's structure is flat, with only three layers. Huy tries to keep people fully informed of what is going on, even at the risk of information overload. Huy says that as the business has grown, they have brought in skills from outside, with as many as 350 employees and contractors working for them during peak periods.

Setting Up Retail Alliances

Huy Truong always anticipated that in time, off-line retailers would move online. Having a gift site was important as it would mean that they would not be competing head to head with such retailers, and in fact could potentially be in a position to help them build their e-tailing businesses. This approach has already enabled them to offer off-line retailers such as OshKosh B'Gosh, Lego, Sony, Esprit, Fisher Price, Alessi, Kodak, Scanlan & Theodore, and Jan Logan a new avenue of distribution complimentary to their current channels.

Having developed the credibility and performance record to give other retailers confidence in its e-commerce ability, Wishlist wants to expand its technology provider service.

Most significantly, on December 1, 2000, Wishlist announced that it had made just such an alliance with Country Road. The Country Road site that would be developed would exploit the marketing and merchandising strengths of Country Road and the e-commerce and infrastructure strengths of Wishlist.

Following this, in June 2001, Wishlist and Sanity Music announced the imminent launch of a cobranded online store, offering Australia's largest range of music and DVDs online.

LESSONS LEARNED

When asked what it is that has made Wishlist survive the tech wreck and its competitors, Huy Truong points to a number of factors that he believes has influenced its survival and growth.

- **Focus:** They have never tried to be all things to all people. From the outset, they decided they would be a gift service and had to perform against the various critical success factors that entailed. They have never tried to be a department store or a traditional business using e-commerce, and whilst they have adapted their business plan, the company core purpose is still the same: gifts. They have always been realistic about what they would achieve and when, and have kept faith with their investors with this approach.
- **Revenue Streams:** They always planned for two revenue streams: corporate and retail. At first, retail accounted for around 70% of their business, but the ratio evolved to more like 50:50.
- **Relationships:** They have the ability to make partnerships, such as building and operating the Country Road e-commerce site, giving them an additional service revenue stream, access to inventory, and a share of the customer base. It is a Country Road site, but is branded jointly with Wishlist.
- **The Quality of Customer Service:** This has been crucial right from the word *go*. They encourage their call-centre staff to spend time with their customers to make sure problems are resolved rather than getting customers off the phone as quickly as possible.

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KEY TERMS

Customerization: The personalization of a Web site.

Fulfillment: The capability to deliver that which is transacted.

Infrastructure: The underlying resources that provide the necessary capability for achieving outcomes.

Security: The capability to be reliable in delivering goods and information, and to keep confidential and safe that information and resources.

Strategic Alliance: An agreement between two or more to engage in business transactions, or shared resources or ventures to their mutual benefit.

Benchmarking Local E-Government

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INTRODUCTION

Increasingly, almost everything we do in our daily lives is being influenced by information and communications technologies (ICTs) including the Internet. The task of governance is no exception with an increasing number of national, state, and local governments utilizing ICTs to support government operations, engage citizens, and provide government services. As with other things, the process of governance is now being prefixed with an "e". E-governance can range from simple Web sites that convey basic information to complex sites that transform the customary ways of delivering all sorts of government services. In this respect local e-government is the form of e-governance that specifically focuses on the online delivery of suitable local services by local authorities.

In practice local e-government reflects four dimensions, each one dealing with the functions of government itself. The four are: (a) *e-services,* the electronic delivery of government information, programs, and services often over the Internet; (b) *e-management,* the use of information technology to improve the management of government. This might range from streamlining business processes to improving the flow of information within government departments; (c) *e-democracy* the use of electronic communication vehicles, such as e-mail and the Internet, to increase citizen participation in the public decision-making process; (d) *e-commerce,* the exchange of money for goods and services over the Internet which might include citizens paying taxes and utility bills, renewing vehicle registrations, and paying for recreation programs, or government buying office supplies and auctioning surplus equipment (Cook, LaVigne, Pagano, Dawes, & Pardo, 2002).

Commensurate with the rapid increase in the process of developing e-governance tools, there has been an increased interest in benchmarking the process of local e-governance. This benchmarking, which includes the processes involved in e-governance as well as the extent of e-governance adoption or take-up is important as it allows for improved processes and enables government agencies to move towards world best practice. It is within this context that this article discusses benchmarking local e-government. It brings together a number of discussions regarding the significance of benchmarking, best practices and actions for local e-government, and key elements of a successful local e-government project.

BACKGROUND

Local e-governance is like other advancements involving the use of ICTs. It is seen as somewhat of a revolution, with many researchers considering e-governance as part of a new vision of local government for the 21st century (Jones & Crowe, 2001; Kearns, Bend, & Stern, 2002; Lenk & Traunmuller, 2002; Macintosh, Malina, & Whyte, 2002; OECD, 2001; Pardo, 2000; Socitim & IDeA, 2002). The definitions of local e-governance differ but read something along the lines of "the use of ICTs by local councils to enhance the access to and delivery of local services to benefit citizens, business partners, and employees" (VanDermeer & VanWinden, 2003: pp. 411), and tend to include those activities such as the type referred to above. According to Mahizhnan and Andiappan (2002, p. 1), local e-governance means more than simply technologizing government.

It requires a fundamental rethinking of governance itself and ... a re-inventing of local government ... e-government re-examines the organizing principles of bureaucracy and governance, re-defines the objectives and deliverables of local government and re-deploys the resources available.

The history of local e-government technology applications goes back to the 1990s, to the early days of the Internet. For example in UK, e-government efforts started in November 1996 with the publication of the "Government Direct Green Paper" (Government Direct: A prospectus for the Electronic Delivery of Government Services), outlining the way in which Government might make fuller use of ICTs within Government departments (including local councils) and in its dealings with citizens and businesses. Publication of the first version of the "e-Government Interoperability Framework (e-GIF)" in October 2000 set out national and local governments' technical policies and standards for achieving interoperability and information systems integration across the public sector. In particular, it adopts XML (extensible markup language) as the primary standard for data integration and presentation on all public sector systems. It also defined the essential pre-requisite for joined-up and Web enabled government, the e-GIF is a cornerstone in the overall e-government strategy. And the launch of the "UKonline.gov.uk" citizen portal, the "one-stop shop" for electronic public services for citizens in December 2000 was one of the most important steps of establishing e-government for UK (IDGES, 2005) (see Relyea & Hogue, 2004 for more information on the history of e-government).

As local e-government practices are becoming more wide spread, governments have realized the significance of developing standards and benchmarking local e-government. The benchmarking efforts and developed standards are working as a visionary guide for federal, state, and local government authorities to adopt ICTs for their e-governance practice.

Benchmarking Local E-Government

Benchmarking can be described as the process of searching for, and achieving, excellent levels of performance. This is achieved through a systematic comparison of performance and processes in different organizations, or between different parts of a single organization, to learn how to do things better. Its purpose is continuous improvement in levels of performance, by identifying where changes can be made in what is done, or the way in which things are done (CIPFA, 1996). The effective use of benchmarking can lead organizations to a best value.

Benchmarking of e-government projects, special local government procedures, as well as technical operations (e.g., data exchange formats) will result in uniform best-practice solutions. This will also prevent redundant developments, thus enabling a considerable increase in the economic efficiency of local e-government.

Benchmarking of e-governance practices and processes has tended to take two forms. There are those who have attempted to benchmark the readiness of societies and local councils to adopt e-governance (Yigitcanlar, 2003) and those who have looked at the e-governance tools and content (Mahizhnan & Andiappan, 2002). The former is aptly illustrated in the United Nation's Online Network in Public Administration and Finance's global e-governance readiness report (www.unpan.org/egovernment4.asp). That report, released in 2004, presents an index ranking of the countries of the world according to two primary indicators: (a) the state of national and local e-governments' readiness; and (b) the extent of e-participation. Countries including the United States, Denmark, and Sweden score highly on the e-government readiness index, while the UK, the United States, Canada, and Singapore score highly on the e-governance participation index.

Reflected in this index of e-governance "readiness" is the suggestion that in developing a comprehensive set of e-governance tools societies pass through several stages. Four stages have been suggested: emerging, enhanced, interactive, transactional, and seamless. *Emerging* is when a local government Web presence is established through a few independent official sites and information is limited, basic, and static. *Enhanced* is when the content and information is updated with greater regularity. *Interactive* is when users can download forms, contact local council officials, and make appointments and requests. *Transactional* is when users can actually pay for services or conduct financial transactions online. *Seamless* is when total integration of e-functions and services across administrative and departmental boundaries takes place.

As of 2001, 88% of the UN Member States have made a legitimate effort to commit to some form of national and local e-government; that is 169 countries have an established online presence with official government Web sites. However, for over a quarter of the countries, the content of official Web sites consisted of static and insufficient information often of a public relations nature and consistently with strong political overtones. Such sites can hardly be described as service delivery or considered citizen-centric since they are not a medium to elicit useful feedback (UN, 2002). Although there are different stages of e-government, some of the countries' e-government schemes did not fit in any of them.

Benchmarking of the processes and content of local e-governance is often of more importance as this aids government departments in building world class e-governance presence and is often associated with best practice examples. The process of benchmarking can involve several steps, but the key factors that appear to be critical to the effective use of benchmarking can be summarized as follows (IDeA, 2004):

- Developing an organization's capacity to learn from other operators in the field or market, or from others who have carried out a similar service or thematic best value review,
- Orientating an organization's future to be open to new ideas on how to do things,
- Effectively and routinely collecting service and process data to enable valid comparisons to be made,

- Connecting appropriately with market leaders or service providers recognized as best in class, and
- Acknowledging that benchmarking is not an end in itself but more a critical component or even building block in continuous service improvement processes.

Formal benchmarking of e-government process can be seen in the results of the Annual Global E-Governance Report (www.insidepolitics.org/egovt04int.html). Developing an index based on the content of government Web sites across 198 nations around the world. The specific areas of interest included in the index include the extent to which Web sites offer publications and databases, the extent to which they offer online services such as online transactions and the extent to which the Web sites include visible statements regarding privacy and security. An index based on how the 198 nations ranked overall provides nations with a means of benchmarking their performance and comparing it across time (indices prepared for 2001, 2002, 2003, and 2004). The top country in the ranking for 2004 was Taiwan at 44.3%, suggesting that for each Web site analyzed, Taiwan has just less than half of the features important for information availability, citizen access, portal access, and service delivery. Other nations that score well on e-government include Singapore (43.8%), the United States (42.9%), Canada (40.3%), Monaco (39.0%), China (37.3%), Australia (36.7%), Togo (36.0%), and Germany (35.0%).

Over and above benchmarking exercises the process of identifying best practice examples is also important. There are several examples of best practice in e-governance. The Annual Global E-governance Report discussed in the previous paragraph outlines several examples including Taiwan, Singapore, and the U.S. The Singapore government, for example, has purposely pursued a strong e-government policy. A Singapore government tag-line reads "many agencies, one government". The strategy to achieve this, as set out in the e-Government Action Plan, is to deliver integrated electronic services that are customer centric and accessible online, anywhere, anytime. For local governments, best practice examples are also present and local e-government in Minnesota (U.S.) can be given as an example. In Minnesota, large local governments are far more likely to already offer e-government than small ones. The main reasons behind the success of e-government in Minnesota were that before implementing e-government, the local governments of Minnesota set-up their standards and ongoing resources and weighed the potential costs against likely benefits. Additionally citizen access to computers and the Internet is expanding rapidly, and Minnesotans are more likely than residents of most other states to have access to the Internet.

For benchmarking at the local government level, best practice examples are also present and German *MEDIA*@Komm-Transfer Project can be given as an example. The participating municipalities in Germany have combined in the national *MEDIA*@Komm-Transfer network to standardize a selection of their e-government schemes. This portal supports the transfer of e-government know-how to the municipalities. In this regard it can be seen as a good practice in levering local e-government.

Another local e-government benchmarking initiative is the eEurope project. The objective of this project is to develop modern public services and a dynamic environment for e-government and e-business, and benchmark e-government for EU member countries (ECDG, 2004). One of the many successful outcomes of that project is the "National Planning Portal" for UK (www.planningportal.gov.uk). That portal provides online town planning services and indicates the e-level of the local authorities. It also allows residents to submit their building permission applications electronically, add attachments, and pay online.

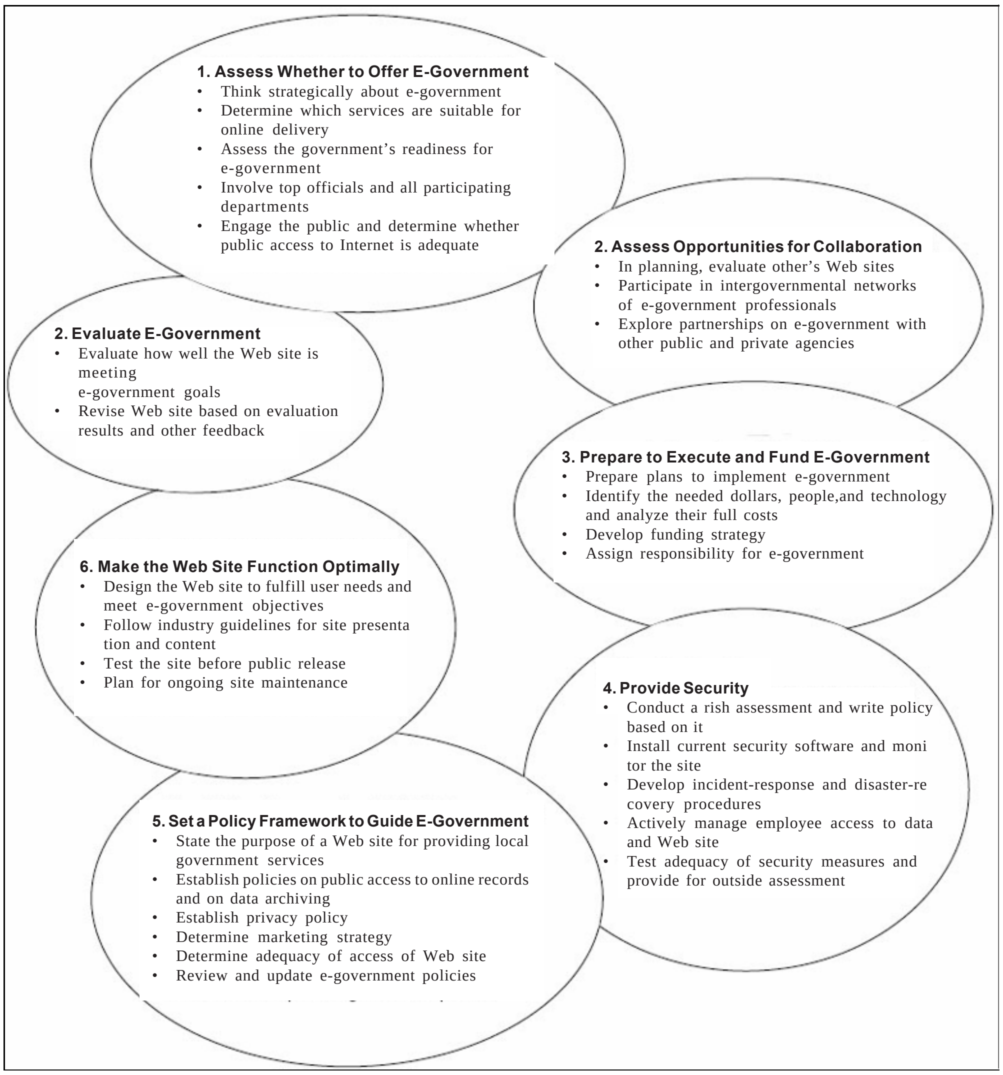
Seven best practices are necessary for effective local e-government. Local governments that fail to consider all of these best practices may not reap the benefits of effective Web sites and run the risk of posting Web sites that are counterproductive. The best practices are cyclic in nature because e-government is not a discrete, one-time initiative. The seven best practices are shown in Figure 1 (OLA, 2002).

FUTURE TRENDS

Current trends are indicating that to form ideal governance, benchmarking will continue to keep its importance. Hence, in the near future e-democracy and ethical local governance concepts are going to have more importance than e-government. Briefly e-democracy can be counted as a version up or reinforcement of the process of democracy by virtue of ICT. With e-government counted as one of the triggers to e-democracy, the future direction of local e-government would likely be "how e-government should be profiled in the process of democracy versioned up by virtue of ICTs."

Without a doubt, benchmarking local e-government and establishing e-democracy will provide administration and politics with the chance to improve their accessibility and image, offer better transparency, and modernize administrative and political processes. Many local administrations have already realized how important e-government and e-democracy will be for the future success of a community to set up an appropriate e-government strategy, scrutinize best practices and start adopting new technologies, introducing new workflows, and publishing their own Web sites.

Figure 1. Best practices for successful local e-government (OLA, 2002, pp. 16)



The technological developments in terms of hardware, software, and network will likely be making development and utilization of local e-government services cheaper and easier. Especially the increasing availability of viable and credible "Open Source Software" for e-government can expand the choices available to public sector organizations and can generate significant savings in hardware and software costs for infrastructure implementation. It can also reduce the licensing costs and hardware refresh requirements for desktop implementation.

CONCLUSION

It has been well acknowledged that the traditional portrait of government agencies worldwide is changing and this change is just as important at the local government level as others. This change, especially as it applies to e-governance, is about governments working better. Peters (2001, p. 35) states that:

…the definition of 'working better' may differ across governments, and even across components of the same government. The basic point, however, is that if government is to be able to overcome the discontent and distrust of its citizens, it must find ways to become more efficient and effective in the processes of making and implementing policy. At the same time, however, there are also pressures for government to become more responsive to the public and to be more transparent in the way in which it makes decisions.

Successful local e-governance depends on a range of processes including the ability of potential users to access e-governance tools (preparedness) and the ability of governments at all levels to develop appropriate e-governance tools (Web site content, etc.). To aid in developing "world best" practice, benchmarking of e-governance tools has become an important part of the development process. Benchmarking has been acknowledged as one of the key elements needed to allow a successful local e-government project (ODPM, 2002) and various benchmarking tools have been developed. Over and above benchmarking measures, best practice examples are also important and there are plenty of examples from national and local governments.

Local governments should get involved with e-government only after determining that they have the wherewithal to develop and, more importantly, maintain a Web site. They must think strategically about what e-government can do, decide which services are suitable, and assess their readiness for it. In the planning stage, local governments should look for partnership opportunities and explore work done by others. They have to plan how to implement and fund e-government. Security measures are essential; they should be based on a thorough assessment of security risks and tested. Local governments also need to set policies that will guide decisions on privacy, marketing, protecting sensitive data, and using the Web site to conduct business (OLA, 2002). In developing the site, local governments should focus on fulfilling users' needs and meeting their own e-government objectives. Local governments should also evaluate their Web sites and be prepared to revise them periodically.

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KEY TERMS

Benchmarking E-Government: Is the continuous process of measuring products, services and practices against the successful governments and making comparisons with them and then learning the lessons that those comparisons throw up.

E-Democracy: Refers to relations of two-way and horizontal power—using technologies to enhance democratic practice. It is about: interconnecting citizens amongst themselves; participation; empowering those in the margins; inclusion; creating and maintaining responsiveness; accountability; maintaining universality; and openness.

E-Government: Refers to relations of top-down power—governing populations through use of online information and services. It is more about transforming government services to provide more effective and more efficient services and also coming to the realisation that those services have to be customer-centric.

Ethical Local Governance: Refers to a government that members and staff recognize the importance of ethical standards in local governance thus enabling the authority to construct and develop an ethical culture and values for the authority.

Local E-Government: Refers to information, services or transactions that local governments provide online to citizens using the Internet and Web sites. It is also the realization of the e-governance vision at the local level, at the point where the vast majority of services are delivered.

Local E-Government Standards: Are being established to ensure that National Local E-Government Strategies are supported with effective and appropriate standards and mechanisms to exploit existing projects, products and services. Their primary aims are to provide: easy access to comprehensive and authoritative best practice; information on local service interoperability standards; analysis and development of standards; and scrutiny of e-government projects.

Open Source Software for E-Government (OSS): Is a viable alternative to commercial proprietary software, with potential significant value for money benefits for e-government. It is based on the principle of software products made available by the OSS developer community licensed for use with or without a fee. OSS licenses generally give the user the freedom to use, copy, distribute, examine, change and improve the software.

BigTrumpet.com

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INTRODUCTION

This article presents a case study on the world's first nationwide portal, BigTrumpet (BT), which showcases an early adoption of the evolving Web-services technology. BT is intended as a community portal that will touch the lives of Singaporeans through the concept of multiagency participation. BT is unique due to the technology behind it, the connectivity enabled by BT's applications, and the collaborative partnerships in its implementation.

Web-Services Overview

Web services is a new, emerging technology that is increasingly being called the next driver of growth in the IT arena. Gartner (2003) estimated that global spending on Web services and portals by the year 2005 would amount to $156 billion, and IDC (2002) expects Web services to drive total software, services, and hardware opportunity to $34 billion by year 2007. Web services hold much potential, like EDI (electronic data interchange), but without the associated problems of rigidity, a fixed data representation, or the requirement of expensive, specialized software (Glikson, 2003; Hartman, Flinn, Beznosov, & Kawamoto, 2003).

Technically, a Web service is a software application identified by a URI (uniform resource identifier) whose interfaces and binding are capable of being defined, described, and discovered by XML (extensible markup language) artifacts. It supports direct interactions with other software applications using XML-based messages via Internet-based protocols (Adams, Gisolfi, Snell, & Varadan, 2002).

Web services are a standards-based technology (Oei, 2003) that leverages on Internet technologies like the hypertext transport protocol (HTTP). Web-services standards define the format of the message, specify the interface to which a message is sent, describe conventions for mapping the contents of the message into and out of the programs, implement the service, and define mechanisms to publish and discover Web-services interfaces (Newcomer, 2002a, 2002b). The four basic Web-services standards consist of XML, the simple object access protocol (SOAP), the Web services description language (WSDL), and universal description, discovery and integration (UDDI).

The key benefit of Web services is that they enable interoperability between diverse applications and platforms (Tan, 2003). Furthermore, the use of HTTP makes Web services pervasive as even firewalls are designed to allow HTTP access (Bochsler, 2003).

Interoperability means unfettered information flows and therefore better integration of disparate internal and external IT applications. A reduction in integration complexity can help build better relationships with customers and external partners, and also lead to improved cycle times (Oei, 2003).

Interoperability also gives companies the flexibility to adopt the technology that is most suited to their own needs without having to take into consideration their partners' systems. Considerations of using the .NET or J2EE (Java 2 Platform, Enterprise Edition) platforms need not be made with reference to the systems of others (Hartman et al., 2003). Hence, Web services using XML provide a flexible model for data interchange with partners while at the same time allowing a company to build a tailored IT infrastructure internally.

BT Background

BT was initiated with a vision to unite the three *P*s: people, the private sector, and the public sector. It was designed to be a one-stop solution for a wide range of services delivered in a personalized manner using the Web-services technology.

BT was a combined vision of the software giant Microsoft and IDA,[1] both of whom wanted to promote and build a showcase Web-services project. It was created within a broader framework called .NETMySingapore crafted between the two stakeholders in 2002.

The BT portal is hosted by NTUC (National Trade Union Congress) Income (also referred to as Income), who has championed the project and become the main service aggregator for the portal. Though initiated by IDA, BT has been implemented as a private-sector initiative with decisions and actions governed by market demands. BT is therefore very different from another platform called E-Citizen (Ke & Wei, 2004), which is an e-government showcase championed, funded, and developed entirely by public agencies in Singapore.

NTUC Income

NTUC Income is Singapore's only insurance cooperative, which was formed in 1970. It has grown rapidly over the years, having over 1.5 million policyholders by the end of 2002. In addition to insurance plans, Income also offers special benefits like loans, 24-hour repair services, house-moving services, tuition services, health screenings, fitness-center memberships, and will-writing services. Its broader mission is to help improve the quality of life of Singaporeans.

Income has always been at the forefront of using technology. It was the first insurer in Singapore to install a mainframe computer system in 1980. Since then, it has enhanced its IT capability regularly in order to raise the level of service to its policyholders.

Income was the first insurer to launch an Internet Web site in 1995. Today, the Web site attracts over 7 million hits per month and about 4,500 visitors per day.

DESCRIPTION OF BT

The BT portal offers a wide range of services to consumers who no longer need to visit different sites to perform many common tasks. A total of 16 services, called Web-services scenarios, have been implemented in BT so far. These services pull data from 14 different agencies at the back end: 6 from the government sector and 8 from the private sector. All services, for the most part, are synchronous in nature whereby users get an instant response after sending their request from the BT portal. These 16 services also demonstrate how collaboration, aggregation, and orchestration can be used to offer distributed services from one, single, common platform.

Before describing each Web-services scenario in more detail, it is important to discuss some general core services that form an important component of BT design.

Core Services

The BT portal offers five general core services that can be utilized together with any Web-services scenario at the users' convenience. They are Calendar, Profile, List, Contacts, and Alerts. All these services allow the users to store personalized information.

- **Calendar:** This service provides users with a digital organizer that allows them to record important events or appointments at their ease. Relevant dates relating to any of the Web-services scenarios can be tagged onto the user's personalized calendar.
- **Profile:** The profile service enables users to store their personal profiles, search preferences, and upload their resumes. In addition, users can customize their Web page via subscription and management of various e-capsules available.
- **List:** Users can store three different types of lists under this service: a shopping list, job list, and course list.
- **Contacts:** It allows users to store, categorize, and control access to their businesses and personal contact information.
- **Alerts:** This last core service offers users a choice of notification via either electronic mail, short message service (SMS), or the BT Web page.

Web-Services Scenarios

BT offers 16 Web-services scenarios that were implemented in three phases. Five scenarios were implemented in Phase 1, which was completed in October 2002.

Phase 1 Web Services

- **myCareer:** This scenario is provided in collaboration with the Ministry of Manpower (MOM),[2] which opened up its back-end job databank and exposed it as a Web service. Users can search for jobs in accordance to their preferences that are stored in their profile.
- **myClub:** This scenario consists of different forums based on different interests, schools, activities, and hobbies made available for discussion.
- **myFolder:** This allows users to store their important documents online such as wills, school certificates, or transcripts in a safe and trusted manner. myFolder is essentially the backbone of myWill as the online will stored in this folder is accepted in the eyes of court as the original copy. The electronic will is stored in a trusted vault located at TrustedHub's[3] premises.
- **myHome:** This scenario aims to help users locate a range of domestic improvement services for their home. For example, users can search for a suitable tutor or register themselves as a tutor. Similarly, electricians, plumbers, and renovation contractors can be contacted according to users' preferences. myHome also includes online shopping through a joint effort with FairPrice[4] that has over 5,000 grocery and household items.
- **myMoney:** This service aims to help users keep charge of their monetary matters. Users can check

the status of their insurance application, fix an appointment with insurance agents, and purchase home and travel insurance online.

- **myInsurance:** This scenario allows users to find out how much they need to save for retirement, how to invest their central provident fund (CPF)[5] and cash savings, and how to identify suitable investments based on their risk appetite.

Phase 2 Web Services

Six further scenarios, as listed below, were implemented in Phase 2, which was completed in May 2003.

- **myBill:** This scenario allows users to pay recurrent bills through the online e-payment gateway.
- **myCar:** This scenario provides aggregated car announcements, avenues for the payment of fines, and other car-related services including seasonal parking, motor insurance and vehicle maintenance, and rental service. In this scenario, the Web services of both the URA[6] and HDB[7] are consumed to extract information on enquiries on car parking fines.
- **myHealth:** The three main functions that are offered under myHealth include aggregated health announcements, health insurance, and healthy lifestyle tips. While Income's servers process insurance applications, BT serves as the platform to retrieve the health-insurance policies and details by consuming the Web-services of Income. Similarly, the search for sport facilities is enabled by consuming Web services of the Singapore Sports Council.
- **myMagazine:** This allows users to view some preferred magazines online free of charge and download others at a fixed charge per copy. Content owners who register with Income as service providers can publish magazines online on the portal.
- **myTravel:** It provides aggregated travel announcements, an avenue to get tour packages, travel insurance, travel loans, travel tips, and country visa information. It also allows national service men travelling out of Singapore for a holiday or business to send a notification as required by MINDEF (Ministry of Defence).
- **WillTrust:** This, together with myFolder, allows the safe and confidential keeping of wills in the electronic vault of TrustedHub, a BT partner. Wills can now be reviewed anytime, anywhere by users who log in using encrypted passwords.

Phase 3 Web Services

In the final phase of the project, five new scenarios were added (listed below). This phase was rolled out in October 2003 and it marked the completion of the BT project.

- **myChild:** This scenario provides parents with a suite of child-related services such as searching for child-care centers, tutors, recreation avenues, child insurance, and the provision of information required to prepare children for school. The Ministry of Community Development and Sports and the Ministry of Education provide the data for this service.
- **myLearning:** In this scenario, users can state their course preferences and store them as part of their profiles. They can search for courses offered by the People's Association[8] using keywords and course categories.
- **myMaid:** The services provided include searching for both full-time and part-time maids, paying for maid insurance, and renewing foreign maids' work permits and booking their air tickets.
- **myRecreation:** This service provides users with information about five areas of general interest: sports, entertainment, food, reading, and shopping. Users can view concert and S-League (soccer league) schedules, and book their tickets online via SISTIC.[9] Similarly, information on books at the National Library Board and Amazon.com are also provided; in fact, users can add books they want directly into the shopping cart of Amazon.com.
- **VIP Club:** This is a virtual membership club that offers shopping deals on a wide range of products and services.

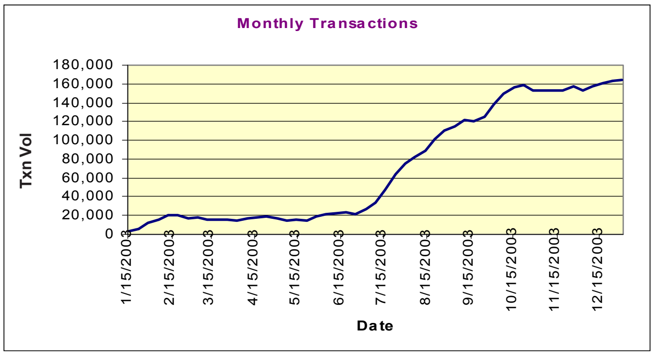
IMPACT OF BT

The BT platform and architecture provides a single user interface through which a range of common services from multiple parties can be accessed in a synchronous manner. There is no need for users to access multiple sites, learn multiple interfaces, or integrate diverse data. All of it is done from one site and in a manner that is transparent to the users. The motto of BT is "One user, one interface, one platform." It is the beginning of a new way in which users can interact easily and seamlessly with an array of Web sites and databases at the back end without ever moving out of a single, personalized site that tracks, monitors, and aggregates their needs.

Web Services: An Illustration

The *myCar* service has greatly benefited the 600,000 car owners in Singapore. Prior to the implementation of BT, car owners needed to put aside considerable amount of time to physically go down to two different places to pay the annual road tax and renew car insurance. Now, the two transactions can be completed via a single interface, thus saving time and improving user convenience.

Figure 1.



Since the launch of BT, the portal has enjoyed significant user growth, reaching about 300,000 at the end of 2003 (in a short span of 3 months). During the same time frame, there was also a tremendous growth in transactions as well, as shown as follows. This trend continues today.

Key Lessons Learned

- **Project Profile:** The BT project, right from the start, started as a high-profile project. It was launched by none other than Singapore's prime minister and Microsoft's CEO (chief executive officer). This high profile created a climate where the stakeholders knew that they could not afford to fail. The visibility from participation was also what led to external partners' cooperation to expose their data through the various Web services. Though recent research (Thamhain, 2004b) shows that project visibility has only a weak influence on project success, our findings strongly indicate otherwise; this can be further investigated by future studies.
- **Partnerships:** The BT project was carried out by multiple parties who collaboratively pooled their expertise together. Unlike most government contracts that are awarded to single vendors, BT was implemented through strategic technology alliances, which are commonplace in business (Zoller, 1999). Though partnerships increase coordination costs, they do allow for best-of-breed solutions. For BT, Microsoft was the key provider of the Web-services framework and technology. HP was chosen to build the technical infrastructure. A local technology vendor, National Computer Systems, acted as the systems integrator. NTUC Income provided project-management services and hosted the BT portal. A solutions provider called TrustedHub was brought in to provide its secure solutions platform for the management of digital content.
- **Formal Project-Management Structure and Project Leadership:** BT deployed more than 100 people in various teams. Most people were handpicked by their organizations as the best talent to work on the project. Managing them was a challenge. A formal project-management office was created to monitor the progress of the venture. The entire BT project was supervised and chaired by the CIO (chief information officer) of NTUC Income (James Kang) and supported by three cochairs from partner vendors. James walked the fine line between maintaining a strict project schedule, coordinating multiple technology partners, and still being flexible with business partners who were providing data for BT. His leadership style conforms well to the new role of leaders in technology teams (Thamhain, 2004b, p. 36): "Often the project manager becomes a social architect who understands the organisational and

behavioural variables, facilitates the work process, and provides overall project leadership for developing multidisciplinary task groups into unified teams, and fostering a climate conducive to involvement, commitment, and conflict resolution."

- **Project Design:** As compared to other IT projects involving Web-services deployment (Milroy & Doyle, 2002), this project was large in scale as it had involved multiple external agencies. The time frame of 18 months for deployment was also a major challenge; in fact, the programmers only had 11 weeks in the first phase to write up to 200,000 lines of code!
  As a strategy, the project adopted a "think far, start small, and scale fast" approach. This explains why a three-phase approach was adopted. The team started with high-level planning of the 18-month delivery, focusing on detail planning for Phase 1. On the delivery of Phase 1, they gathered feedback from the users and used the feedback information to plan the details of the following phase.
- **Open Channels:** The requirements of the project were complex on both the organizational and technological dimensions (Xia & Lee, 2004). The project used brainstorming extensively to discuss key issues and thrash out technical and business needs. For example, brainstorming sessions were conducted with NTUC Income executives to understand how they interacted with external partners. Such brainstorming sessions brought the business and IT people together. Furthermore, requirement workshops were held at the beginning of each of the three phases so that the technical team could derive the desired system functionality. Future studies can more formally look at such strategies for dealing with project complexity, a critical research area in IT project management (Xia & Lee).
- **Buy-In:** Perhaps the most critical challenge faced by BT was to persuade external parties to buy into the BT vision and provide services through the portal. Web services are an emerging technology, and many companies and government agencies were reluctant to adopt them due to issues related to security, which remains a global concern (Anonymous, 2002; Westbridge Technology, 2003), as well as concerns about interoperability, standards maturity, and the overall cost benefits. Government agencies were further reluctant to work with NTUC Income as it is a private organization.
  The challenge was resolved through extensive education aimed at the private and government agencies. Regulatory government agencies like IDA were roped in to alleviate concerns and to reconcile the sometimes-conflicting national and commercial interests related to the project. Microsoft provided training to the agencies to alleviate technical and other concerns. Thus, an extensive process of buy-in through persuasion, education, and coercion worked to ultimately convince 14 agencies to come on board.

CONCLUSION

The BT portal is one of the largest implementations of Web services in the B2B (business-to-business) and B2C (business-to-consumer) domains. It stands as a unique platform that is changing the way ordinary citizens gain access to electronic services in an integrated, personalized, and one-stop manner. It is also an exemplar of collaboration between the public and private sectors. Many lessons can be learned from the BT experience in both the technical aspects of integration and Web services, as well as leadership for managing IT and business alliances.

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KEY TERMS

Orchestration: The process that sequences, coordinates, and manages conversations among Web services.

Service Provider: This organization hosts the Web service that any application can consume.

SOAP (Simple Object Access Protocol): A protocol that applications use to communicate in a distributed environment. SOAP can be used to exchange data between applications created using any programming language and deployed on a computer running on different platforms.

UDDI (Universal Description, Discovery and Integration): UDDI, initiated by Ariba, IBM, and Microsoft, is an industry standard for registering, publishing, and discovering Web services in a central registry called a UDDI directory.

Uniform Resource Identifier (URI): Identify abstract or physical resources. A resource can be a collection of names that has been defined by some organizations, or it can be a computer file that contains that list. The most familiar form of URI is the uniform resource locator (URL).

WSDL (Web Service Definition Language): An XML-based language that is used to provide information about a Web service to requesting applications. This information includes a description of the Web service, a location of the Web service, binding information, a method for accessing the Web service, and a way to exchange data by using the Web service.

XML (Extensible Markup Language): A text-based markup language that describes data in a document. Since XML is a platform-independent language, it is used as the standard format for transferring data over a network using Web services.

ENDNOTES

1 IDA (InfoComm Development Authority) is a government agency that regulates and promotes the IT industry in Singapore.

2 MOM is a government body that controls labor supply and demand in Singapore.

3 TrustedHub provides managed services in the secure creation, storage, and management of electronic documents in compliance with the Electronic Transaction Act and Evidence Act of Singapore.

4 FairPrice is the leading supermarket retailer in Singapore. It has a retail network of more than 100 stores island-wide.

5 The central provident fund is a comprehensive social-security savings plan that seeks to provide many working Singaporeans with a sense of security and confidence in their old age.

6 The URA (Urban Redevelopment Authority) is Singapore's national planning authority.

7 The HDB (Housing Development Board) is a government board responsible for public housing in Singapore.

8 People's Association is the leading Singapore government agency that promotes government-to-people connectivity.

9 SISTIC is a real-time ticketing Web site with facilities to book tickets online.

Category: Concepts, Trends, and Challenges

Biometric Identities and E-Government Services

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INTRODUCTION

Governments are using the Internet and e-commerce technologies to provide public services to their citizens (Watson & Mundy, 2001). In so doing, governments aim to form better relationships with businesses and citizens by providing more efficient and effective services (Al-Kibisi, de Boer, Mourshed, & Rea, 2001). E-government provides opportunities to streamline and improve internal governmental processes, enable efficiencies in service delivery, and improve customer service (Bannister & Walsh, 2002). As a result, achieving successful e-government delivered over the Internet has become a key concern for many governments (Eyob, 2004). Additionally, there are privacy, security, and trust issues for citizens interacting with government services compounded by the electronic nature of the interaction. Biometric identifiers may present a solution to some of these concerns, leading to increased levels of secure, private, and trusted e-government interactions.

BACKGROUND

E-Government Challenges

The Internet can be used to provide access to centrally stored data to support services and transactions and can help the efficient running of government and provide convenient services to citizens. However, the permanent storage of confidential and personal data present significant security challenges (DeConti, 1998). International data protection reforms recommend security measures to protect sensitive information, and in doing so present potential restrictions for government agencies on the usage of data in transactions and the storage of citizen information (Dearstyne, 2001).

With e-government, citizens are exposed to threats to data privacy and the security of information, similar to those encountered in an e-commerce environment. Privacy, security, and confidentiality are thus natural concerns for businesses and citizens in this context (Layne & Lee, 2001). Furthermore, the design of e-systems may also deter some citizens from using the electronic medium, preferring the familiarity of traditional physical interactions (Jupp & Shine, 2001). These factors necessitate the building of trust between citizens and government to ensure successful levels of adoption of Internet-based e-government services (Bellamy & Taylor, 1998).

The development of biometrics has ignited widespread interest by citizens, businesses, and governments, on how these technologies operate and the implications of their usage. In addition, the development of new technologies has the potential to develop citizen trust by offering advanced levels of security (Dearstyne, 2001; Dridi, 2001).

Biometrics

Biometrics is the application of computational methods to biological features, especially with regard to the study of unique biological characteristics of humans (Hopkins, 1999). As an emerging technology, biometrics offers two related and important capabilities: first, the reliable identification of an individual from the measurement of a physiological property, which provides second the ability to control and protect the integrity of sensitive data stored in information systems (Oppliger, 1997).

As the levels of worldwide information system security breaches and transaction fraud increase, the imperative for highly secure authentication and personal verification technologies becomes increasingly pronounced. Governments are concerned about user verification and system security in developing e-government services particularly with moves towards combined, seamless services, which are delivered electronically. As a result the potential benefits of biotechnologies, in particular identification issues and security, are gaining importance on political agendas for e-government development (UK Government Strategy Unit, 2002).

Biometrics and Authentication

Three general categories of authentication exist with respect to electronic systems: (1) PINs (personal identification number) or passwords, (2) keys, smart cards, or tokens, and (3) biometrics (Liu & Silverman, 2002). Passwords are the most commonly used means of authentication in information systems (Furnell, Dowland, Illingworthand, & Reynolds, 2000). However, this authentication technique is often insecure, as users tend to choose passwords that are easily guessed or breakable by hackers (Bradner, 1997). Jain, Hong, and Pankanti (2000) describe token-based security and verification approaches as physical entities an individual possesses to make a personal identification, such as a passport, a driver's license, ID card, and so on. Such identification entities are currently widely used as methods of authentication for numerous applications worldwide. However, Ratha, Connell, and Bolle (2001) argues that the process of biometric authentication can be automated, and unlike token- or password-based methods, physiological characteristics cannot be lost or stolen.

Emerging Issues in Biometric Adoption

Biometrics is an emerging technology. There are a number of implementation issues pertinent to its widespread development and diffusion. Furthermore the lack of international biometric standards together with privacy and security concerns are relevant as potential inhibitors affecting the growth, deployment, and effective delivery of e-government services. However, recent international developments, for example the U.S. visa waiver scheme, have put biometrics on numerous political agendas in the context of enabling e-government, and have consequently fuelled rapid growth in interest in biometric technologies over recent years.

As a result of the "Enhanced Border Security and Visa Entry Reform Act " and new U.S. border control policy, countries currently eligible for the visa exemption program, including all current EU countries, must set up a programme to issue their nationals with biometric passports (IDA, 2003). European countries which have started to update their border control policies incorporating the use of biometric authentication include; the UK (UKPS, 2004), Bulgaria (EBF, 2004a), France, Germany, and Italy. In Australia, the Customs Service (ACS) has revealed a biometric passport recognition pilot (ENN, 2004). Elsewhere, the Japanese government plans to introduce biometric features in passports (EBF, 2004b).

INTERNATIONAL STANDARDS

Due to the relative youth of biometric technologies, as well as the fragmented nature of the biometric industry, a lack of international standards has impeded many types of biometric implementation and has slowed the growth of the biometric industry (Nanavati, Theime, & Nanavati, 2002). In order to gain acceptance in both commercial and government environments, biometric devices must meet widely accepted industry standards, which in turn would stimulate increased funding and developments in the industry (Nanavati et al., 2002; Ryman-Tubb, 1998). The development of standards would reduce the implementation and development risks of biometric solutions, making their deployment more attractive to risk-averse government-run public sector environments.

Privacy Concerns and Trust

Biometric technologies have the potential to provide governments and other organizations with increased power over individuals, thus threatening personal entitlements and civil liberties (Clarke, 2001). As such, privacy concerns are an important consideration in successful biometric implementation and uptake amongst citizens. These privacy issues relate to data collection, unauthorized use of recorded information, and improper access and errors in data collection (Smith, Milberg, & Burke, 1996). Biometric technologies have the potential to be more privacy invasive in cases where it involves the storage of personal information without the knowledge or consent of the individual (Crompton, 2002).

Trust is a central defining aspect of many social and economic interactions; it is the belief that others will behave in a predictable manner. In e-government, threats to data privacy and the security of information necessitates the building of trust between citizens and government to ensure successful adoption levels of e-government services (Bellamy & Taylor, 1998). Specifically, trust should be developed in e-services to allay fears that information collected for one purpose is not used for secondary purposes without prior authorization from the individual, and to ensure the non-repudiation of services (Tolchinsky et al., 1981). Governments also have an interest in developing trust in electronic transactions, since electronic mechanisms require the capability to uniquely identify the individual to prevent fraud.

Range of Biometric Technologies

An "ideal" biometric should be universal, where each individual possesses the characteristic; unique, where no two persons should share the characteristic; permanent, where the characteristic should neither be changed nor alterable; and collectable, the characteristic is readily presentable to a sensor and is easily quantifiable (Jain et al., 2000). In attempts to satisfy these requirements, a diverse and varied range of different biometric technologies have become available from recognition-based scanning systems measuring iris and retinal patterns, fingerprint layout and hand geometry constitution, to methods that gauge the accuracy of human sense-based output, such as voice patterns and olfactory sensing.

BIOMETRICS FOR E-GOVERNMENT SERVICES IN IRELAND

Background

In 2001, the Irish government set up a Biometric Task Force, under the auspices of the Department of Communications, Marine, and Natural Resources (DCMNR), to consider the use of biometrics technology in the delivery of government services. In order to assess governmental attitudes towards biometric services and the underlying biometric technologies available to enable these services, four in-depth structured interviews were conducted with management personnel working in the area of biometrics in the DCMNR and management personnel within the Irish government's Biometric Task Force. Complementing the interviews previously mentioned, supplementary data sources included two report documents produced by the Irish government's Biometric Task Force (one from 2002, the other from 2003), and informal discussions outside of interview contexts with management working in the area of biometrics in the DCMNR and within the Biometric Task Force.

Developing a Framework for E-Government Services

In June 2003, the European Council stated that a coherent approach is needed in the EU for the standardization of biometric identifiers. In response to requirements of the European Commission, the development of a European Biometrics Forum has been implemented in Ireland. In 1999, the Irish government released its first action plan on the Information Society; this plan made specific reference to the need to develop e-government initiatives and outlined an initial commitment to e-enable the delivery of public services. In March 2002, the Irish government further committed itself to placing all appropriate services accessible via the Internet by 2005 (Government of Ireland, 2002).

The concept of a portal-based public service broker (PSB) was subsequently adopted as the central mechanism for delivering the e-government agenda, as this was identified as the most efficient model to provide mediated, citizen-centred services (Government of Ireland, 2002). An online prototype of the PSB known as "reachservices", was officially launched and implemented in 2002. A tendering process has also been completed for the construction of the full version of the PSB and a complete installation of the PSB is for 2005.

Potential Role for Biometrics

At present, user authentication on reachservices is limited to a user name and password provided by the government. As part of the procurement process for the construction of the PSB however, the use of biometrics has been included as a mandatory feature for development. In order to provide more sophisticated security for user identification and verification, biometric identifiers are highlighted as an essential component of the services intended for the PSB.

A Regulatory Framework for Biometrics

The Irish government has progressed data protection legislation in line with EU recommendations, to govern how citizens can be identified and to define and govern how citizen data can be used by service agencies. The Irish government's commitment to data protection is evidenced by the legislative acts that have recently been implemented: Data Protection Act (1998), EC (Data Protection and Privacy in Telecommunications) Regulations (2002) and the Data Protection (Amendment Bill) (2002). The concept of a single unique identifier (termed a "PPS number", that is, a Personal Public Service number), which is compulsorily allocated to all citizens at the registration of a birth, was motivated by the need to uniquely identify citizens and in response to EU directives, to provide the citizen with the ability to decide what information is stored about them and to determine the conditions of that information's usage.

Various legislative procedures have also been progressed to support the introduction of biometrics in facilitating and enabling e-government services. For example, The Social Welfare Act 2002 provides for the creation of a public service identity (PSI), which consists

Table 1. Principles for biometric implementation

Principle	Description
Implemented biometrics must be accurate	Biometric technologies should significantly increase the accuracy of personal identification measures already in use or adaptable from other applications to e-government services.
Strong forms of authentication methods are necessary for e-government provision. As such, biometric technologies are a necessary authentication measure	Inherent in the effective provision of usable e-government services is a dependable and effective authentication process.
Biometrics are an important component in the provision and delivery of e-government services, in addition to other applications	Biometric technologies are fundamental to the effective interaction between citizen and state inherent in the secure handling and execution of e-government services. Biometric identifiers are also appropriate for other applications, such as driving licenses and health-related matters.
Biometric implementations for e-government must address privacy and citizen trust	Biometric systems should not become a de-facto standard for personal identification without consideration of citizen perceptions and attitudes towards potential infringements into privacy. Potential biometric implementations for e-government services should use a framework that encompasses both privacy and trust as components central to effective deployment and acceptance.
The Irish government needs to be aware of internationally external factors influencing advances in biometric deployments	The adoption and usage of various biometric technologies are heavily influenced by international politics, such as concerns over immigration, terrorism, requiring accurate means of user identification. The Irish government must be cognizant of biometric developments in other countries, so that Irish systems equivalent to international measures of personal identification are not 'lagging'. Also, the Irish government needs to be aware of technological advances in some forms of biometric technologies over others, spurred by external factors, which could impact upon the methods and tools used in Ireland to provide electronic government.

of the PPS number and associated identity data. This act allows for the inclusion and legal recognition of biometric data as part of the PSI identity data set. In turn the PSI is intended to act as the key component of registration and authentication used by the PSB.

Key Issues in Biometric Implementation

With respect to electronic, biometric-involved citizen-to-government interactions, the key issues influencing successful biometric implementation encompass governmental views on privacy, security, and trust, both from planning and implementation standpoints. Although the development of governmental policy governing the use of biometrics in Ireland is at an early stage, there have been a number of distinct areas of growth. Specifically these areas recognize the potential role for a range of biometric technologies as enablers of public service delivery. Table 1 presents a number of key principles for successful implementation of biometrics and a description of the challenge each presents.

Privacy, Security, and Trust

Results of interviews with members of the DCMNR and the Biometric Task Force indicate that to effectively provide citizens with secure electronic access to public services and indeed for e-government to be successful, it is imperative that the underlying systems can instantly and accurately validate the claimed identity of any individual. Furthermore, a strong form of authentication, such as those facilitated via biometric methods, is a key enabler in the delivery of online public services.

In terms of privacy and trust, the interviews suggest that the Irish government should not try to impose biometric technology on citizens, but that a challenge exists to develop reliable high-trust biometric mechanisms for citizens to interact securely and privately with e-services in through well-planned, well-designed, usable, and non-threatening implementations that are tuned with existing legislation on data privacy and access. Findings here indicate that the deployment of biometric technologies facilitating e-government provision should not result in citizens feeling that their government are overreaching themselves in terms of invasion of their personal privacy.

Interviewees also stressed the influence of external factors, such as the measures initiated by U.S., UK, and other governments regarding security and immigration controls post September 2001, as key to recent increases in interest in biometric technologies, their uses and their potential. These interviews suggest that the Irish government must not only be aware of developments in relation to international biometric standards, but additionally that the Irish government should monitor the current situation in relation to the use of biometric technologies to ensure that Irish citizens will not be excluded from international or EU-based e-services because their government has not kept pace with international policy and developments.

FUTURE TRENDS

Range of Biometric Technologies

The range of potential biometric technologies being considered for differing situations to support the provision of services has an important impact on the likely success of the implementation effort. The task force identified that each technology has particular strengths and weaknesses and as such no single technology is likely to suit all applications. The two variables that influence the implementation of biometrics in the public domain were identified as (a) public perception of the technology, and (b) performance of the technology. Fingerprint scanning was identified as being the most accurate technology; however, it has the lowest public acceptance rate given the associations with criminality. The technology with the highest level of public acceptance is facial scanning; however, this is the weakest performing technology, as there are difficulties in distinguishing between similar facial images. The technology that satisfies both public perception and performance criteria is iris scanning. This application does not require physical contact and is accurate; currently trials are underway at UK's Heathrow and The Netherlands' Schipol airport under the auspices of these countries' governments.

CONCLUSION

Increased security concerns associated with global terrorism are currently driving the need for biometric enhanced passports as the standard, minimum documentation required for international travel. As a result, citizens will have little choice but to participate in biometric identification schemes, as determined by their passport issuing authority. Given the fact that in most developed countries a very high percentage of citizens hold passports, it will be tempting for governments to extend the use of biometric technology beyond passport identification. While the implementation of biometrics to e-government services offers many advantages for both citizen and government alike, the extended use of biometric identifiers needs to be carefully evaluated.

In this study, some critical factors have been highlighted relevant to the implementation of biometric identities as a necessary enabler of e-services. Public acceptance of the technology is imperative for although strong forms of authentication have been shown to be a prerequisite for effective e-service provision, the deployment of biometric technologies must be cognisant of a number of issues. Biometric mechanisms must not only be reliable and user friendly but also appropriate to the service. An indiscriminate application of biometrics to government services may exacerbate public fears that personal privacy is being unnecessarily compromised. Hence, a central question in the context of utilizing biometrics in e-government service provision is the extent of verification deemed necessary and appropriate to access a particular service. The issue of implementing biometrics is further complicated by the need to adhere to strict EU laws on data protection, which protect data integrity but also challenge the design and operation of authentication mechanisms.

The use of biometric technologies by governments is being accelerated by technological developments and the need for increased security. However, while it will become beneficial for governments to use biometric identification procedures outside the realm of international travel and associated security issues, such an extension needs careful consideration. Further research into citizen acceptability, and citizen trust of biometric identifiers would add significantly to the current debate on biometric usage.

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KEY TERMS

Authentication/Identification: Biometric identifiers operate either in verification (authentication) mode or in a recognition (identification) mode. A verification system authenticates a person's identity by comparing the captured biometric characteristic with the person's own biometric "original". In a recognition system, the system establishes a subject's identity by searching the entire template for a match, without the subject initially claiming an identity.

Biometric Identifiers: The use of biometric data to enable the reliable identification of an individual from the measurement of a physiological property which provides the ability to control and protect the integrity of sensitive data stored in information systems.

Biometrics: The application of computational methods to biological features, especially with regard to the study of unique biological characteristics of humans.

Fingerprint Scanning: Enables the identification of an individual based on the analysis of unique patterns and ridges found in a fingerprint.

Iris Scanning: Enables the identification of an individual based on the analysis of the colored tissue surrounding the pupil.

Portal: The provision of integrated services, combining personalisation features via the Internet.

Privacy: Measures or regulations created to protect the individual in relation to data collection, unauthorised use of recorded information, and improper access and errors in data collection.

Speech Recognition: Enables the identification of an individual based on the analysis of a "voiceprint" derived from the digital acquisition of unique patterns found in individual speech patterns.

Trust: The provision of adequate measures to ensure the security of private or sensitive data thus providing confidence in the reliability of electronic services.

Branding on the Internet

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INTRODUCTION

Marketers have regarded the Internet as the consummate direct-response medium. The ability to interact one-on-one with customers and the ability to track their every move allowed precision targeting never before possible. More recently it has become clear that the Internet can also be used in *branding* efforts. The ability to blend direct-response and branding efforts is the Internet's greatest benefit and its ultimate challenge to marketers.

This article reviews evidence for the branding impact of online marketing activities. It also looks at the key concepts of *interactivity* and *consumer experience* online. It then presents a construct we call interactive brand experience and describes the Internet-specific techniques that can be used to orchestrate brand experience on the Web. It concludes by summarizing the implications of using the Internet for brand development and discussing the way in which branding on the Internet is evolving.

BACKGROUND

The most comprehensive and best-known study of branding effort on the Internet is the Cross Media Optimization Study of the Interactive Advertising Bureau. Begun in 2002, the study includes more than 30 leading brand marketers, and on- and off-line publishers as participants. Methodology builds on established off-line metrics by adding accepted online measures. Selected studies provide evidence that Internet advertising does affect various brand metrics.

- One of the earliest was conducted in conjunction with the introduction of Unilever's Dove Nutrium brand. The basic research design was to run print advertising only in week 1, add online in week 2, and television in week 3. The study concluded that keeping the total advertising budget constant but increasing online spending from 2 to 15% would produce an 8% increase in overall branding impact and 14% increase in purchase intent (http://www.iab.net/xmos/pdf/xmosdatadove.pdf).
- Another study focused on Kimberly-Clark's introduction of the Kleenex Soft Pack. The media allocation was 75% to television, 23% to print, and 2% to online. It found that online advertising reached the 42% of the target audience that is not reached or only lightly reached by television (http://www.iab.net/xmos/pdf/xmosdatakleenex.pdf).
- A recent study for Volvo used the Sponsorship Effectiveness Index to compare the effectiveness of shared sponsorship (multiple ad placement on a single Web page) with exclusive sponsorship in which no other advertising is present on that particular page at that particular time. The study concluded that shared exposure resulted in no significant lift in brand inclusion in the consideration set, while exclusive sponsorship resulted in a 6.1% increase in brand inclusion in the consideration set (http://www.iab.net/resources/iab_volvo.asp).

Other organizations report similar results. The British marketing research firm Taylor Nelson Sofres Interactive conducted four separate studies during 2000 and 2001. The studies showed that online advertising generally did increase brand awareness, more for unfamiliar and less for familiar brands. However, higher levels of ad recall were not always correlated with higher levels of brand awareness (Hughes, 2002). A 2003 study by the agency Advertising.com monitored conversions from a credit card offer over a five-day period. They found that about 33% of the conversions occurred on the same day as ad exposure, but only 11% occurred within three hours. In another study, when viewer activity was monitored for 14 days after initial impression, as many as 85% of the conversions occurred more than one day after exposure (Advertising.com, 2003). This delayed impact is taken as evidence that brand develop can and does occur online. There is also evidence that brand development does not always take the same route. In recent years two complimentary models of brand development have emerged. While neither one was developed specifically for the Internet, both apply to the online as well as to the off-line environment.

Brand Equity

Arguably the most widely accepted brand development model is Keller's Customer-Based Brand Equity Framework (Keller, 1998, pp. 68-83). It is composed of tools and objectives (brand elements, marketing programs, and secondary brand associations) that are mediated through knowledge effects (brand awareness and associations), with resulting enhancements of brand equity that include larger margins and greater brand loyalty. Keller expanded on the static model by providing a series of steps for creating a strong brand: establish the proper identity, create the appropriate brand meaning, elicit the right brand responses from customers, and forge strong relationships with them (Keller, 2001).

Ilfeld and Winer (2002) studied the development of brand equity on the Internet. They used a traditional hierarchical approach, adapted to take Internet differences into account. This allowed them to test three models: persuasive hierarchy (Think-Feel-Do), low-involvement (Think-Do-Feel), and no-involvement (Do-Think-Feel). Overall, the Think-Do-Feel model performed significantly better on all measures, suggesting that awareness is followed by site visitation, which, in turn, is followed by brand equity. They liken Web visitation (the dependent variable) to mature, frequently purchased product categories (low involvement) in which advertising is useful in building awareness and driving usage, and note that both online and off-line efforts are required.

Brand Relationship

A different approach is taken by Fournier (1998). In a study of how consumers develop relationships with their brands, she advances the concept of brand relationship quality (BRQ). BRQ is a multidimensional construct composed of positive affective feelings (love/passion, self-connection), behavioral ties (interdependence, commitment), and cognitions (intimacy and brand partner quality). BRQ is mediated by a number of psychosocial filters with the outcome determining the stability and durability of the consumer/brand relationship.

Thorbjornsen, Supphellen, Nysveen, and Pedersen (2002) operationalized the BRQ dimensions and tested whether customer communities (person-to-person interaction) or personalized Web sites (machine-to-person interaction) were most effective in building BRQ for hypothetical products. They found that for less experienced consumers, customer communities were more effective. For more experienced users, personalized Web sites were more effective.

Fournier's model specifies an outcome—the quality of the relationship that consumers have with their brands. It is an outcome predicated both on consumers' own life experiences and brand-related marketing actions. Marketers cannot control consumers' life experiences, however they can create and exercise control over customer experience. We therefore turn next to the concept of consumer experience.

Customer Experience

The concept of customer experience as a key to brand learning predates the Internet. Hock and Deighton (1989) characterize it as a type of learning, a four-stage information processing model. They postulate that consumers formulate working hypotheses for testing, are exposed to evidence about the product, encode information based on their own familiarity and motivations, and finally integrate new evidence into their existing belief structure. They distinguish between learning by description (most advertising falls into this category) and learning from experience, which is recognized as more effective.

Pine and Gilmore popularized the concept of customer experience, saying that "companies stage an experience whenever they engage customers, connecting with them in a personal, memorable way" (Pine & Gilmore, 1999, p. 3). The word "stage" is important and reflects Hoch and Deighton's (1989) contention that marketers can control the experiential learning of consumers.

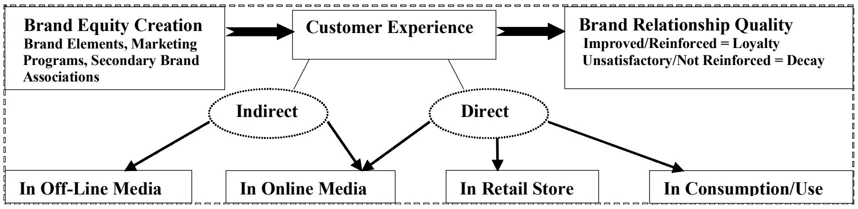
Li, Daugherty, and Biocca (2001) argue that virtual experience is similar to indirect experience in that it is mediated. It is also similar to direct experience in that both are interactive. Their research found virtual experience to be an active psychological process. It was accompanied by three other characteristics: presence (which they define as a sense of being in another place generated by indirect experience), involvement, and enjoyment. They conclude that virtual experience consists of vivid, involving, active, and affective states that are closer to direct than to indirect experience. That supports the research by IAB and others that finds the Internet to be a useful channel for brand development. It also leads to a construct in which customer experience is the central focus of brand development on the Internet.

Creating Interactive Brand Experience

The concept of customer experience encompasses all the marketer-initiated activities that influence brand equity. Learning, or indirect experience, takes place in the traditional media. Direct experience is gained at the point of purchase and in actual use. Experience gained through interactive media, particularly the Internet, has characteristics of both direct and indirect experience. Figure 1 summarizes the relationship of the brand development

B

Figure 1. The role of customer experience in brand development (Roberts, 2005)



concepts. It identifies customer experience as the mediating factor between the marketer's efforts to create brand equity and the consumer's perception of the quality of relationship with the brand.

INTERACTIVE TECHNIQUES

In 2000 consultants at McKinsey identified interactive tools that can be used to create digital brands—*personalization, customization, co-creation, purchase-process streamlining, self-service, product design toolkits*, and *dynamic pricing* (Dayal, Landesberg, & Zeisser, 2000). Research has also demonstrated that *brand community* can be built or strengthened on the Web (e.g., Bagozzi & Dholakia, 2002). Astute use of these tools and techniques creates an *interactive* environment in which meaningful dialog can take place between marketer and customer in a way that enhances brand development.

It is important to keep in mind that these techniques are available in addition to the traditional brand elements and secondary associations identified by Keller. Elements like the brand name and logo, and associations like the company and its channels of distribution, are the foundations of all branding activities, online and off-line.

Before we look at the specific interactive techniques, we should consider the concept and importance of interactivity itself.

Interactivity

In an early and influential study, Hoffman and Novak (1996) introduced the concept of the computer-mediated environment (networks) in which both machines and persons could interact in a one-to-one or many-to-many fashion. There are still interactive media that do not directly involve the Internet—CD-ROMs ATMs, and kiosks come to mind—but higher access speeds have made the Internet the focal point of interest in interactivity.

Liu and Shrum (2002) found that higher interactivity provided a more involving experience that led to greater user learning. Their definition of interactivity includes three dimensions: active control by the user, two-way communication, and synchronicity (simultaneous input and response). In a later study, Liu (2003) developed an interactivity scale using the three dimensions that were shown to have both validity and reliability. An empirical study of interactivity by McMillan and Hwang (2002) revealed three dimensions that are similar, but not precisely the same. They called their dimensions real-time conversation, no delay, and engaging.

These studies support the conventional marketing wisdom that asserts that well-done interaction engages the visitor, enhancing learning and increasing the likelihood of immediate response (purchase or other action) or delayed response (brand experience).

We now turn to a brief description of each tool with examples of its application.

Personalization

Database marketers have personalized communications with name and targeted content for at least two decades. Applications range from greeting an identified user by name when she enters a site, to using active server pages to deliver content targeted to the user's known interests, to serving advertising on the basis of anonymous profiles or those of registered users.

There are some situations in which personalized customer contact produces a profitable return and some where it does not. A study by Jupiter Communications did not find that personalization of Web sites influenced consumers to purchase more. Easy navigation was, however, found to be effective. The study also points out that personalization of e-mails does generate greater impact (Gonsalves, 2003). Holland and Baker (2001) suggest that personalization is effective for both task-oriented and experiential Web site users if it permits them to better fulfill their objectives. Amazon.com has led the way in deep personalization of site content.

Customization

It seems reasonable that the next step after personalization of content would be customization of products and services. There is, however, confusion between definitions of personalization and customization that renders this statement hard to evaluate. Nunes and Kambil (2003) define personalization as reliance on algorithms that uncover patterns in customer data and extrapolate to make recommendations directly to consumers or to personalize Web page content. They contend that customization lets site visitors specify the desired content. Wind and Rangaswamy (2001) carefully use the term "mass customization" to refer to products that are made to the customer's specifications using flexible manufacturing techniques. Ansari and Mela (2003) call the process of providing individualized content "e-customization." Their research indicated that optimization techniques that varied both content and order of presentation in persuasive e-mails could increase the click-through rate.

It seems reasonable to employ the term "mass customization" to refer to made-to-order products (Pine, Victor, & Boynton, 1993). Then personalization can be used to describe marketer-initiated individualization (either machine-to-machine or person-to-machine), and customization can be reserved for customer-initiated choice of content alternatives in computer-mediated environments. Using this distinction, one can point to applications like the NikeID site, on which visitors can build their own customized athletic shoe from menus of options (www.nikeid.com).

Co-Creation

Sawhney and Prandelli (2000) called the phenomenon "communities of creation" in which knowledge is created in a distributed network. Prahalad and Ramaswamy (2000) applied the concept to marketing when they pointed out that consumers have become active players in creating content through focused dialog, software tools such as collaborative filtering, and online communities. They state that customers can help to co-create their own experiences and, in so doing, determine the level of involvement they wish to have with the brand. Whether the process involves direct personal contact as occurs in eBay auctions, or is machine based like Amazon's use of collaborative filtering, co-creation can be a highly engaging activity. The proliferation of blogs on the Internet is a prime example of consumer co-creation of content.

Dynamic Pricing

Priceline in the consumer marketplace and auction sites for B2B procurement provide evidence that dynamic pricing can be a key element of an Internet business model. Wyner (2000) points out that customers experience price in a different way on the Web. In the physical world, price is most often a take-it-or-leave it feature. On the Internet consumers have a range of options they can use to search for the best prices and to decide which e-retailer to patronize. For marketers who cannot offer lowest prices, turning to a differentiation technique like product self-design may be an option.

Product Self-Design Tools

A *choiceboard* can be used to implement product self-design. Bovet and Martha (2000, pp. 76-79) state that a choiceboard has four key elements: a communication process, the ability to capture real demand, real-time choice management, and the resulting configured-to-order product. Customer product self-design is likely to experience rapid expansion in the coming years. The NikeID example may be an early indicator of this phenomenon. It allows consumers a wide range of latitude in configuring their own product, but it does not allow them to change the basic design of the shoe model they are purchasing.

Purchase-Process Streamlining

The best-known example of purchase-process streamlining is Amazon's 1-Click process. Their customers can enter information about purchaser and payment method, which is then stored for future use. It is also the most controversial example, because Amazon applied for and received a patent for the underlying software that has been disputed by other Internet retailers (Gleick, 2002). Nevertheless, other sites have implemented processes that make it easy to purchase, increasing the likelihood of repeat visits.

Self-Service

Self-service, either on the Internet or through other electronic technologies, is a growing force as companies try to provide customers with more service alternatives at the same time they lower their service costs. Meuter, Ostrom, Bitner, and Roundtree (2000, p. 54) found 56% of their respondents describing satisfactory self-service encounters and 44% reporting unsatisfactory encounters over a broad range of technologies. Moon and Frei (2000) suggested that, in order to make self-service satisfactory, companies must limit the range of choices and streamline the self-service process. It appears that consumers are willing to use self-service options when they solve a difficult problem, are better than the alternatives, and work properly (Bitner, Ostrom, & Meuter, 2002).

Transitioning Internet customers from more expensive service options like call centers to self-service is in the economic best interest of marketers, as demonstrated by Federal Express and their ever-growing array of customer self-service options. However, they need to ensure that the service options are robust, and that they include human interaction if self-service cannot resolve the customer's issue.

Brand Community

Defined as a "structured set of social relationships among admirers of a brand" (Muniz & O'Guinn, 2001), brand community is not an Internet-specific phenomenon. The H.O.G. (Harley Owner's Group) association of motorcycle enthusiasts has been extensively documented (see especially Fournier, McAlexander, & Schouten, 2000). McAlexander, Schouten, and Koenig (2002) studied the Jeep user group. Muniz and O'Guinn (2001) studied Saab and MacIntosh user groups, noting the importance of product-related Web sites in group activities. Holland and Baker (2001) note that many Web sites are encouraging the development of virtual communities in the belief that they promote brand loyalty. The communities of interest on the women's portal iVillage provide a robust example of building community on the Internet.

FUTURE TRENDS

The development of techniques that promote satisfying interactive brand experience is still in the early stages. Both marketing creativity and technological developments will continue to add to the array of interactive options. Marketers are in even earlier stages of learning to use these techniques in a way that engages and satisfies their customers and thereby promotes brand development. The objective must be to embed the brand message in experience-producing activities that customers are motivated to engage in and even to seek out.

We are beginning to accumulate valuable data about Interactive brand experience. The research to date, however, focuses almost exclusively on individual tools in individual channels. Except for the IAB studies, there is virtually no published research on the effect on brand development of executions of the same message in various channels or the use of different, supporting messages in diverse channels. Understanding interactions between channels and messages, both online and off-line, is critical to success in multi-channel marketing. Increased understanding of the interactions will help marketers meet the challenge of using the right combination of tools to create Interactive Brand Experience that supports and enhances overall customer experience and fosters the development of strong brand equity.

CONCLUSION

The Internet has provided marketers with another channel for communicating and transacting with their customers. Research indicates that brand development can take place as a result of customer exposure to online marketing activities in ways that are similar to the branding effects of off-line marketing activities. Customer experience provides the focal point for the branding messages received from both online and off-line sources.

The interactive environment of the Internet has generated a set of techniques, some that are new and some that predate the Internet but have found new richness and vitality there. Marketers are still learning to use the interactive techniques in customer-pleasing ways. They then face the challenge of integrating the online and off-line experiences into a single cohesive branding effort. All of this takes place in the context of a media environment undergoing change, both off-line and online. The business case for engaging in brand development efforts online as well as off-line, however, is compelling.

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KEY TERMS

Brand: As defined by the American Marketing Association, a name, term, sign, symbol, or design—or a combination of them—intended to identify the goods and services of one seller or a group of sellers, and to differentiate them from those of competition.

Brand Equity: The value of a brand, measured in financial terms.

Choiceboard: An interactive, Web-based tool that lets customers design their own products and services by choosing from a menu of options.

Customer Experience: The target customer's overall outcome, which includes both results and image factors, after using a product or visiting a retail store or a Web site.

Interactivity: Media or channels that permit two-way communication whether the format is one to one (telephone), one to many (interactive television), or many to many (the Internet).

Multi-Channel Marketing: Using more than one channel of distribution to reach the customer; for example, a bricks-and-mortar retailer who also has a Web site and perhaps also a paper catalog.

BSC-Based Framework for E-Business Strategy

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INTRODUCTION

E-business is far more about strategy than technology (Raisinghani & Schkade, 2001). An effective e-business strategy is concerned with e-business multidimensional characteristics associated with different levels, parties, elements, and growth pattern features (Bakry & Bakry, 2001). In the process, the strategy must incorporate the effects of the instant and global Internet communication mechanism on the company's business management architecture. The global reach and interconnectivity of the Internet have spawned new models of e-business strategy and radically transformed existing ones (Pant & Ravichandran, 2001). Indeed, what distinguishes many of the dot-coms is not their new technical power, but the radical new business models (Hamel, 2000).

Aided by such innovative e-business models, managers will be able to identify the major decision factors involved in their business strategies and generate strategies that would improve their overall performance and profitability. In the current context, four essential perspectives are identified to be associated with an e-business strategy: financial, customer, internal processes, and learning and growth. These four perspectives were first introduced in early 1990s as the balanced scorecard concept (BSC) (Kaplan & Norton, 1992). Because the BSC methodology explicitly focuses on links among business decisions and outcomes, it is intended to guide strategy development, implementation, and provide reliable feedback for management control and performance evaluation. This BSC rationale is thereby appealing to managers who face new challenges in the current turbulent e-business climate.

The real challenge is to determine how the BSC can be successfully applied in the context of e-business's constantly changing environment of interdependencies (Hasan & Tibbits, 2000). E-business introduces new business objectives and strategies and the old measures of success may no longer apply. It is anticipated that the departure from the original BSC for a strategic e-business management framework would be more radical than the existing BSC adaptations (e.g., Martinson's balanced IS scorecard; Martinsons, Davison, & Tse, 1999).

BACKGROUND

Few, if any, precise and complete e-business strategy models are available from the literature (Dubosson-Torbay, Osterwalder, & Pigneur, 2001). There are a few theoretical academic studies with some empirical evidence on e-business models success (Horsti, Tuunainen, & Tolonen, 2005). Generally, these e-business model studies fall into two categories: subsystem research and generic frameworks. Examples of the subsystem research include modeling for price structures (Liu, Wynter, & Xia, 2003), customer needs (Olsson & Karlsson, 2003), process synchronization (Park, 2002), and knowledge sharing (Koh & Kim, 2004). Since these subsystem models deal with a particular aspect of e-business, they do not offer a global and complete view of e-business strategy.

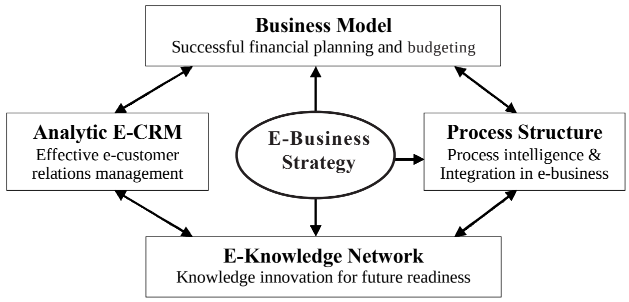
There are several generic frameworks for the development and analysis of e-business models. Whelan and Maxelon (2001) proposed that an e-business architecture requires product, channel, customer management, resource management, and information elements. Afuah and Tucci (2001) presented a more detailed list of components including scope, customer value, revenue sources, connected activities, and so forth, but like Whelan and Maxelon, they did not specify the interrelationships. Hamel (2000) specified a complete four-part framework with bridge components that is geared toward guiding strategic choices of management. Similarly, Dubosson-Torbay et al. (2001) used a framework with four principal components to analyze e-business: product innovation, customer relationship, infrastructure management, and financial aspects. Going beyond the segment frameworks, De, Mathee, and Abraham (2001) developed a pragmatic framework that offers different perspectives for the analysis of e-business including transaction costs, switching costs, infrastructure investment, and revenue models and so on.

For the most part, the generic models offer theoretical, not analytical, decision guidance for practitioners. One exception is the BSC-based e-business framework, with preliminary empirical evidence, proposed by Hasan and Tibbits (2000). Their empirical evidence, which was gathered from a case study in an Australian state-government utility, gave four high-level perspectives but no specific and explicit measures with each perspective. Currently, there is no comprehensive and concrete investigation that applies the traditional BSC to e-business strategy.

EBBSC FRAMEWORK SPECIFICATION

Considering a wide range of factors and relationships in this fast-changing e-era, we adapt the original BSC methodology into a comprehensive e-business strategy framework (EBBSC) consisting of four updated perspectives: business model, analytical e-CRM, process structure, and e-knowledge network (see Figure 1). The EBBSC framework links business strategies to a broad range of innovations and measures, examines important business issues facing e-business managers, and provides a complete view of e-business strategies. The framework can be better understood by examining the components in detail.

Figure 1. Adapted four perspectives of e-business strategy

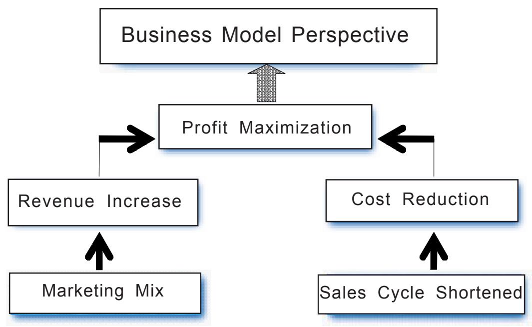


Business Model Perspective

Although e-business models differ from the traditional brick and mortar models in various ways, the fundamental needs of consumers and businesses remain much the same. Consumers want the best deal by price and service comparison, while businesses want to grow sales by targeting the right e-shoppers. On the other hand, traditional rear-view and static planning and budgeting cycles don't measure up to the dynamic, competitive, and compressed business cycles in the global e-era. E-business managers need to focus on a future-oriented profit maximization strategy that will support on-the-spot decision making at the turning points.

- **Profit Maximization:** Profit is equal to the difference between the revenue and cost. Many intangible and tangible factors may affect profit by influencing revenue and cost directly or indirectly, creating risk or uncertainty in achieving the company's profitability (Palmer & Wiseman, 1999).
- **Revenue Increase:** Revenue increase refers to expanding and re-pricing product and service offerings to achieve a higher value added mix. According to economics theory, revenue equals the product of the purchases and price. Purchases equal the minimum of the product quantity offered (quantity supplied) and quantity customers are willing and able to purchase (quantity demanded). Quantity demanded is treated as a function of the customer retention, marketing mix, and competition. Customer retention measures the company's customer stickiness or loyalty. The marketing mix includes the company's major marketing decisions. Competition represents the rivalry between the company and other businesses in the target market. Determinants of the quantity supplied include price, capacity, supply chain management efficacy, and staff proficiency. E-business capacity measures not only the limit imposed by the equipment and/or available personnel, but also the limit associated with the network technology. Supply chain management efficacy refers to the effort of the company in managing relationships with its suppliers.
- **Cost Reduction:** The Internet age enables businesses to reduce unnecessary or redundant buyer–seller costs. Generally, cost is composed of fixed cost, which in an e-business context can include e-business system development and maintenance expenses, and variable cost, which equals the product of unit cost and quantity supplied.
- **Marketing Mix:** Marketing effort helps in identifying market opportunities and generating marketing strategies that support attainment of e-business objectives. The major factors involved in the marketing mix include people, promotion, price, product, presentation, and distribution effort. The original "Place" factor is decomposed into presentation and distribution effort to represent e-market reality. Presentation refers to the effort involved in online product presentation and distribution. Distribution effort facilitates the connection of the product with the target customer.
- **Sales Cycle Shortened:** The sales cycle consists of the time that elapses between the customer interest and the purchase decision. In e-business, a shorter sales cycle enables management to respond promptly to emerging opportunities or threats. The major factors that impact the sales cycle include the customer profile, product, price, promotion, and presentation. A customer profile is a composite vari-

Figure 2. Business model perspective for e-business strategy



able that reflects the customers' demographic characteristics, preferences and behavior patterns. Generally, the more positive the customer profile index, the lower the product price, the higher the product quality, the better promotion methods and efforts, and the more preferable presentation formats, the shorter the sales cycle would be. Figure 2 summarizes the business model perspective in the framework.

Analytic E-CRM Perspective

The Internet enables customers to conveniently shop online, have a broader selection, get competitive pricing and greater access to critical business information (Chen et al., 2004). Online retailing, however, is impeded by security and privacy concerns, downloading time and other technology barriers (Chen, Gillenson, & Sherrell, 2004). Furthermore, customers can switch to other competitive URLs in seconds with minimal financial cost, which makes successful customer management vital in e-business.

- **New Customer Acquisition:** Customer acquisition depends on precise and timely targeting that delivers valuable offers to prospects. The factors involved in customer acquisition include the company's marketing mix, e-service quality, the customer profile and competition. Competition represents the company's external relationship with the supplier, availability of other distribution channels, entry barriers, and product substitutes. When addressing the factor, we have converted the original customer perspective from an external view (Kaplan & Norton, 1992) into a relationships perspective (Hasan & Tibbits, 2000).
- **Customer Satisfaction:** Satisfaction is influenced by lead time, product quality, service quality and competitive pricing (Kaplan & Norton, 1992). Lead time measures the time required for the company to meet its customers' needs, sometimes referred to as "order-to-delivery cycle time." A product with high quality and customization level and relatively lower price may increase the degree of the customers' satisfaction. E-service quality represents the level of the service offered in e-business.
- **Customer Retention:** Satisfied customers are not necessarily loyal customers. Loyal customers, who repeat their purchases, are valuable assets of the business. We identified customer satisfaction, goodwill, customer profile, channel flexibility, and competition as the major determinants of retention. Satisfied customers are more likely to return for repeat purchases. Goodwill, the favor or prestige that a business has acquired beyond the mere value of what it sells reflects the cumulative customer satisfaction (Jennings & Robinson, 1996). Companies need to identify and retain customers based on their profile. Channel flexibility refers to the availability of distribution channels besides the Internet. According to Reichheld, Markey, and Hopton (2000), the seamless integration of different channels can prove to be valuable.
- **Customer Profitability:** Succeeding in customer acquisition, satisfaction and retention does not necessarily ensure the company profitable customers. The focus of the business's customer strategy, then, should be on profitability. Although the purchase margin is straightforward, specific customer initiated cost is not that obvious and tends to be hidden in the customer support, marketing and sales functions. Those costs uniquely traceable to customers include the customer transactional cost, customer service/support cost, packaging delivery and post sales costs. The ratio of the customer purchase margin to the serving cost is revealing when compared on an individual customers basis, or by segment or channel basis (Schoeniger, 2003). Figure 3 summarizes this analytic e-CRM perspective.

Process Structure Perspective

With increasingly competitive global markets, efficiency remains vitally important. E-business processes must be timely, flexible, and dynamic. A generic value chain is illustrated in Figure 4, which offers an abstract description of the processes within any type of business. To be feasible in e-business, the internal process view should consider the flexibility and intelligence of the process structure (Hasan & Tibbits, 2000). This view implies that e-business process perspective affects not only internal business processes but also the whole business structure.

Figure 3. E-CRM perspective for e-business strategy

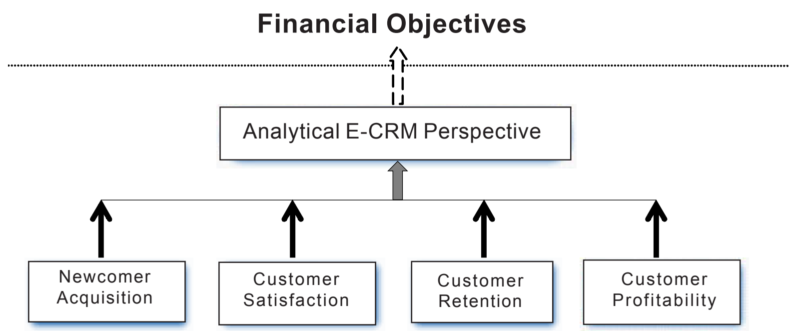
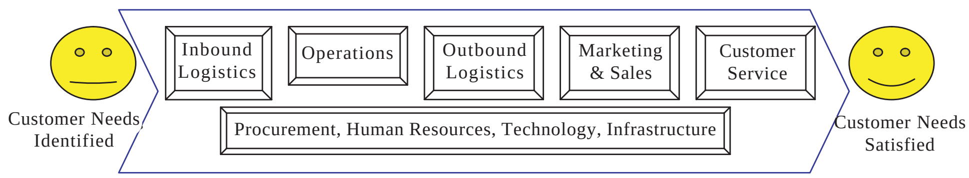


Figure 4. A generic value chain (From Lewis, 2001)

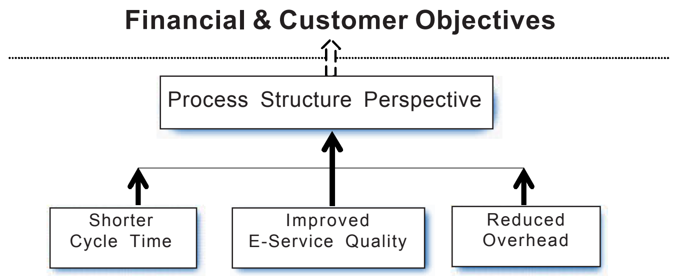


- **Shorter Cycle Time:** The notion of shorter cycle time can be directly translated into bottom-line revenue for nearly all companies. General cycle time measures the time to plan and stock (inbound), inventory and scheduling (operations), lead time (order-to-delivery time) and invoice a particular product (outbound). Effective process integration and intelligence can optimize this cycle, measurably reducing inventories and matching market desires. Wherever there are manual and sporadic tasks in the cycle, there are chances for overhead costs, delays, and errors, which can all contribute to a longer cycle.
- **Improved E-Service Quality:** E-service is the glue that holds the e-business process together. According to Voss (2000), customer service generally involves three levels:
  - The minimum necessary services, such as site responsiveness, site effectiveness, and order fulfillment. Network performance and infrastructure can ensure the basic services customers would expect.
  - Customer-oriented services, which can promote retention and satisfaction, fall into two categories: (a) informational capabilities: help information availability and interactive communication with the service representatives; and (b) transactional capabilities: order customization and tracking, complete support during ordering process and after purchase period.
  - Value-added services are extra services such as location sensitive selling/billing or online training. Overall, value-added services provide operational and administrative synergy among other levels of services.
- **Reduced Overhead:** Every dollar saved from overhead adds to profit. Being agile and flexible, the virtual process of e-business replaces the traditional product inquiry and physical clearinghouse process and provides greater operating advantages that may lead to reduced overhead. Process integration and intelligence reduce the need for a well-defined organizational structure and often whole layers of staff. As a result, e-business initiatives have resulted in a flatter organizational hierarchy, which leads to higher process efficiency, visibility and transparency. Figure 5 summarizes this process structure perspective.

E-Knowledge Perspective

Because success targets keep changing, the company must make continual improvements to survive and suc-

Figure 5. Process structure perspective for e-business strategy



ceed in this intensive global competition. Knowledge innovation and management facilitates continuing business readiness in the "new world" of e-business. Organizations are now creating Internet-based knowledge networks to facilitate improved communication of data, information, and knowledge, while improving coordination, decision making, and planning (Warkentin, Sugumaran, & Bapna, 2001). Figure 6 highlights some of the characteristics of e-knowledge networks.

This enhanced e-knowledge network will lead to greater back-office efficiency, flexible adaptation to market changes, greater customer intimacy, and other organizational benefits. In other words, the intangible effect of e-knowledge networking is reflected through the tangible measures of the other perspectives. There are additional implications of staff proficiency, process integration, and process intelligence.

- **Staff Proficiency:** Specific manager proficiency and employee skills are required in the new competitive e-business environment. The e-knowledge network offers a repository where new knowledge is created and collected while existing knowledge archived in data warehouses is renewed and updated. Management and operational judgment, knowledge, and experiences are shared and managed to facilitate improved communication, coordination, decision making and planning. Also, staff with higher qualifications can work more efficiently and effectively, while training can be utilized to improve their skills and keep them updated with the technology shift.
- **Process Integration:** Process integration enables a company to unify every aspect of its back-end infrastructure and increase responsiveness to changes by integrating disparate business processes. E-knowledge innovation and management facilitates the integration process by creating e-knowledge networks that are characterized by automated capture and exchange of rich knowledge to direct the operation of key interactive processes. The flattening of the organizational hierarchy also contributes to process integration, which leads to higher process efficiency, visibility and transparency.
- **Process Intelligence:** Process intelligence facilitates matches between the company's offering and target customers, competitors, and the current business by automating the decision and action processes and initiating real time analytics of sales and business alerting (Park & Park, 2003). The e-knowledge network generates and stores immediate knowledge about internal and external processes, customers and markets, strategic partners, and supply chain partners. Effective communication with trading partners across different platforms can help represent, implement and track the external business processes in a dynamic and flexible way (Park & Park). Figure 7 summarizes the e-knowledge network perspective.

Figure 6. E-knowledge networks characteristics (Adapted from Warkentin et al., 2001)

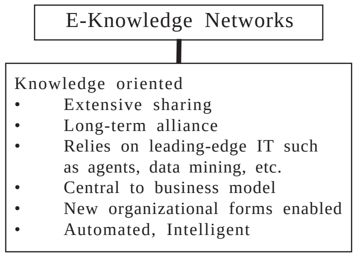


Figure 7. E-knowledge network perspective for e-business strategy

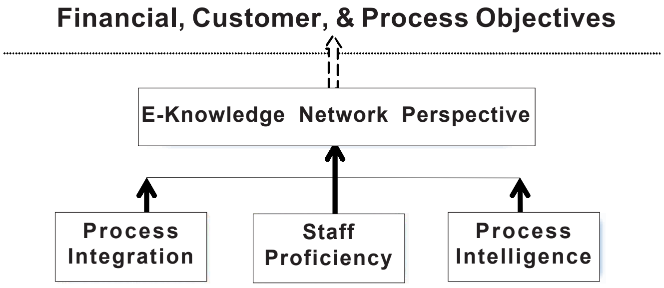
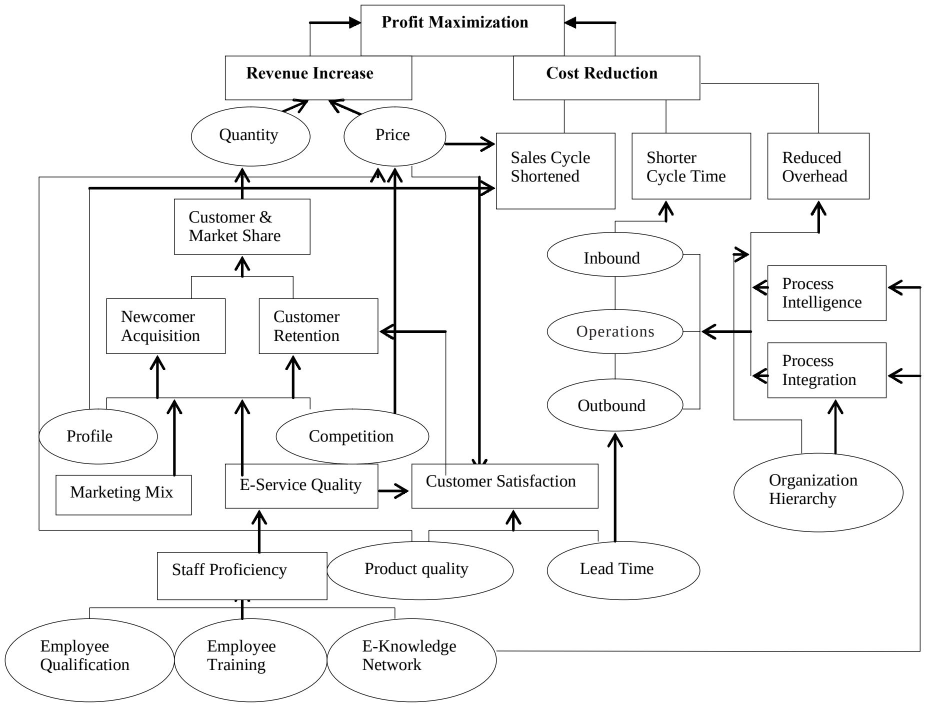


Figure 8. Simplified EBBSC framework overview



EBBSC IMPLICATION AND FUTURE TRENDS

Figure 8 summarizes the major measures (Square) and the corresponding decision factors (Oval) and relationships (Arrow Lines) identified in the proposed EBBSC framework.

At the conceptual level, the framework offers e-business managers a big-picture perspective that is critical in generating and evaluating effective e-business strategies. As an illustration, consider an e-business company that seeks to acquire more prospective customers in the next planning period. The manager first will locate the strategic measure of Newcomer Acquisition in the framework and identify the relevant decision factors. As the EBBSC framework indicates, these factors include the Customer Profile, Competition, the Marketing mix, and E-service Quality. Next, the manager can formulate a tentative strategy plan. In this case, the framework suggests that the company needs critical information regarding the prospective customer population and the competitors. Based on the collected information, management must decide on a specific marketing mix and e-service solution.

Starting from the market mix or e-service quality, the EBBSC framework suggests the steps to follow to create the mix and quality plan. Having the priority of the strategic objective at each stage, the manager can allocate the available resources more effectively to achieve these objectives.

As an innovative and exploratory framework for e-business strategy, the framework offers directions for future endeavors. First, empirical research is needed on the specification of the measures, factors, and relationships in each e-business perspective. Such effort will lead to a more precise and explicit model that offers e-business manager concrete and quantified support in generating strategies. The EBBSC framework also can be adapted to nonprofit e-business applications. The conceptual framework is feasible and directive in both profit-driven and non-profit Internet-using organizations. Different performance measures will be identified under each adapted e-business perspective, and the corresponding factors and relationships will be updated accordingly.

CONCLUSION

In closing, this EBBSC framework for e-business strategy contributes to both theory and practice. From a theoretical standpoint, it explains how the adaptation of BSC offers a methodology to formulate and evaluate e-business strategy. The framework also offers an evaluation model for strategic e-business decision support. In practice, it provides a means of identifying business opportunities and threats, analyzing current business capabilities and resources to address the opportunities and threats, and generating effective e-business strategies that would improve overall performance and profitability. In addition, the framework provides a stable reference for companies to understand and manipulate the fundamental changes introduced by e-business initiatives, and it enables e-business managers to plan and allocate resources more effectively and align strategic objectives with performance results.

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KEY TERMS

Channel Flexibility: The convenience and availability of distribution channels other than the Internet which contributes to increased profit and customer retention.

EBBSC: A balanced scorecard based framework to formulate and evaluate e-business strategy consisting of four perspectives: business model, analytic e-CRM, process structure, and e-knowledge network.

E-Business Strategy: An elaborate and systematic plan of action intended to accomplish specific e-business goals, which considers e-business multidimensional characteristics

E-Capacity: The limit of the e-business company's ability to produce or perform that is imposed by the equipment and/or available personnel and the network technology and performance.

E-Knowledge Network: A repository where new knowledge is created and collected while existing knowledge archived in data warehouse is renewed and updated.

E-Sales Cycle: The time that elapses between the customer initiating the buying process online, and the point at which a decision is made on which product to buy.

E-Service Quality: Customers' overall perception and experience of the three levels of the service offered in e-business: foundation of service, customer-oriented services, and value-added services.

Process Integration: The degree of problem critical information sharing and transmission across different departments and the combination of two or more stages in producing or distributing a particular product.

Process Intelligence: The ability of the business processes to perceive and act in the surrounding environments, to respond to the prevailing circumstances in dynamic business situation, and to learn and improve the process with prior experiences.

Category: Concepts, Trends, and Challenges

Building Government-to-Government Enterprises

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INTRODUCTION

Electronic government has proven a watershed in the domain of public administration, despite being difficult to pin down precisely. Indeed, the government-to-government (G2G) arena is one of the least studied aspects of this newly established field of knowledge, despite its importance in fostering cooperation and collaboration between government agencies, mainly with respect to the management of their knowledge, in order to increase the effectiveness of public administration.

The main scope of this article is to present some key success factors for building G2G enterprises successfully. It also aims to show how public agencies themselves can benefit when they are electronically linked to others, thereby innovating and streamlining their working processes, in order to achieve greater agility and efficacy at reduced cost.

In order to pinpoint the key G2G success factors, a single explanatory and successful case study approach was used, namely one involving the Brazilian Central Bank (BCB) and the Brazilian Justice Department (BJD). The BacenJud system developed by the Brazilian Central Bank was analyzed in a more detailed manner. This case—considered a success—shows how this G2G project made it possible for both the Brazilian Central Bank and the Brazilian Justice Department to achieve greater agility and effectiveness regarding the processing of legal demands made by the Brazilian Justice Department, thereby handing down its sentences at reduced cost.

Furthermore, this study examined the factors that had a clear nationwide impact on the success of this endeavor in the realm of the Justice Department.

Therefore, this article intends to answer the following research question: From the case study analyzed, what are the key success factors in the implementation of government-to-government processes between public agencies in Brazil?

BACKGROUND

The Incremental Effects of Information Technology in Organizations

According to Henderson and Venkatraman (1993), the contribution of IT to business was affected by skepticism in the early 1990s due to the failure to achieve the promised results. In view of this perception, Venkatraman (1994) pointed out the pressing need to create and develop new criteria to evaluate the impact of IT on business, duly reappraising automation logic, cost reduction and internal operation efficiency-based logic, which had prevailed until that time and might well no longer be relevant parameters.

In order to overcome this hurdle, the author developed a referential model in which five levels of IT-enabled transformations in organizations were described: localized exploration; internal integration; business process redesign; business network redesign and business scope redefinition.

The first level, localized exploration, is the basic one for leveraging IT functionality within a business. The second level, internal integration, is a logical extension of the first, reflecting a more systematic attempt to leverage IT capabilities throughout the entire business process. The third level, business process redesign, reflects a strong view that the benefits from IT functionality are not fully realized if superimposed on the current business processes, however integrated they may be. The fourth level, business network redesign, represents the redesign of the nature of exchange among multiple participants in a business network through effective deployment of IT capabilities. The fifth level, business scope redefinition, directly addresses the question: What role—if any—does IT play in influencing business scope and the logic of business relationships within the extended business network?

According to Venkatraman (1994), the first two levels are evolutionary, whereas the latter three are revolutionary. His main thesis addresses the fact that the use of IT associated to evolutionary levels only has a very slight impact on business change, despite the complexity of the technological infrastructure used. Consequently, the real benefits of IT in business only arise from the revolutionary levels, that is, the redesign of business processes and also of business networks and the redefinition of business scope.

Internet technology-enabled organizations to rethink ways of doing business (Evans & Wurster, 1999). As regards the G2G realm, the redesign of business networks among public agencies is now a reality (Andersen, 1999) and the bedrock for G2G enterprises, as will be seen in the case study presented as follows.

E-Government: An Idea Lacking a Clear Definition

E-government is still an exploratory knowledge field and is consequently difficult to define accurately. Moreover, it encompasses such a broad spectrum that it is difficult to find one expression that encapsulates exactly what e-government really represents.

According to Zweers and Planqué (2001), one can say that "E-government concerns providing or attainment of information, services or products through electronic means, by and from governmental agencies, at any given moment and place, offering an extra value for all participant parties" (p. 92).

Lenk and Traunmüller (2001), on the other hand, choose to see e-government as a collection of four perspectives based on citizens, processes, cooperation and knowledge management, which is obviously merely taxonomy developed to help researchers study this field. Naturally, there is a great deal of interdependence among the facets quoted, and they can seldom be studied individually.

Other authors define e-government in a broader sense (see, for instance, Kraemer & Dedrick, 1997; Perri 6, 2001; Traunmüller & Wimer, 2004). For them, e-government encompasses a broad gamut of activities, from digital data and electronic public service to online pool, e-democracy, and e-governance. Yet, the most recent definitions see e-government as the various ways government uses information and communication technologies to remain relevant in the knowledge society (ITAC, 2002), that is, to support government operations, engage citizens, and provide government services (Dawes, 2002).

Currently, we detect substandard efficiency, efficacy and effectiveness, and at a high cost, in the traditional governmental processes between two or more public agencies. Faced with this reality one question arises: If enterprises have discovered the enormous benefits that the Internet can generate for them through linkages among themselves, why do public agencies not use this technology and the integration it provides, in order to become more responsive at reduced cost? As public budgets are shrinking all over the world and society is increasingly calling for more accountable public administration, integrated electronic processes between public agencies, via the Internet, known as government-to-government, can be the answer to this question (Cavalcanti-Neto 2002; Lutz & Moukabary, 2004).

CASE STUDY

The Brazilian Federal Constitution grants very few institutions right of access to the bank accounts of both citizens and companies or, indeed, the power to freeze financial assets of either. One such institution is the Justice Department, which intervenes by means of judicial orders handed down by the judges of several courts nation wide.

As required, a judge can either freeze or liberate the bank accounts of both citizens and businesses and even declare the bankruptcy of a company. Judges are further empowered to suspend a decreed bankruptcy or request financial information about organizations and citizens under scrutiny.

When it issues orders relating to information about the financial assets of either citizens or institutions, the Justice Department sends them directly to the Central Bank, which then forwards the orders to the specific recipients, namely either an institution or the Brazilian Financial System. It is almost impossible for the Justice Department to know precisely where the request should be sent.

As there was already a computerized system in the Central Bank linking it to the Brazilian Financial System (JUDNET, 2001), it was relatively easy to meet the Justice Department's requests. However, the increasing demand for this kind of information made by the Justice Department obliged the Central Bank to involve several employees on a full-time basis and expend considerable financial resources just to deal with this requirement. Over the years, the number of claims has increased dramatically. In the meantime, the Central Bank's Legal Department issued an opinion alleging that the Central Bank had no constitutional duty to assist the Justice Department with these specific demands. However, in order not to jeopardize its relationship with the Justice Department, the Central Bank decided to rethink its *modus operandi,* in order to continue giving assistance to the Justice Department.

Consequently, the Central Bank acknowledged the need to redesign this working process, by streamlining it and achieving greater efficiency and responsiveness at reduced cost. At a time when the Federal Government has reduced the public spending budget and society is demanding greater efficiency, efficacy and accountability from the public agencies, it was of paramount importance to achieve this.

An Innovative Process

By 1999, the Central Bank realized it was no longer feasible to process this operation manually, that is, receiving claims on paper and feeding them into the communication systems linked to the National Financial System. In 2000, the Central Bank received 300 claims per day, totaling 71,775 claims in that year. A team of 23 people working full time on this task was unable to meet the Justice Department's demands in time, thereby causing problems in terms of efficacy. The Bank was spending approximately US$1 million per year to process these requests, including wages, equipment and so forth.

The Bank soon realized that there was a pressing need to develop an information system where the Justice Department itself could formulate its requests that could then be forwarded directly by the Central Bank to the financial institutions.

The Bank looked into the possibility of a revised information flow, seeking to take advantage of the deployment of the existing Internet access in most Brazilian courts. A Web-based system was developed in order to centralize the interaction of the judges with the Bank so that they could file their requests directly. A Web-based system was selected such that the judges would not have to install any specific software on their desktops, thereby reducing costs involved in the process.

Process Architecture

From the moment a court signs an agreement with the Central Bank, it designates a professional in charge of managing the system on its premises. This manager is supposed to conduct operations including: adding users; altering data; changing passwords; granting permission to judges to access the system and withdrawing this permission when necessary. These operations are done through the system itself, which has a dynamic interface, according to user profile. Users can then access a restricted site on the Internet and after their identity is verified, the system offers Web templates to allow them to fill out their requests. These are recorded directly in the Central Bank's corporate database.

At 7 p.m. every day, all requests received during the course of that day are processed and forwarded to the financial institutions as electronic files. Each institution then replies directly to the judge involved. The process allows the institutions to standardize their answers and send them directly to the judges' e-mail addresses.

Key Success Factors

Thus, by consolidating information from all the observations, interviews and questionnaires, it can be seen that access and information security, organizational culture, and training were the key success factors in this G2G enterprise, as detailed in the following.

Access and Information Security

As the Internet has become a very important link between governmental agencies, it is of paramount importance to avoid security flaws, such as information violation by "crackers," breakdowns in communication and so forth. Losses caused by such problems are more than just financial, as they can cause loss of confidence and acceptance by users and even involve the interruption of a given communication link (Endler, 2001).

In G2G processes, the issue of security is even greater, as confidential information can leak and be made public. Most of this information is protected by laws of secrecy under Brazilian legislation.

Thus, as was shown generically above, it is clear that security is one of the key success factors for a G2G endeavor. An authentication failure can allow any person to issue a legal request and expose the private life of citizens and relevant organizational information to all and sundry. Several courts insisted on seeing how the process worked before actually deciding to join the network proper.

Organizational Culture

Another factor that influences the success of an electronic governance model is the culture of the public agency in which it is developed. New processes of electronic governance, at different levels within the public administration, demand changes in organizational culture (ITAC, 2002).

The influence of the culture is even more relevant when two different public agencies are working together, concurrently. The changes required in the organizational cultures in order to integrate different internal processes demand very clear prior definition of leadership and respective function. This role, itself, demands that a clear path be followed and precise judgement so as to make innovative workflows feasible (Kieley et al., 2001).

Hence, as seen above, the success of the use of a new process depends on the culture within the organizations involved, in this case, the culture of the courts nationwide. It was observed that the courts that already had a culture of using computerized processes assimilated the new *modus operandi* very rapidly and naturally. On the other hand, courts without Internet access or that barely used information systems in their daily activities have resisted greatly in joining the G2G process.

Training

New technologies, new processes and new models of electronic governance require the acquisition of new knowledge not just by the persons involved directly in the process, but also by the persons in charge of administrating them. Consequently, public agencies must assess their human capital carefully, as it is mandatory to train personnel before deployment of G2G enterprises (Dujisin, 2004).

When the process involves more than just one public agency, all players must implement training efforts, in order to leverage the knowledge of the personnel in the agencies involved equally.

Insufficient training can lead to misuse of the electronic processes hindering the potential benefits that might be attained by this new model.

Although the system was developed based on a user-friendly environment via a web interface, the Central Bank felt it necessary to make presentations to judges across the country, in order to explain how the system worked and explain the best practices associated with this new workflow.

In October 2001, the Central Bank started to make presentations to the judges in the courts in a state where only 10 judges had joined the system and a mere 8 requests had been generated until that moment. In the two months following the presentations, 130 judges joined the system and nearly 100 requests were generated. Interviews made by the researchers have shown that the use of the G2G process by trained people is increasing, proving the efficacy of the training strategy.

FUTURE TRENDS

In the business sector, when all the tasks and procedures of an undertaking are centralized in a single company, it is simpler to organize and assess knowledge accrued from a project. The problem is that a handful of different players may now be involved in any major project. Consequently, the question that arises is: how is it possible to manage and store the knowledge generated during a given venture in such a way as to use it in the course of a specific project and also manage to access it for use on future projects?

Some very important research has already addressed several aspects of this issue, such as Badaracco (1991), Bahrami (1992), and Baker (1994), to name but a few.

However important these articles are in their own right, the scope of this research just touches on how to create, deploy, transfer, store and retrieve the intelligence of an undertaking encompassing a handful of different companies, in different places, with different, although important, duties. Therefore, the next logical step includes expanding the research to ongoing and ad-hoc inter-organizational groups.

Government as a collection of public agencies, each of them having their own information and knowledge, needs to ensure that these agencies are linked so as to share their explicit knowledge. It can be said that government is (or should be) similar to metabusinesses—quasi-firms, or virtual firms, created via digital links between several companies—in such a way that it is almost impossible to define their precise boundaries (Joia, 2005).

This is the main reason why knowledge management within public administration cannot be adequately researched and studied other than in the G2G realm. Thus, a future trend is to study G2G processes as enablers in the deployment of knowledge management initiatives within government. Knowledge management in public administration is still in its infancy (Lenk & Traunmüller, 2001, pp. 70-71).

CONCLUSION

From the case study analysis and interviews, it is possible to conclude that responsiveness to a G2G process is far greater than that obtained in traditional processes. This agility, itself, is of paramount importance in deploying more effective and efficient public policies. Besides, the security issue in a G2G process is a critical factor, as breakdowns arising from it can cause losses not only for public agencies, but for society as a whole.

Moreover, to overlook the organizational culture of a public agency by concentrating efforts on a technological facet of a G2G project may cause the undertaking to fail. Nonetheless, public administration is ruled by the same legal agenda and must comply with similar procedures and rules. However, each public agency has its own identity, values and culture, leading it to develop different workflows, sometimes far different from workflows addressing a similar process in another public agency. To analyze the culture and values of a public agency is of paramount importance to the success of a G2G enterprise.

Finally, although technology offers people a user-friendly interface and, in some cases, the technology is already being used in the public agency, a G2G enterprise involves a *modus operandi* that is new for most of the people involved. It is necessary to show the benefits this new process can bring and the best *praxis*, as important steps for proper implementation of G2G projects (Joia, 2004).

The case study addresses the “process” and “cooperation” dimensions in the e-government taxonomy proposed by Lenk and Traunmüller (2001), as presented earlier in this article, as well as allowing public agencies to attain levels 3 (Business Process Redesign) and 4 (Business Network Reconfiguration) regarding the use of Information Technology, according to the model proposed by Venkatraman (1994).

This is a very recent knowledge field; therefore far more research is needed. This article attempts to make a contribution in this very challenging area, in the hope that the results achieved may benefit societies worldwide.

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KEY TERMS

BacenJud: An Internet-based linkage between the Brazilian Central Bank and the Brazilian Justice Department.

Business Processes: The interaction, coordination, communication and decision choices made by organizations in order to transform inputs (resources)—personnel, equipment, technology, information, energy, capital, and so forth—into products or services of added value to the customer/citizen.

E-Governance: The application of electronic means in the interaction between government and citizens and government and businesses, as well as in internal government operations to simplify and improve democratic, government and business aspects of governance.

E-Government: The various ways government uses information and communication technologies to remain relevant in the knowledge society.

G2G (Government-to-Government): The digital-enabled collaboration and cooperation perspective among distinct government agencies.

Knowledge Management: Techniques and tools for collecting, managing and disseminating knowledge within an organisation.

Metabusiness: A *quasi*-firm created through digital links among several companies, in such a way that it is almost impossible to know exactly its boundaries.

Category: Concepts, Trends, and Challenges

Business Process Analysis

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INTRODUCTION

Business-process management (BPM) is nowadays a key technology for the automation and support of processes in medium-sized and large organizations. This technology has been successfully applied to business-to-consumer (B2C) and business-to-business (B2B) e-commerce since the '90s, and it is now being applied also in e-government for the management of administrative procedures. As stated in Aalst, Hofstede, and Weske (2003), the origins of BPM technologies can be found in the '70s with the research on office information systems. Research in this area was almost stopped in the '80s, but it rose again in the '90s under the name of work-flow management. Now it is evolving with a more integral approach and a new name: BPM. It is defined in Aalst, Hofstede, and Weske (2003, p. 4) as "supporting business processes using methods, techniques, and software to design, enact, control, and analyze operational processes involving humans, organizations, applications, documents and other sources of information." The main functionalities provided by a BPM system are defining business processes, automatically enacting them, controlling their enactment, and analyzing them. This article is focused on the last functionality: business-process analysis (BPA).

BPA can be defined as a set of technologies that provide support for obtaining relevant properties of business-process models in order to reason about them, detect functional errors, or improve their performance.

BPA was a neglected area in the work-flow management systems developed in the '90s. Will van der Aalst (1998) was one of the first researchers in this field. He proposed the use of petri nets for modeling business processes and the application of the analysis theory developed for this formalism to demonstrate the correctness of the developed processes, analyze performance, and so forth. Since then, other approaches, based on formal methods, were proposed. BPA is important for BPM because it provides the technology for improving the reliability and efficiency of the business process of organizations. Reliability considerably reduces expenses caused by errors in transactions. Efficiency reduces expenses caused by an inefficient use of resources and can improve the satisfaction of customers.

The next section provides a background on the most important analysis technologies: functional verification and performance measuring. Then, the discussion is focused on functional verification. An overview on how different authors applied functional verification to business processes is presented. Then these works are analyzed and an open, modular, and extensible architecture for the functional verification of business processes is presented. Later, the future trends on this topic are outlined. Finally, the conclusion highlights the main concepts introduced in this article.

BACKGROUND

BPA technologies help process designers to reason about process models in order to guarantee a desired level of quality. The objectives of BPA can be classified into two main groups: functional verification and performance measuring. Functional verification consists of checking if the process is consistent with its functional requirements; that is, the process does always what it is supposed to do. Results of this type of analysis are used to correct functional errors in process models. Performance measuring consists of obtaining statistics about the performance of the process from the point of view of the customer (response times) or from the point of view of the organization that performs it (usage of resources). Results of this type of analysis can be used to obtain statistics, or to identify parts of the models that should be reengineered in order to improve performance. Depending on the type of reasoning needed, different analysis techniques are used. They are normally adapted from other fields like computer science. This section provides an overview of some of these techniques and shows how they are being applied for analyzing business processes.

Functional verification is an active area of research that is being applied to different fields, such as software engineering, digital-circuits design, or protocol design. As stated in Clarke, Grumberg, and Peled (1999), the main techniques for functional verification are guided simulation, testing, deductive verification, and model checking.

Performance analysis is used, for example, for designing telecommunication networks, operating systems, or manufacturing processes. Techniques for performance analysis are normally based on queuing theory and simulation (Gross, 1998).

Guided simulation and testing are two traditional and widely used approaches for verification. Guided simulation is performed by executing the process model in a fictitious environment provided by a simulator. The designer can, for example, guide the simulation, view or modify the content of variables, or put break points into the process definition. Testing consists of checking the correct behavior of the process in the real business-process management system before its definitive deployment. Although they are very useful analysis techniques, simulation and testing cannot, in general, analyze the behavior of all the possible execution traces of a process. In addition, they require too much human intervention and cannot be automated.

Deductive verification and model checking are techniques based on formal methods. They can be used to prove that a given property is true (or false) for every possible evolution of a process model.

Deductive verification is based on the use of mathematical axioms and rules for proving properties of models with the assistance of semiautomatic theorem provers. Deductive verification can be used to prove properties even in infinite-state process models. However, its main disadvantages are that it must be performed by trained experts, it requires a large amount of time, and it is an error-prone technique (Wang, Hidvégi, Bailey, & Whinston, 2000). These problems could be solved in the future with the development of more powerful theorem-proving algorithms. Formalisms like Z (Spivey, 1992), the B method (Abrial, 1996), or VDM (Jones, 1990) can be used for this purpose.

Model checking is a powerful technique for automatically verifying finite-state, concurrent systems. Verification can be performed using efficient algorithms. This technique was born in the early '80s with the development by Clarke and Emerson (1981) of the first algorithm for verifying CTL (computation-tree logic) properties in finite-state models. Since then, model checking has been an active area of research and much more powerful algorithms have been developed, like symbolic model checking or bounded model checking, combined with simplification techniques like abstraction. Nowadays, they can be applied to process models with a very large number of states (Clarke et al., 1999). Another advantage of this technique is the rich expressiveness of the temporal logics, like LTL (linear-time logic) or CTL, used to define the verification properties. There are several widely used open-source model checkers, like Spin, SMV (Symbolic Model Verifier), or NuSMV, which provide implementations of the most important state-of-the-art model-checking algorithms.

Business processes are modeled using specific languages and formalisms. Each BPM system normally defines its own proprietary language. Although there are several initiatives that try to establish a common language like XPDL (XML [extensible markup language] process definition language), BPML (business process modeling language), or BPEL4WS (business process execution language for Web services), none of them have succeeded until now. Deductive verification and model checking are based on low-level state- or transition-based formalisms, like, for example, petri nets or finite-state machines. Therefore, state- or transition-based formal semantics should be added to process models in order to be analyzable with these techniques. When using queuing theory for performance analysis, transformation algorithms should be defined in order to obtain queue net models from process models.

Several research works have demonstrated the feasibility of formal methods for verifying business processes. In the following, we describe briefly some of the approaches that apply formal methods to BPA.

Aalst (1998) was a pioneer in this area. He proposed petri nets as a formalism for modeling business processes. He states that petri nets can model complex business processes, and that the powerful analysis techniques developed for them can be used to prove the correctness of business processes. These analysis techniques can be applied both for functional verification and performance measuring. On the one hand, they can be used to prove functional properties (safety properties like invariants, or liveness properties like the absence of deadlocks). On the other hand, they can be used to calculate performance measures like response times, waiting times, occupation rates, and so forth. Woflan (Aalst, 1999) is a tool that demonstrates the feasibility of this approach.

Eshuis and Wieringa (2002) realized that, although UML (Unified Modeling Language) activity diagrams were gaining popularity as a business-process modeling language, they were not suitable for performing analysis on them because of their lack of formal semantics. They designed specific semantics for modeling business processes using UML activity diagrams. Verification was performed by automatically transforming UML activity diagrams into verifiable SMV models.

In Wang et al. (2000), the authors use VerySoft and the model checker Spin to verify processes in e-commerce applications. The main problem of this solution is that it cannot be automated because it requires the modeler to code the verification models.

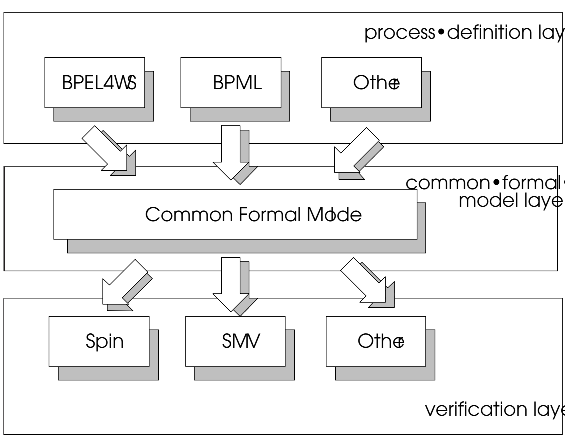
The field of the verification of Web-services compositions and coordinations has similar problems to those of BPA. There are several related works in this area. In Narayanan and McIlraith (2002), petri nets are applied to verify Web services defined using DAML-S (DARPA Agent Markup Language for Web Services). In Foster, Uchitel, Magee, and Kramer (2003), the authors propose the verification of BPEL4WS compositions by transforming them into LTSA (Labeled Transition System Analyzer) verification models.

ARCHITECTURE FOR BUSINESS-PROCESS ANALYSIS

The large number of business-process modeling languages and formalisms used now in BPM systems makes it difficult for the development of BPA systems to not be tied up to specific modeling languages. This is a big barrier for the commercial development of high-quality BPA systems. It also precludes the broad adoption by the industry of these kinds of tools. The situation can change in the long term if the BPM industry is capable of developing a commonly accepted modeling language. However, despite the fact that several attempts were made, this seems to be hardly possible for the short term. Therefore, BPA technologies have to face a great challenge in the short term: the development of BPA architectures in which different business-process modeling languages can fit.

VERBUS (Verification for Business Processes) is a first step toward this objective (Fisteus, Sánchez Fernández, & Delgado Kloos, 2004). It is based on an architecture that disconnects process-definition languages from verification tools by means of an intermediate layer. This layer provides a low-level state- or transition-based formalism specially designed for business processes. Process-definition languages can be integrated in this architecture by defining their semantics using the intermediate formalism of VERBUS and, based on these semantics, providing a translator from this language to the language of VERBUS. Once process models are translated to the VERBUS language, they can be translated to the input language of different verification tools. The current prototype of VERBUS provides translation tools to the input languages of Spin (Promela) and SMV, and can verify business processes defined with BPEL4WS. Figure 1 shows this architecture.

Figure 1.



VERBUS defines and uses its own intermediate formalism, which is formally defined in Fisteus, Marín López, and Delgado Kloos (2004). There is not yet research analyzing the expressiveness of this formalism, that is, if the formalism is expressive enough to be applied to any process-definition language. Future research should perform such an analysis based on work-flow patterns (Aalst, Hofstede, Kiepuszewski, & Barros, 2003). Other different formalisms, like petri nets, should also be considered for this intermediate formalism.

FUTURE TRENDS

An ideal BPA tool should be modular and extensible, enabling the installation of plug-ins for any process-definition language or analysis tool (performance-measuring tools, human-guided simulators, model checkers, etc.). It should be also easily integrable with BPM process-definition environments.

However, BPA is nowadays an emergent research area, and the proposed solutions are far from this ideal tool. There are only a few tools. Although there are too many business-process definition languages, the existing tools are, in general, designed for a specific language and verification tool. VERBUS is a first step toward this ideal solution, but it is only a research work in its first stages of development, and it is not clear if the intermediate formalism is expressive enough to model all the most used process-definition languages.

Research in this area should be focused on several areas. One area is the development of an intermediate and neutral formalism for representing business processes. This formalism should be expressive enough to be capable of representing processes modeled with major modeling languages. It should be also suitable for both functional verification and performance analysis. The achievement of this objective is difficult because of the variety of business-process modeling languages and formalisms used now in commercial BPM tools. Another area of research is the identification of generic properties to be verified in business processes. This research can be done by continuing the work of Aalst (1998) in WF-Nets (Workflow Nets). This would help to simplify the verification of processes by nonexpert people, and to integrate automated verifications in BPM tools.

CONCLUSION

Business-process analysis is an emerging technology that can provide many benefits to business-process management. It permits one to prove mathematically properties of business processes and to measure performance. This analysis can be applied at design time, or later as a diagnosis tool for reengineering processes.

Formal methods provide the foundations for BPA. Their feasibility for BPA has been demonstrated in multiple research works. However, BPA is not integrated yet in many BPM systems. In part, this is due to the fact that BPA tools are normally designed for specific business-process modeling languages, and that the research in this area is yet immature. Therefore, research in this area is needed in order to make BPA practical. An intem of special interest is in the development of a platform that could integrate many different process-definition languages in order to make them interoperable with proprietary BPMs.

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KEY TERMS

Business-Process Analysis (BPA): Set of technologies that provide support for obtaining relevant properties of business-process models in order to reason about them, detect functional errors, or improve their performance.

Deductive Verification: Technique that, based on models of systems defined as sets of axioms and rules, verifies them by mathematically proving propositions and theorems.

Formal Methods: Set of tools and notations (based on formal semantics) used for unambiguously specifying the requirements of computing systems that allow one to prove properties of specifications and to prove the consistency of implementations with their specifications.

Formal Verification: Act of proving or disproving the correctness of a system with respect to a certain property (specification) using mathematical formalisms and methods.

Model Checking: Technique for the formal verification of temporal-logics properties on finite-state, concurrent systems using efficient algorithms.

Petri Nets: Process-modeling technique based on directed bipartite graphs with two node types called places and transitions that are connected by arcs.

Queuing Theory: Mathematical study of waiting lines (queues and networks of queues) normally applied for designing telecommunications networks and transports.

Businesses and Consumers as Online Customers

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INTRODUCTION

The emergence of e-commerce as a way of doing business has created an environment in which the needs and expectations of businesses and consumers are rapidly evolving. Marketing managers must decide how often and how radically to adapt to the dynamics of the marketplace. Firms may simply offer a Web site, or they may embrace change as evidenced by frequent and/or major updates to obtain the maximum potential from e-commerce activities. Managers need to continuously evaluate their marketplaces to assess how much adaptation makes sense. The more managers know about customers' expectations and their likely reactions to e-commerce activities, the better they will be able to attract, satisfy, and retain online buyers.

BACKGROUND

Early adopters of innovation provide revenue needed to pay for research, development, and launch costs involved in bringing a new product to the market. This is true for adopters of a new e-commerce channel, as well. Further, although it is necessary to acquire new customers continuously to replace those who leave, attracting new buyers is not enough. Firms must retain at least a portion of first-time purchasers to remain viable. Loyal, satisfied customers add value for the firm because they tend to increase spending over time, spread positive word-of-mouth, and provide valuable feedback regarding the Web site (Reichheld & Schefter, 2000).

How are companies using Web sites to reach potential and current customers? Liu, Arnett, Capella, and Beatty (1997) examined the Fortune 500 to identify motivations for adopting e-commerce: the results include reduced costs of market coordination and improvements in efficiency, communication, and information processing. The presence of a Web page and revenues are often related (Liu et al., 1997)—this makes sense because, typically, homepages provide overview information about the companies and descriptions of products. The Web sites of smaller sized firms tend to focus on direct selling and immediate revenue generation, while larger firms' Web sites focus on communications, with apparent goals of building awareness and relationships. A focus on selling may neglect the need to communicate and assist potential customers in developing a relationship with a firm—this may be part of the reason so many smaller firms failed in the dot-com bust of 2000.

Although many of the critical issues are the same in business and consumer marketplaces, customer needs and behaviors differ for each of these types of markets. Pertinent observations are summarized in Figure 1 for convenient reference.

Characteristics of Business Online Buyers

Potential business online customers need to obtain specific information, including pre-sale support, delivery conditions, pricing options, documented quality, and post-sale service (Gattiker, Perlusz, & Bohmann, 2000). Search attributes (including product price, brand name, and warranty) and recommendations from others have greater influence online than in a brick-and-mortar retail store where other product features can be readily evaluated. As Web sites began to provide more of the necessary information, the business-to-business (B2B) marketplace exhibited phenomenal growth, far surpassing consumer online revenues. According to *E-Stats* (2002, 2003, 2004, 2005), an online publication of the U.S. Department of Commerce, B2B e-commerce in the U.S. totaled $913 billion in 1999, $997 billion in 2000, $1.01 trillion in 2001, $1.42 trillion in 2002, and was projected at $1.57 billion for 2003. In sum, B2B exchange is typically 94% of all e-commerce activity.

Figure 1. Overview of online buyer attraction, satisfaction, and retention

TYPE OF INTERACTION	Business-to-Business (B2B)	Business-to-Consumer (B2C)
Attraction	Marketing mix Customer demographics Convenience, efficiency Use of digital data transfer Availability of specific info Documented quality Support services Warranty	Marketing mix Consumer demographics Consumer psychographics (e.g., innovativeness) Positive attitude toward online buying Prefer online functionality Prefer online experience
Satisfaction	Lower prices On time, correct delivery Excellent communication Met expectations Lack of problems or opportunistic behavior	Positive online experience Outcome meets expectations Reduction of functional, financial, social, and psychological risk Recovery in case of failure
Retention	Repeated satisfying experience Consistent delivery Convenient re-buy Provide added value Customer relationship management (CRM)	Repeated satisfying experience Consistent delivery Post-sale support Frequent Web site updates Loyalty programs and CRM Building of trust

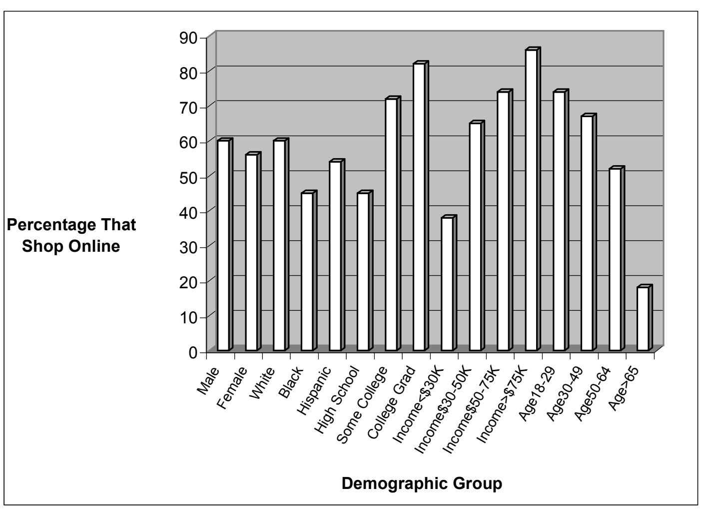
Some industries are more inclined to utilize e-commerce than others. *E-Stats* (2005) notes that 70% of all manufacturing e-shipments occur in only five industries, including transportation equipment, chemicals, computer and electronics, food, and petroleum and coal products. Merchant wholesaler e-sales were concentrated in only three industry groups, with drugs and druggist sundries, motor vehicle parts and supplies, and professional and commercial equipment and supplies explaining 61% of the total. There may be greater opportunities for increasing B2B e-commerce in industries that are not yet heavily represented.

Characteristics of Consumer Online Buyers

Shopping online has been adopted by increasing numbers of consumers each year, representing various demographic groups. Figure 2 relies on information from Lenhart et al. (2003) to provide a picture of Internet shopping behavior by demographic group.

Total business-to-consumer (B2C) online commerce, including services and retail trade, was $40 billion in 1999, $65 billion in 2000, $70 billion in 2001, $86 billion in 2002,

Figure 2. Online shopping by demographic group



and was projected to reach $106 billion in 2003 (*E-Stats*, 2002, 2003, 2004, 2005). Consumer trade represents only about 6% of the total e-commerce activity in the U.S. Four industry groups account for 45% of e-revenues in B2C services, including travel arrangement and reservation, publishing (including software), securities and commodities contracts intermediation and brokerage, and computer systems design and services (*E-Stats*, 2005).

Retail e-sales are concentrated in only two groups that total over 90% of this marketplace; these are non-store retailers, and motor vehicle and parts dealers. Retail e-sales grew 25% between 2002 and 2003, as compared to total retail sales growth of only 4% (*E-Stats*, 2005). Merchandise categories having the highest percentage of online sales include books and magazines, and office equipment and supplies. This is consistent with previous research, which suggests that books and CDs are common items for initial online purchases (Florsheim & Bridges, 1999). Other product categories are more likely to be purchased by more experienced online shoppers, and thus may have greater potential for e-tailer entry and growth.

ATTRACTING AND RETAINING ONLINE BUYERS

Attracting Business Buyers

Business buyers tend to purchase in large volumes and B2B sellers tend to have fewer, but larger, customers than B2C sellers. They are quite used to direct channels, and the Internet represents another mechanism for facilitating the supply chain. Further, they are typically motivated to find least-cost solutions, subject to meeting minimum requirements. When the same products are purchased repeatedly through a standard process, there is no need to interact with order takers or sales representatives. Of course, a number of personal selling encounters might be required before two firms agree to engage in automatic e-commerce. But then, a routine re-buy would certainly be flagged as the type of purchase that might be completed automatically, reducing both time requirements and the potential for human error. Thus, buyers tend to move online more easily for routine than non-routine purchases.

For a new purchase, the buying process might include protracted negotiation, reciprocity, or leasing; thus, it may be complex. Firms typically initiate a process of search and evaluation, possibly aided by information available on one or more Web sites. However, particularly if the product requires a large investment (such as capital equipment), it may be necessary to involve purchasing agents, sales representatives, engineers, and other personnel in a rather complex purchase process. The firms' online interaction may still be a part of the process, because it can provide information, reduce search costs, and facilitate relevant communication and post-sales follow-up activities. Companies also use the Web for many types of post-purchase support, ranging from reviewing technical specifications and ordering spare parts to participating in user group discussion forums.

Large firms are more likely than small firms to invest in installation of automated supply chain management and inventory control, such as an enterprise management system (Min & Galle, 2003). Moreover, firms in more information-intensive industry sectors are more likely to purchase online than those in less information-intensive sectors. Thus, firms that can best benefit from e-commerce are those that stand to gain the most from digital data transfer, enhanced supply chain efficiency, real-time information regarding product availability, inventory level, shipment status, and production requirements.

In summary, structural and economic factors drive businesses to switch to e-commerce. Such factors include newness of the type of purchase, specific inventory requirements, and benefits that might accrue from having a single hub.

Attracting Consumers Online

Online marketspace presents many advantages to consumers, including 24/7 availability, selection, perceived lower prices, online customer service, ability to personalize, no pressure from salespeople, and ease of search and comparison (Goldsmith, 1999; Hofacker, 2001; Xue, Harker, & Heim, 2000). Of course, there are also potential disadvantages, such as loss of privacy or personal information, delayed gratification owing to slow delivery, possible errors in order fulfillment, and inability to inspect or experience the product prior to purchase.

Individual attitudes and personal predispositions are important influences in consumer decisions regarding Web-based shopping (Goldsmith & Bridges, 2000). Further, buyers are more confident than non-buyers that orders will be filled accurately and promptly, that online merchants have good return policies, and that buying online offers good value. Goldsmith and Lafferty (2002) observe that innovative consumers tend to view online shopping as quicker, cheaper, and more fun than traditional shopping. Further, such consumers buy more online, report a greater likelihood of future online purchases, and believe themselves to be knowledgeable about online buying.

Factors that encourage consumers to buy online include utilitarian characteristics related to Web site usefulness and ease-of-use, and hedonic features related to enjoyment of the experience. Childers, Carr, Peck, and Carson (2001) use a technology acceptance model (TAM) to understand how characteristics of the Web influence its adoption. Although noting that usefulness is the primary determinant of a decision to adopt technology, Childers et al. (2001) anticipate that process dimensions of the online experience, and enjoyment in particular, may play a greater role than previously thought in a consumer's decision to shop online. Specifically, they postulate that context may differentiate the importance of various antecedents of technology adoption—their results indicate that usefulness is more related to shopping online when the goals are instrumental, while enjoyment is more related when the shopping value is hedonic.

What Web site design elements lead to increased buying? Flexibility in navigation, convenience, and substitutability of the Web site visit for personal examination of the product are critical (Childers et al., 2001). Further, the online experience must be intrinsically enjoyable, while it offers some improvement over the physical retail store. Design elements include structural attributes (e.g., frames, graphics, text, pop-up windows, etc.), media (graphics, text, audio, etc.), and site layout (organization of product offerings). Web site design may influence buying behavior by encouraging a state of "flow" in Web site visitors (Hoffman & Novak, 1996). This is corroborated by Goldsmith, Bridges, and Freiden (2001), who find a significant relationship between reported online buying and two key elements of flow—confidence and fun. Korzaan (2003) also observes an impact of flow on purchase; specifically, being in flow positively influences a customer's intention to buy online.

In summary, marketers must make efforts to address the needs of their respective target markets. Innovative shoppers view e-commerce as convenient, quick, and safe, and Web sites should be designed to facilitate search, selection, and purchase. Because some consumers enjoy the activity of online browsing and buying, enhancing the aesthetic and entertaining aspects of Web sites makes them attractive to consumers with hedonic goals.

Retaining Online Buyers

Attracting new buyers to online sites is only part of the job of the e-marketer; it is also important to generate customer satisfaction to retain those customers who have made purchases, and to build loyalty. This is difficult owing to intense competition and low switching costs in online environments, which provide customers opportunity and motivation to switch vendors (Xue et al., 2000).

Customer relationship management (CRM) systems are often recommended to enhance customer retention. These systems allow online collection of customer data and convenient interaction. Adopting an e-CRM system is often assumed to be a good way to draw together all of the elements of marketing strategy to obtain customer satisfaction, sales, and profit. However, recent research shows that although product customization ability is important, and the presence of some e-CRM features is positively related to customer satisfaction with a Web site, e-CRM activities are unrelated to success in attracting and retaining buyers (Feinberg & Kadam, 2002).

Retaining Business Buyers

Many of the characteristics of B2B relationships in traditional marketplaces continue to be of interest when building online relationships. For instance, the Internet may be used to facilitate collaboration between supply chain partners (Downes & Mui, 1998). Because it is difficult to develop and maintain trust in the online environment, a critical success factor in online business relationships is the absence of opportunistic behavior by either firm (Williamson, 1994). Freytag and Bridges (2003) observe that more dynamic marketplaces, characterized by changing relationship structures, require the firms involved to invest both financially and otherwise to obtain continuing relationships. Because online markets are so new and involve innovative players, they are inherently dynamic; thus, they would be expected to require continuing investment in order to be successful.

As the popularity of online B2B marketplaces grows, sellers may be expected to compete more strongly through differentiation that provides added value. By customizing the product to provide added value and integrating customers into its own systems and procedures, a firm may create switching costs that act as a barrier to leaving the relationship. Thus, an online B2B relationship strategy can create bonds between companies to the benefit of all involved.

Retaining Consumers Online

Providing the utilitarian and/or hedonic attributes desired by target segments may mean changing the Web site continuously, so it appears fresh and alive, and utilizing timely specials that appear at unpredictable intervals. Firms can also add value by offering information (e.g., product usage tips, specifications, manuals, parts lists, glossaries, histories) or by providing opportunities to interact with other buyers (e.g., games, chat rooms, and idea exchanges), which enhance flow and lead to more favorable attitudes toward the site and the sponsoring company.

Firms should prepare for rapid growth if they engage in marketing activities intended to draw new customers.

When online sales increase quickly, and firms are unable to sustain the aggressive pace, service quality erodes and the firm is vulnerable to competition. This may lead to price competition when it is least affordable (Oliva, Sterman, & Giese, 2003). Thus, the firm must set prices at a level to attract a sufficient number of customers, but also make a profit while continuing to provide quality service. Finally, it is important for B2C online vendors to build customer trust, because consumers are more likely to trade with online businesses that they trust (Gefen, Karahanna, & Straub, 2003).

FUTURE TRENDS

Web site design is crucial in attracting and retaining online customers—it is important for future research to address how best to do this. Hopkins, Raymond, and Grove (2003) suggest that available information and entertainment strongly influence customer attitudes and purchase intentions. Interestingly, they also find that site layout and functionality influence attitudes but not intentions to buy. Korzaan (2003) recommends that Web site designers attempt to enhance elements of flow associated with control, challenge, and stimulation. Specific ideas include eliminating error messages and dead links, and increasing interaction speed. Huang (2003) finds that complex Web sites are perceived to be useful (but distracting), while interactivity creates flow through control, curiosity, and interest. Thus, to attract online customers, the Web site should be designed to provide access to information/entertainment desired by the customer base, while meeting needs for control and stimulation.

To retain customers, e-commerce managers must cultivate a culture of service, by providing information and advice, and emphasizing promptness, helpfulness, and knowledge. Firms can also sponsor the development of online communities in which customers provide product feedback, information to each other, and recommendations that relieve the risk associated with online buying and encourage purchase (Hagel, 1999). Investigating how best to develop a culture of service online is another important direction for future research.

CONCLUSION

Unique features of the Internet allow tailoring of business strategy to match the needs of individual customers, driving attraction and retention. Many e-marketers are less successful than they should be in personalizing interactions because they do not match the extent of their (financial and time) investments to the levels desired by their customers (Moeller, Egol, & Martin, 2003). These authors suggest that, to create value and retain customers profitably, managers should optimize the entire customer interaction process to add variety to offerings, develop a deeper understanding of customer needs, and tailor business streams to provide value.

In summary, attracting and retaining customers online is much like accomplishing these tasks offline. Old recommendations are still true. Know your customers, create value, and provide satisfaction. Thus, managers should use research results to learn what customers need and want, and how they interact with the new media. Online marketplaces offer substantial advantages not available elsewhere, including the ability to provide information conveniently, to receive orders 24/7, and to unobtrusively gather customer database information for use in customer relationship management. Thus, over time the Internet will assume a place alongside other types of marketplaces, customers will shop and buy successfully, and businesses will thrive by adapting to this new reality.

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KEY TERMS

Buying Process: In B2B settings, buying raw materials, maintenance, repairs, and operating supplies is a necessary business activity involving multiple decision makers and formal vendor selection and evaluation procedures.

CRM (Customer Relationship Management): Refers to retaining and using information about customers in databases, to develop customer loyalty and increase sales.

Flow: A psychological state in which one is so focused on an activity that one loses a sense of self and of the passage of time.

Hedonic: Referring to the senses, feelings, and emotions.

Re-Buy: The B2B buying process may vary in complexity from a new task buying situation, to a modified rebuy where the firm shops for a new vendor of a current product, to a straight re-buy, which is a periodic, perhaps automated repurchase situation.

Supply Chain: This includes the sequence of activities and participants involved in the process of developing, producing, marketing, delivering, and servicing a product.

Utilitarian: Plain, practical, useful.

Challenges and Policy Imperatives for E-Government in Africa

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INTRODUCTION

Government is a system of social control under which the right to make laws, and the right to enforce them, is vested in a particular group in society. Organizationally, governments may be classified into parliamentary or presidential systems, depending on the relationship between executive and legislature. Government may also be classified according to the distribution of power at different levels. It may be unitary—that is, with the central government controlling local affairs—or it may be federated or confederated, according to the degree of autonomy of local government. When this system of social control is being implemented to a large extent on the platform of information and communication technology (ICT), then we have an electronic government (*e-government*).

E-government refers to the provision of online public services to citizens and businesses. Services for citizens include registration to government services, such as health care, education or employment benefits. For businesses, e-government services can take the form of online alerts for public procurements or funding opportunities as well as information and support on applicable legislation in a given sector. E-government is widely viewed as an extraordinary opportunity for administrations to cut down their costs, speed up procedures and, therefore, increase their efficiency and reactivity. No doubt, e-government has grown in the past decade worldwide. Its efforts can vary from Web portals to online license renewals to experimentation with online voting. E-government is generally recognized as a means of making government more efficient while allowing it to be more responsive to customer needs (Jeffery, 2005).

The growth in e-government has been rapid. For example, in the United States, the percentage of local governments with Web sites increased from 8.7% in 1995 to more than 80.0% in 2000 (Holden, Norris, & Fletcher, 2003). Advances in ICT are helping to make the growth in e-government a global phenomenon. A United Nations report shows that governments around the world are moving towards higher levels of e-government to better serve their citizens (UN-ASPA, 2002).

In Africa, e-government is not yet widespread. However, some African countries have embarked on e-government initiatives and have recorded varying degrees of success. This article aims at reviewing some of these initiatives and ultimately recommends the way forward in terms of policy issues and strategies that African governments must put in place for their e-government projects and initiatives to be worthwhile.

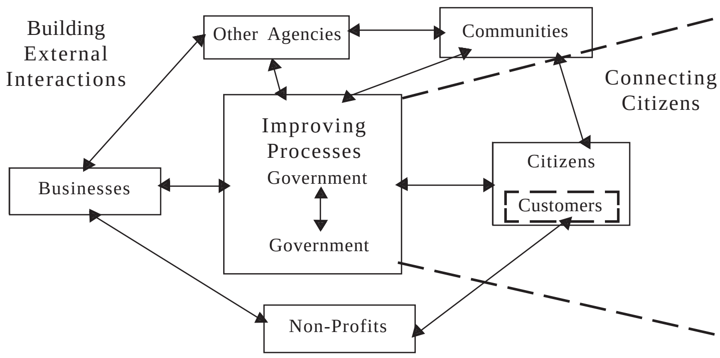
BACKGROUND

There is no unique, agreed definition of e-government. The term is being used extensively nowadays to refer to the use of ICT by government agencies. It is the application of ICT to improve efficiency and effectiveness, create transparency and accountability of informational and transactional exchanges within government, between governments and government agencies at national, state and local levels (G2G), citizens (G2C) and businesses (G2B) (Heeks, 2001a). According to Abet Open University (2004), G2C, G2B and G2G e-government is all about government agencies working together to use technology so that they can better provide individuals and businesses with government services and information. Much of it is about: establishing common standards across government; delivering services more effectively; and providing ways for government agencies to work together, all using the best technologies available.

Put differently, e-government refers to the use by government agencies of information technologies (such as Wide Area Networks, the Internet and mobile computing) that have the ability to transform relations with citizens, businesses and other arms of government. These technologies can serve a variety of different ends: better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information, or more efficient government management. The resulting benefits can be less corruption, increased transparency, greater convenience, revenue growth and/or cost reductions (Abet Open University, 2004).

According to Heeks (2001b), e-government is the use of ICTs to improve the activities of public sector organizations. He holds that all digital ICTs are included, as well

Figure 1. Domains of e-government initiatives (Source: Heeks, 2001b)



as all public sector activities. He holds that there are three main domains of e-government, illustrated in Figure 1:

- **Improving Government Processes:** e-administration
- **Connecting Citizens:** e-citizens and e-services
- **Building External Interactions:** e-society

Respectively, these particularly address the problems that government is too costly, too inefficient and too ineffective (e-administration); too self-serving and too inconvenient (e-citizens and e-services); and too insular (e-society).

HIGHLIGHTS OF E-GOVERNMENT INITIATIVES IN AFRICA

An e-government project in Nigeria was the management information system (MIS) to assist with management of the university sector in Nigeria. The MIS was originally planned to run on a PC using dBase software, with a PC placed in the administrative sections of every Nigerian university, and further PCs at the federal-level Nigerian Universities Commission (NUC). The application was supposed to perform the following functions: to act as the central point for collection of data from individual Nigerian universities on students and staff, building a comprehensive statistical database; to have that data utilized by the NUC and Federal Ministry of Education for the purpose of planning and development of infrastructure, and for the production of statistics such as student registrations, staff/student ratios, gender and geographical distributions; and to provide support to individual universities for the purpose of processing examination results and transcripts.

The project began in 1993, and despite the significant sums that have been invested, it has still not been able to achieve the objectives that were set, leading it to be seen as a white elephant and a waste of money. No university has been able to generate either transcripts or correct enrollment data from the system, and the NUC has stopped the funding of the project in a number of universities. The project has been largely unsuccessful, considering its long duration and the level of achievements recorded. This was due to the fact that the project and its design given by the individual universities were not well used by the project coordinating unit within the NUC and to frequent changes in political leadership, which was mirrored by a lack of continuity within the government policy-making body overseeing the use of data and ICTs in the university system (Anonymous, 2002a).

In Mozambique, the Beira Executive Council (the local government authority for the city of Beira in Mozambique) initiated development of a decision support system, with a simple geographic information system (GIS) interface. Jackson (2002) reported that the data for the main database was based upon the register of city land plots, their zoning (open space, industrial, residential) and their status (vacant, under development, built on). The application produced information in two forms: a database report with information on plot status, and a digitized map of city plots that spatially represented the database. A common database package was used to hold the database, which was run on two stand-alone PCs linked to a digitization tablet and two printers.

The operation of the database produced politically sensitive information about plot usage, some of which was used as an excuse to settle old scores. However, the application never properly worked, it never replaced the old system and it was never updated after initial implementation. Its impact on operational decisions was negligible. Thus, the project failed to influence decision-making as anticipated and, therefore, can be deemed a total failure. However, the installation introduced computer literacy into the Registry and, as an adjunct, greatly increased use of word processing (Jackson, 2002).

In Uganda, there was the electronic voter registration project, which was a citizen service to take photographs of all citizens of voting age using digital cameras. The photographs were then to be loaded onto a voters' register database. The database was supposed to be maintained on a mainframe at the Interim Electoral Commission (IEC) headquarters, which would be connected to District Electoral Commission offices through the Internet. It was supposed to be used as the basis for voter identification at polling stations for the 2001 election. There were no formal benefits, because the system was not put to use for the 2001 elections.

The project has been described as a total failure due to the fact that things went wrong at an early stage with the hardware, with criticism that the tenders for procurement of the digital cameras were not transparent, leading to problems with the equipment delivered, and with reports that a number of the cameras were stolen from what should have been a safe government store. Although citizen photographing did proceed, it took place within a very short time and many people were not captured by the system. There were complaints from opposition parties that security agency staff had intervened in the workings of the computer system (Anonymous, 2002b). The initiative failed largely because it was a technical instrument introduced into a highly politicized situation; a situation in which there was a perceived lack of political will from government to implement the system as intended; a lack of political awareness on the part of many Ugandan citizens; and a lack of capacity on the part of the IEC to create conditions in which the system would not only be used impartially, but be seen to be used impartially.

In South Africa, there was the e-government initiative of supporting democracy with ICTs by South Africa's Independent Electoral Commission. This was the use of ICTs to manage the electoral process in South Africa during the 1999 parliamentary and presidential elections. The technology was used for voter registration, the polling process, relaying of ballot collection and verification, and relaying of results of the elections throughout the country. The hardware and software used included a satellite-enabled wide area network (WAN), plus connection to fax machines. These were used to enable people in rural areas to participate in the electoral process. Bar code readers enabled voters to be registered as well as votes to be counted. A GIS was used to draw up boundaries around the districts. An election center with a set of heavy-duty servers was linked to a giant call center to collect and display results to the public. The application was used to manage the electoral process (Mutula, 2002).

According to Mutula (2002), the positive impacts of the e-government application are claimed to be: enhancing the free and fair democratic process in South Africa; increasing transparency of the electoral process; putting in place an enduring infrastructure for future elections, for example, the WAN; and increasing the efficiency of the voter registration and polling processes, among others. It was largely successful, as the electoral process was expeditious, long queues during voting were not experienced, and the electoral process was accepted by the great majority of stakeholders as transparent, free and fair.

Also in South Africa, there was a Personnel Information System (PIS) for Southern African Government. This was an integrated PIS—consisting of a basic data entry/storage component and an MIS component—that would handle details of all public servants. Its introduction has been largely unsuccessful. Though it was implemented, it was hardly used. More than 3 years after the system was finally introduced, personnel data was only being updated by the ministry's staff. After some initial attempts, staff in the ministries and departments reverted back to their manual personnel records.

Another e-government initiative in South Africa was the Computerised Integration of Two Pension Funds in Southern Africa. The national Welfare Agency administers a variety of social security funds, including a National Pension Fund (NPF) paid to those who retired normally from work, and a Workers' Compensation Fund (WCF) paid to those forced to retire because of workplace injury, or to their dependents in case of death. The application was the planned introduction of IT into the Welfare Agency in order to computerize and integrate and decentralize the previously separate, previously manual, previously centralized operations of the NPF and WCF. This involved a national network of PC workstations and servers using a single national database of contributors and claimants (Kekana & Heeks, 2003).

According to them, the project was partly successful and partly not. In terms of successes, the project has improved service delivery. For instance, for fairly simple benefit claims, lead times have come down dramatically and employers now receive a single unified monthly bill for the two Funds that is generally accurate and timely. This has made debt-chasing a faster and more confident process. Also, numbers of complaints have been reduced, and business can be transacted directly at a local office (Kekana & Heeks, 2003).

POLICY ISSUES AND STRATEGIES FOR THE SUCCESS OF E-GOVERNMENT INITIATIVES IN AFRICA

From the preceding section, it is noteworthy that the e-government initiatives in the African countries reviewed did not record the same level of success. Only one in

South Africa was actually successful, one was partially successful and the third was unsuccessful. None of those in other countries was successful. Why is this the case?

Heeks (2002) submitted that e-government in Africa is essentially a concept based on imported designs. There are growing numbers of e-government projects, some of which are contributing to public sector reform and delivering gains of efficiency across a broad agenda. However, this positive picture must be set alongside significant challenges. E-government is only slowly diffusing within Africa because of a lack of readiness. According to Heeks (2002) e-government projects in Africa arise particularly because e-government concepts and designs have their origins in the West. The challenges, he submitted, are the following:

- E-government solutions designed for one sector or country are being forced directly into a very different reality, creating failure.
- Many of the key players—donor agencies, consultants, IT vendors and African civil servants—are complicit in the continuing importation of inappropriate, Western e-government models and systems.
- The gulf between IT professionals and mainstream public servants/politicians is one root cause of design-reality gaps and, hence, of failure in African e-government projects.
- Successful projects are those where key stakeholders cross this gulf by being hybrids: those who understand the technology and the business of government and the role of information in government.

Failure will remain the dominant theme for e-government in Africa unless the above challenges can be addressed and appropriate policies put in place. In specific terms, therefore, policy options for the success of e-government in Africa should address the following:

- **Vision and Strategic Agenda:** African societies keen on using ICTs to improve governance must build a shared vision backed by a strategic agenda. This must include, among other things, broad principles on the nature of the information society they plan to build, the form of governance, the character of government and the role of the people, with a strategic agenda for ICTs in making the vision a reality. Preceding each ICT project to improve governance, the "governance goals" to be addressed must be selected. In addition, the goals must be specific and measurable. In developing the ICT project, formulating the strategic agenda and selecting the objectives, the following steps could be followed: Select and prioritize improvement goals, develop and evaluate alternative ICT solutions and develop the implementation plan, with monitoring, evaluation and feedback (Bhavya, Gaumer, & Manhica, 1999).
- **Building the Infrastructure:** A key challenge that must be addressed if African countries are to be able to exploit the opportunities provided by ICTs for improved governance is the lack of infrastructure. Telecommunication infrastructures will have to be upgraded and extended to where there are none right now. With little financial resources, creative solutions can be found. The satellite revolution holds considerable promise for African countries in this regard. Wireless technology, such as cellular telephony, is already making a difference in some parts of the continent, and this could be exploited for the success of e-government.
- **Creating Data Banks:** Data banks designed to serve critical economic sectors are of the utmost importance in harnessing the power of IT for e-government projects and initiatives. Data banks should be set up that will serve as repositories of accurate and reliable socioeconomic data about the activities of government in the different sectors. The development of a government-wide or country-wide data bank presupposes the availability of resources to make this work. Thus, African governments should make provision for a national data bank and an integration of the data bank with related systems; availability of manpower and tools to manage the databases and information network; improved awareness of and provision of user-friendly access to the data bank and so forth. The National Data Bank in the respective African countries, where they exist, should be strengthened and put in charge of this sector, and be created where they are nonexistent (Olatokun, 2004).
- **Human Resources and Institutional Capacity Building:** Human and institutional capacity will have to be built to facilitate the use of ICTs for improved governance in Africa. At the institutional level, African countries will need effective institutions that can set and implement policies, provide the regulatory framework, manage the policy environment to encourage competition and facilitate universal access. At the human level, policy makers will have to build their skills and develop an understanding of what it takes to implement ICT projects for improved governance. Likewise, educational curricula from primary schools through to universities must include computer training. Women and youth, those left out traditionally, must also be targeted.
- **Building the Right Policy Environment:** The role of governments in creating an information society that

can seize the opportunities provided by ICTs is crucial. In this connection, governments must help create the right regulatory and public policy environment based on stakeholders' participation and consensus building. African governments will also have to ensure that their ICT strategies and actions play a catalytic role.

FUTURE TRENDS

E-government is about opportunity. For both governments and citizens, clearly its advantages far outweigh the risks of investment. With a regional index of 0.84, Africa's e-government capacity could be described as deficient (Ronaghan, 2002). Clearly, this reflects a near total absence of the core areas necessary to sustain an enabling e-government environment. But despite the region's appalling lack of an adequate telecommunications infrastructure, nearly all Sub-Saharan countries have some form of Web presence. Seventy-five African countries offer only static information Web sites. There are, however, several notable exceptions: South Africa (1.56), Djibouti (1.35), Gabon (1.17), Cote D.Ivoire (1.05), Nigeria (1.02), Ghana (0.98), the Central African Republic (0.98), Congo (0.94), Mauritania (0.91) and Kenya (0.90), all of whom exceed the regional Index of 0.84.

As demonstrated above, e-government is no longer an experiment in administrative reform but a crucial part of the governing process in some African countries. In some, however, efforts have to be geared towards effective adoption of e-government. Yet, how a country chooses to approach, design and ultimately implement e-government is dependent upon its capacity to put the right policies in place and sustain an enabling environment with a view to addressing the needs and priorities of its citizens. Hopefully, in the few years to come, many more African countries will have adopted e-government in their operations by upgrading their online services, while many more will be striving to find the best possible approach to the adoption of e-government.

CONCLUSION

E-government has already arrived in some African countries, as some of them have embarked on e-government projects. However, there are several challenges that could be addressed through customization of e-government practices to match African realities. Consequently, we submit that it is imperative for deliberate policy strategies to be implemented to make e-government initiatives a success. Areas of concern for such policy strategies should include a clear-cut vision and strategic agenda, infrastructure development, human resource capacity building and the building of the right regulatory and policy environment. It is hoped that if these policy issues could be addressed in the respective African country's ICT policy, the future of e-government in Africa cannot be but bright.

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KEY TERMS

Africa: The second largest continent; located south of Europe and bordered to the west by the South Atlantic and to the east by the Indian Ocean.

E-Administration: E-government initiatives that deal particularly with improving the internal workings of the public sector.

E-Citizens: E-government initiatives that deal particularly with the relationship between government and citizens; either as voters/stakeholders from whom the public sector should derive its legitimacy, or as customers who consume public services.

E-Government: The use of information and communication technologies (ICTs) to improve the activities of public sector organizations.

E-Society: E-government initiatives that deal particularly with the relationship between public agencies and other institutions—other public agencies, private sector companies, nonprofit and community organizations.

Information and Communication Technology (ICT): Includes technologies such as desktop and laptop computers, software, peripherals and connections to the Internet that are intended to fulfill information processing and communications functions.

Initiative: The characteristic of originating new ideas or methods.

Policy: A course of action developed for the achievement of a set of goals.

Strategy: A plan or method for obtaining a specific result.

Classification Systems

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INTRODUCTION

Classification systems are an easy way to assign objects such as products, services, or even company profiles to a category. Classifying information offers many advantages when dealing with a large amount of different information. For example, it enables one to find information by group or to easily detect similar items. They are meaningful wherever a large set of different, but sometimes similar information is managed. In order to clarify the meaning and the application of classification systems, the following text starting with an example in the area of electronic product catalogs. Important background information about classification systems is given as well as a list of typical classification systems. The text will describe the advantages of classification systems and their meaning for future e-commerce scenarios. The main problem of classification systems today is focused as is the compatibility of classification standards and therefore the reclassification process.

BACKGROUND INFORMATION

The area of product classification gains more and more importance in the e-commerce domain. Within the e-business domain, e-commerce is practically not feasible without the usage of classification mechanisms. The increasing stress of competition of the last years leads to shorter product cycles and to an increasing amount of products. An assignment of products into an organizational structure helps to keep an overview about a large amount of products (see Hentrich, 2001). An essential characterization of e-business is to offer products from more than one manufacturer in a single electronic catalog, for business-to-business relationships as well as for business-to-consumer commerce. There are often catalogs, containing a large number of different products from various manufacturers. In order to group similar products, it is necessary to arrange products into product groups. Classifying products with the help of classification systems can boost this process. When adding classification data to a product description, those products can be found faster and easier and a comparability of products is supported as described in Wollin (2002) and Ramakrishnan (2000). In order to classify them, a number of different classification systems were developed, which differ in their purpose, domain and general structure; that is, in using hierarchical structures. An overview about established classification systems is for example given by Omelayenko and Fensel (2001a) and a short overview is also given within this section. Abecker, Tellmann, and Grimm (2001) can be recommended for an overview about common B2B standards. A product catalog that is based on a classification system provides a large economy of time when searching products and comparing them to similar products. An integration of new products into an existing e-business catalog is eased significantly, since all products contain information about their category. Groups and classes are unchangeably defined by a classification system (see Grabowski, Lossack, & Weißkopf, 2002), which means that all products can be classified based on the defined categorization of the classification system. The advantage is that a single string is sufficient to classify a product. For example the string *49-23-15-13* in the UNSPSC-System[1] means that the product is classified as a *toy train*. Integrating new products into an existing group structure is simplified when interpreting classification information. For example, if you own a web shop and you already defined a category *toys*, then you can simply add all products, starting with the classification string *49-23-15* to your category if they are classified using the UNSPSC-System.

Product classification is only one example for the usage of classification systems. There are also a broad number of other use cases. For example, classification systems are often used to classify services in registries such as web services in UDDI- or ebXML registries (see Dogac, Laleci, Kabak, & Cingil, 2002). The North American Industry Classification System (NAICS)[2] can be used for classifying business establishments. For example, the classification code *339932* in NAICS identifies *Game, Toy, and Children's Vehicle Manufacturing*. There are many other situations where classification systems are used. In general its usage is meaningful wherever a large amount of different but sometimes similar objects are managed including product catalogs, service registries and company catalogs.

Managing Different Terminologies and Taxonomies

When dealing with a big amount of similar information, as done in electronic product catalogs or registries such as UDDI or ebXML, there are many ways to organize and group similar items. For example, in the domain of product catalog, there are product groups, defined within each catalog. A product group contains several products. It can contain a set of sub-groups and can therefore be connected to a parent-group. This makes it similar to classification systems. There is, however, a significant difference. Classification systems are defined independently from the concrete catalog or registry. Contrary to this, product catalogs and similar concepts are defined for each set of objects separately. For example, in many cases, each product catalog defines its own catalog groups with its own structure (taxonomy) and its own names for categories (terminology). This means, that taxonomy and terminology differs from catalog to catalog. When using classification systems, only a reference to an entry of a classification system is added to the object. For example *49-23-15-13* is added to the product data. This means that there are no conflicts in the terminology and no different taxonomies since the same element is referenced, independent from the concrete catalog. This makes an integration and combination of multiple catalogs or registries much easier. Hence, it is very advisable to add additional classification information, even when using other concepts such as catalog groups.

Vertical and Horizontal Classification Systems

Classification systems are developed for usage in a defined domain, such as the classification of products or the classification of services. As described in Omelayenko and Fensel (2001b) classification systems can be divided into two different groups:

The first group consists of horizontal classification systems. Those try to cover all areas of a certain domain. Well-known examples are the ECl@ss-system and UNSPSC. UNSPSC is a hierarchical system, based on four hierarchical levels. It consists of more then 12,000 different product groups, which are located on the fourth level (for details, see Ramakrishnan, 2000). UNSPSC is the best known international classification system for products. A direct competitor is ECl@ss, which is based on four hierarchical levels, too. Furthermore, ECl@ss defines attributes for all of the >12,700 categories.

Although the number of categories is very high, horizontal classification systems are not detailed enough for all applications. For example the number of categories for classifying toys might not be high enough for a company that is specialized on producing toys. This manufacturer will not need any other classification area than those dealing with toys. For this purpose, the usage of vertical classification systems is common. Vertical classification systems concentrate on a certain part of a domain but they tend to define this part in a very detailed way. An example for a vertical classification system is ETIM, which was defined for classifying electro-technical products. Figure 1 shows the mentioned concepts graphically.

Structure of Classification Systems

The easiest way of defining a classification system is by providing a simple table with classification codes and their description. Many classification systems are, however, structured more complex. In order to use advantages derived from inheritance information, most classification systems have a hierarchical structure. For example, UNSPSC contains a category *toys*, which contains a subcategory *musical toys* and *toy vehicles*. This hierarchical structure enables not only a selection of entries that belong to a certain category but also to select all entries that belong to a parent category.

Figure 1. Horizontal and vertical classification standards

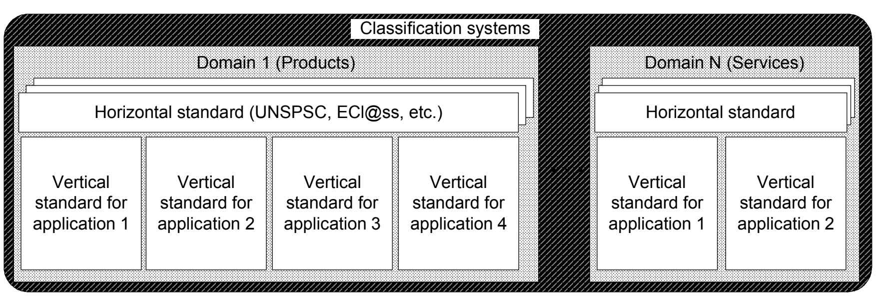
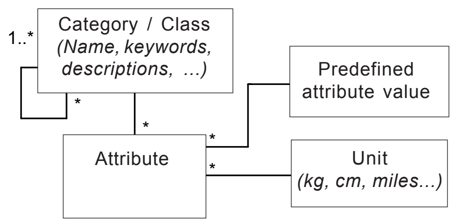


Figure 2. The structure of a classification system



Additionally, some classification systems allow the usage of attributes for a category, which will be inherited by the products classified in the subcategory. Those attributes are used to express more details such as the color or the shape of a product or its manufacturer (see Hepp, 2003). Some classification systems even provide a set of units such as [kg] of [inch] for those attributes.

The eCl@ss system defines keywords and synonyms for each category and provides this information in multiple languages. The usage of attributes, keywords and synonyms as well as a more detailed description of a category can simplify the classification process for enterprises. It helps to avoid confusions and misunderstandings for similar categories. Figure 2 shows the structure of a classification system providing those concepts.

Overview about Existing Standards

The following table shows a selection of standards in the domain of classification systems. Because there are many different classification systems for different domains, this table only summarizes the most popular standards. Since identification standards are often used within the same area, the table also contains some identification standards. For example, DUNS is often recognized as a universal standard for identifying and keeping track of businesses. Unlike this, classification systems are used "To assign each product to a product group corresponding to common attributes or application areas" (Leukel et al., 2002, p. 1).

CHALLENGES OF CLASSIFICATION SYSTEMS

In future e-commerce scenarios, classification systems can play an important role because they enable to process data automatically by defining semantics, up to a certain degree. In the domain of product catalogs, this means that companies could easily integrate product catalogs of business partners into their own catalog or into an existing e-procurement system (see Hentrich,

Table 1. Important standards

Name of standard	**Type** (classification / identification)	**Body**
EAN.UCC	Identification	EAN International and Uniform Code Council *http://www.ean-ucc.org*
EGAS	Classification	ECCMA Global Attribute System *http://www.eccma.org*
ETIM	Classification	ETIM e.V. *http://www.etim.de*
IEC 61360	Classification	IEC TC3 *http://tc3.iec.ch*
ISBN/ISSN	Identification	International ISBN Agency *http://www.isbn-international.org*
ISO 3166	Classification	International Organization for Standardization *http://www.iso.org*
NAICS	Classification	U.S. Census Bureau *www.census.gov/epcd/www/naics.html*
UNSPSC	Classification	UNSPSC initiative / ECCMA *http://www.unspsc.org*
eCl@ss	Classification	eClass e.V. *http://www.eclass-online.com*
DUNS	Identification	Dun & Bradstreet *http://www.dnb.com/us*
profiCl@ss	Classification	proficl@ss International e.V. *http://www.proficlass.de*
RosettaNet RNTD	Classification	RosettaNet Consortium *www.rosettanet.org/technicaldictionary*
SIC	Classification	Standard industrial classification *http://www.osha.gov/oshstats/sicser.html*

2001) with respect to their own product groups and without adding manual work. It also means that it is easily possible to find similar products and to make products comparable. There are, however, several challenges and problems that have to be solved. Those will be addressed in the following sections.

Compatibility between Standards

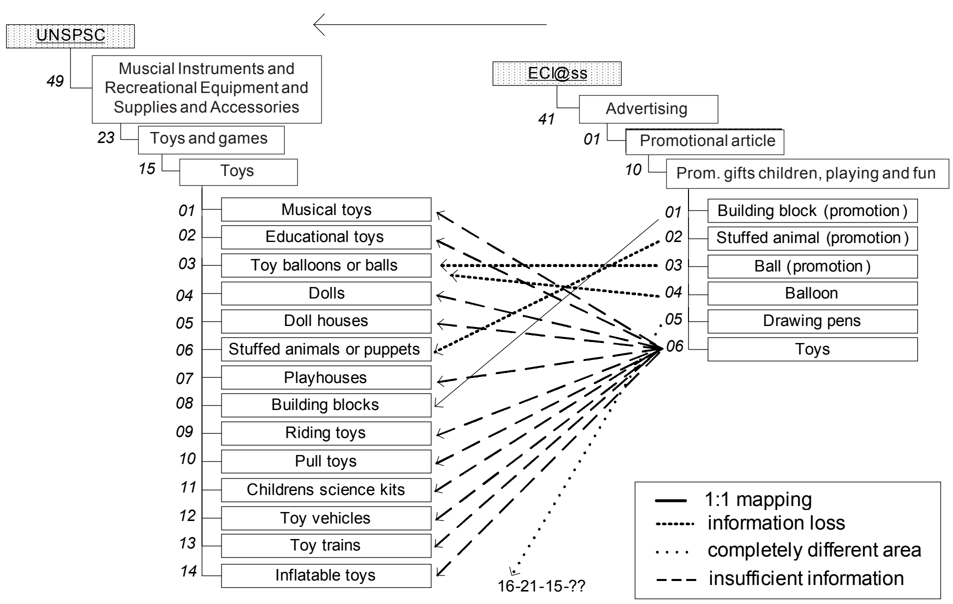
A usage of classification systems has a high potential and many advantages for all participating companies, as described in the last paragraphs. If both use the same classification system (e.g., UNSPSC), an automatic integration of is possible.

Because of different needs and requirements for classification systems, there is no common standard, used by all companies. As explained in the last paragraph, there is a coexistence of many different classification systems (horizontal and vertical), which are sometimes directly competing. Furthermore, many enterprises are using their own (proprietary) classification system to classify their objects (services, products, etc.) for internal usage.

Because of different scale, different structures and various semantics, most classification systems are incompatible, as noted in Schulten et al. (2001). This leads to problems in integrating data when using heterorganic software systems. To reach an automatic or semiautomatic integration of, for example, products into a product catalog of an e-business partner, an interoperability of all participated systems is needed, as described in the introduction. Interoperability in this context can be defined as the ability of two or more systems or components to exchange information and to use the information that has been exchanged" (IEEE, 1990). According to this, not only is a syntactical exchange of data needed but a way to use this data is also needed, which basically means an understanding of semantics. A nontrivial transformation in form of a reclassification of data is needed, whenever two systems are based on different classification systems. For example, it might be necessary to integrate an object, which is based on UNSPSC into a system, which needs eCl@ss information. This means, that a reclassification has to be performed. In case that an unknown classification was used or in case that the objects were not classified at all, an initial classification has to be performed. Therefore, the challenge is in performing a semantic integration transformation of data, based on one standard into another one.

It should be stressed that the needed integration is not just a syntactical integration of the data format, such as BMEcat or any other XML format, but an integration of the classification information, which needs a semantic analysis of data. While converting the data format could be performed with a number of transformation and mapping approaches on the model layer (such as XSLT or the usage of converters, see Omelayenko & Fensel, 2001a), the semantic integration has to consider the data and a more complex number of information. In most cases, a mapping of structures is not satisfying, but an interpretation of data is needed to classify and reclassify information. Figure 3 shows a part of a possible mapping between ECl@ss and UNSPSC.

Figure 3. A possible mapping between ECl@ss and UNSPSC



A direct mapping of categories is only possible in the two different categories, which are displayed as green lines in the figure. The blue lines of the figure are representing mappings that can be performed without problems but which are causing a loss of information, because several products ("Ball [promotion]" and "Balloon") will be included in a single category, which will make it impossible to decide between them any longer. More problematic are the red colored lines, which indicate mappings that can not be performed without knowledge of the data: Products of the category *toys* in ECl@ss could be mapped to more then one category in UNSPSC such as *toy trains* or *musical toys*. It is therefore necessary to perform an analysis of the data itself to make a case-based decision. This means that it is not possible to develop a converter between classification standards without analyzing each product separately.

Approaches for Automatic Classification and Reclassification

When looking at classification systems, an important task is the classification process itself. Beneventano and Magnani (2004) noted that a manual approach is not only tedious, but also cost intensive and error prone. For example, in the area of product classification, Wollin (2002) identified costs of approximately 0.25 USD per product, which is a high expense factor when integrating thousands of products into a large catalog. This means that the usage of classification systems would not be feasible for a large amount of low-cost products, especially since the classification process needs to be repeated for every new classification system, which is an unacceptable hurdle.

In order to foster the usage of classification systems and to make the integration of classification information as cheap and comfortable as possible, a number of approaches and tools were developed in the last years. Those solutions should help to improve the process by performing either an automatic classification/reclassification of product data or by offering a semiautomatic environment to add classification information into electronic product catalogs.

Approaches to automating classification can be found in several software products such as Storeserver (see http://www.storeserver.net) in the area of product classification. Most of them are performing a textual analysis of the objects description. Leukel (2004) stated that most of these textual analyses adapted for product classification are mainly algorithms and tools for classification in general (i.e., VSM [Vector Space Models] or Bayesian classification). Hence, most existing products concentrate on performing their analysis based on interpreting the textual descriptions of products.

The biggest problem of those solutions is the extraordinary high number of possible classes in the classification process. Naïve Bayes and other machine-learning approaches have proven to work quite well to classify data into a limited number of clearly separated classes. For example they are often successfully used to classify spam see Androutsopoulos, Koutsias, Chandrinos, and Spyropoulos, (2000). In the scenario of classifying products into classes of a classification system, it is much harder to classify documents because:

- the number of possible classes is high (e.g., eCl@ss has more than 24,000 different classes),
- the semantics of classes is sometimes very similar,
- the amount of information for each class is low (in most classification systems, it is only a one-line-description for each class), and
- in many cases there are not enough objects to generate a learn-effect for machine-learning approaches.

Hence, solutions for automatic product classification have to use a large training set of similar products. For example the GoldenBullet approach described in Ding et al. (2002) achieves a precision of 78% with one a Naïve-Bayes classification to classify 40% of the products, while they used the other 60% of the same product catalog as training data for the algorithm. They testified that this rate is already higher or at least equal to the error rate of a manual classification.

In order to lower the number of necessary training data and to perform a more accurate classification, research is under progress. For example, the Apricot framework (see Abels & Hahn, 2005) intends to interpret synonyms and to consider information that can be extracted from existing classification information, which is often neglected in existing solutions. This is especially important when having to perform a reclassification of objects. For example, if a product needs to be classified based on the eCl@ss system but has already been classified using the UNSPSC standard then a broad amount of additional information could be used to perform an automated reclassification; that is, the description of the UNSPSC-class or its hierarchy information.

FUTURE TRENDS

Classification systems have proven as a common way of integrating objects into a common catalog or into existing software solutions such as e-procurement systems. The usage of classification system got more and more attractive in the last years. For example, the classification specification of NAICS and UNSPSC are included within most ebXML and UDDI registries. Most e-procurement systems are able to handle UNSPSC as well. There are several standards in this domain that tend to have a broad support by companies. In the domain of product classification systems, UNSPSC is one of the most important standards with worldwide usage. The second important standard is eCl@ss, which has an increasing popularity but is less used than UNSPSC from a global point of view. For classifying business establishments, NAICS became the most popular international classification systems.

A major problem of classification systems today is the complete incompatibility between standards, even if they are defined for the same domain such as product classification. In order to resolve this, it is either necessary to agree on a common (worldwide) standard or offer a way of transforming information, based on one classification system into another standard. The first solution, agreeing on a common standard, is very unlikely since every company got its own needs and therefore it is very probably that there will be several horizontal and vertical classification systems. Unfortunately, the other solution (providing a transformation) cannot be performed easily because of the different breadth and depth of standards and their different semantics. This prevents from performing a simple conversation and forces to perform a case-based (i.e., product based) reclassification.

CONCLUSION

Classification information provide a comfortable way to define the category of objects without depending on the transportation format, language or company defined categories. For example, they help to:

- arrange objects into groups;
- find similar objects;
- process information independent from the language of the description;
- integrate objects, such as products into existing structures, such as existing catalogs or e-procurement systems;
- support the development of quick searches for classified objects; and to
- provide a uniform coding convention for categories.

Because of this, classification information can be found an increasing amount of applications.

The major problem of classification systems today is the complete incompatibility between standards. Further research in this area can improve these problems and lead to a better interoperability between solutions, based on classification systems. Furthermore, approaches for performing an automated classification of data are a key to success of future classification systems.

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KEY TERMS

Classification Process: The classification process describes the manual, semiautomatic, or automatic assignment of products into a class of a classification system. Within this process, each product is completed with a code of a class. For example, the code 49-23-15-13 in UNSPSC could be added to a product, which means that this product is classified as a "toy train."

Classification System: A classification system consists of a list of categories (called "classes"), which can be ordered hierarchically. Classification systems sometimes provide a set of keywords, descriptors and attributes for each class. Product classification systems are used to classify products or electronic catalogs. They are used "to assign each product to a product group corresponding to common attributes or application areas" (see Leukel, Schmitz, & Dorloff, 2002). Figure 3 shows an example for two classification systems. Well-known product classification systems are for example UNSPSC, ETIM or eCl@ss. Classification systems are also used in many other areas within the e-Commerce domain, such as the classification of services or profiles, as done in UDDI- and ebXML-registries.

Clustering: Clustering is the process of identifying groups in data. In the classification all groups are predefined in the classification system and products are arranged into the existing group structure. Contrary to this, the clustering process identifies groups based on the product data. This means that the groups change depending on the product data.

E-Procurement Ssystem: E-procurement stands for "electronic procurement" and means the process of electronically managing the procurement of goods. An e-procurement system cares about this process and offers interfaces to perform typical activities such as ordering products or browsing a list of available products from product suppliers. A more detailed introduction can be found at Hentrich (2001).

Horizontal Classification System: Classification systems can be divided into horizontal and vertical classification systems. Horizontal classification systems try to cover all areas of a certain domain. Well-known examples are the ECl@ss-system and UNSPSC that try to provide classes for all manufactured products. Figure 1 shows the mentioned concepts graphically.

Product Group: A product group contains several products. Furthermore, it can contain a set of sub-groups and can therefore be connected to a parent group. Typically, each electronic product catalog contains at least one set of product groups. Each product should be located in at least one product group and product groups are often compared to classification systems because of their similar nature. Both offer a set of categories to arrange items. Product groups are dependant on the catalog creator. Normally, each catalog has its own taxonomy and terminology and therefore defines its own set of groups. Contrary to this, classification systems are standardized and do not change from catalog to catalog.

Reclassification Process: The reclassification process has to be performed whenever a product was classified based on a classification system A but is needed to be classified based on another classification system B. The difference between re-classifying and classifying a product is the fact that in the reclassification process, the existing information of classification system A is used to determine the class of classification system B.

Vertical Classification System: Classification systems can be divided into horizontal and vertical classification systems. Vertical classification systems concentrate on a certain part of a domain but they tend to define this part in a very detailed way. An example for a vertical classification system is ETIM, which was defined for classifying electro-technical products. Figure 1 shows the mentioned concepts graphically.

ENDNOTE

1 United Nations Standard Products and Services Code, http://www.unspsc.org

2 http://www.census.gov/epcd/www/naics.html

Clicks and Mortar

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INTRODUCTION

"Clicks and mortar" signifies the use of electronic commerce (clicks) in combination with traditional (brick-and-mortar) operations. In the domain of business strategy and operations, this has also been known as "bricks and clicks," referring to the deployment of electronic commerce alongside conventional business operations in a manner that best utilizes the strengths of each channel in a complementary and synergistic manner (Stuart, 2000).

BACKGROUND

Balancing business strategy and operations between electronic commerce and traditional brick-and-mortar channels is one of the most significant challenges facing organizations in recent years. At a strategic level, this challenge raises some significant questions for executives. To achieve success in traditional retail operations in combination with business-to-consumer electronic commerce, it is desirable to achieve a synergy between what optimizes the costs and benefits of each channel. How can business volume grow through electronic commerce without cannibalizing growth in established retail channels? What should be the balance of investment in each channel? Is it possible to establish an interactive relationship such that electronic commerce and the conventional brick-and-mortar business operations are mutually supportive?

At an operational level, there are some even more fundamental questions that are raised by this challenge. First, organizations must distinguish those business activities that can be performed online from those activities whose execution requires a high-touch interaction with the customer and must therefore continue to be performed through brick-and-mortar operations. If certain retail activities such as marketing and presales operations can be performed through electronic commerce, then will the same brick-and-mortar facilities still be required, or will they be reduced or reshaped? If manufacturers adopt electronic commerce to sell directly to consumers, will this enhance the disintermediation of retailers, or will it enhance opportunities for potential cooperation between manufacturers and retailers?

CLICKS AND MORTAR: RECENT RESEARCH

The current research literature describes several perspectives on how firms can successfully deploy electronic commerce in synergy with parallel brick and mortar. Gulati and Garino (2000) state that the degree of integration between the two channels is manifest on several dimensions: the actual business processes used to execute the firm's transactions, the brand identity of the firm, and the ownership and management of each channel. A firm could own and manage brick-and-mortar operations in conjunction with electronic commerce and yet still not integrate the brand identity or business processes of each one. Alternatively, a firm like Barnes and Noble might integrate the brand identity of its traditional retail operations to its electronic commerce and yet still not integrate the business processes used to execute transactions within each channel.

De Figueiredo (2000) asserts that the characteristics of a firm's products or services are what primarily determine how electronic commerce can be integrated alongside traditional business operations. He sees the key determinant characteristics as being the degree to which a product varies in quality and the degree to which a potential customer can easily evaluate a product's quality. Commodity products are of fairly uniform quality, are therefore easy for customers to assess, and hence would lend themselves readily to a clicks-and-mortar approach to electronic commerce. Conversely, "look and feel" products are more difficult for customers to evaluate and will be less likely to be purchased through electronic commerce.

Some recent studies have described that a far more complex synergy exists between electronic commerce and traditional brick-and-mortar business operations. Wilcocks and Plant (2001) assert that there are two distinct paths firms can take in arriving at a synergistic approach to electronic commerce. One path encompasses the creation or extension of an organization's traditional brand identity into electronic-commerce operations. A less risky path is for firms to utilize electronic commerce primarily as a means to create service and quality improvements in the traditional brick-and-mortar arena.

Bahn and Fischer (2003) contend that there are several very different strategies that firms employ in achieving a clicks-and-mortar approach to electronic commerce. These strategies vary according to several dimensions of business constraints that include not only the characteristics of a firm's products, but also the relationships that a firm has with its supply chain partners and the capability of a firm to articulate a strategy that is distinct from its brick-and-mortar strategy. Bahn and Fischer also found that due to these constraints, many firms find it strategically appropriate to minimize their involvement in electronic commerce and relegate it to an auxiliary channel that supports brick-and-mortar operations.

At a deeper level, underlying all of these approaches is a conceptual debate about whether electronic commerce harbingers a fundamental revolutionary change in business (Useem, 2001). Michael Porter (2001) contends that although electronic commerce is indeed superior to many prior forms of information technology, its advent nevertheless renders many traditional brick-and-mortar business processes more essential to successful strategy execution rather than less. Don Tapscott (2001) has vociferously taken issue with this view, arguing that electronic commerce is engendering fundamental change by enabling previously unthinkable business partnerships and process-coordination mechanisms that will eventually completely reshape how most organizations conduct their business operations.

One pertinent case example of the phenomenon of clicks and mortar is manifest in the realm of higher education. Higher education is increasingly perceived as a service-delivery business by providers (educators) and consumers (students) alike (Shepard, 2005). In this particular industry, both the service and the brick-and-mortar facility are being redefined by electronic commerce. Many of the issues and questions cited in the business research about how to strike an effective balance in clicks and mortar are clearly manifest in higher education.

The growth of distance education capabilities through the Internet has generated a number of forms of online education in colleges and universities. Hybrid (Young, 2002) or blended (Voos, 2003) courses feature the reduction (but not elimination) of classroom sessions and the replacement of this class time with online learning activities. Hybrid courses are typically taught over the same time duration as regular courses. Hybrid courses are seen as offering the best of the rich face-to-face experience of regular college instruction juxtaposed with the interactive and student-driven learning of online classes (Hopper, 2003). Traditional teaching activities like discussions, group activities, and some lectures that benefit from a direct and personal experience are still conducted in the classroom, but the repetitive transmission of facts, submission and grading of student assignments, self-paced tutorials, and testing can be moved online. There is some debate over what degree of reduction in regular class sessions is necessary to qualify a course as being hybrid. Some have defined a minimum reduction of at least half of the number of class meeting sessions as the defining criteria for hybrid courses (Leh, 2002), while others have taken a looser approach (Garnam & Kaletta, 2002; Hopper 2003). Furthermore, the reduction of classroom-based learning can be manifest as a reduction in time spent in each scheduled class session or a reduction in the total number of class meeting times, a confusion that has also served to obscure the precise definition of a hybrid course (Aycock, Garnam, & Kaletta, 2002).

In respect to facilities, hybrid courses have conserved scarce classroom resources in overcrowded urban colleges, and have been reported as yielding improved student learning outcomes over traditional classes and reduced dropout rates in comparison to purely online classes (Young, 2002). Despite these preliminary findings, little empirical research has been done to determine the optimal way in which hybrid courses or campus facilities that support these courses should be implemented. Moreover, some have warned that hybrid courses can cause confusion in students who may attend class meetings but insufficiently comprehend the significance of the online components of the curriculum (Reasons, 2004).

FUTURE TRENDS

Whether in the general sphere of business or in the specific arena of higher education, the emergence of clicks and mortar raises significant questions about the future requirements for physical space and the nature of its utilization. In terms of the value chain, if businesses can conduct much of their pre- and postsales activities (as well as a large share of their sales) through the Internet, then what becomes the purpose of brick-and-mortar facilities (Bahn & Fischer, 2003)? Even if some brick-and-mortar facilities are required for business operations, would the same amount of retail space be needed?

If we think of these questions in the specific sector of higher education, it might well be asked whether colleges need to build fewer classrooms. If they are delivering a significant portion of their courses online, then do they need the same campus facilities, or a different set of buildings and classrooms (Bleed, 2001)?

CONCLUSION

Studies of commercial real estate (Muhanna & Wolf, 2002) have indicated so far that no significant changes have been observed yet in the aggregate demand for brick-and-mortar space as a consequence of electronic commerce.

Nevertheless, recent trends in library architecture emphasize the augmentation of meeting and social space

(Young, 1997) and the minimization of shelf space. These trends may offer some tantalizing hints as to what will be the future of retail space and of classroom space in the emerging world of clicks and mortar. Some kinds of brick-and-mortar facilities that enhance an organization's relationship with its customers (and the customers' experiences) may become more critical to strategic success. Conversely, brick-and-mortar facilities or traditional business processes that are routine and that do not enhance the customers' perceptions of the organization or its services or products may well be replaced with electronic-commerce channels where possible.

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KEY TERMS

Brick and Mortar: The direct physical (nonvirtual) channel for conducting business or exchanging value, typically requiring a specific location.

Channel: A course or pathway through which information is transmitted or business is transacted.

Commodity: A generic and largely undifferentiated product that is usually bought or sold by itself without bundled value-added services or differentiated features.

Electronic Commerce: The use of the Internet to transact the exchange of value (even as just information) between organizations and their customers, partners, or employees without time or geographical restrictions.

Hybrid Courses: University or college classes that contain a reduced number of face-to-face class meetings between the instructor and students while concurrently offering significant learning activities though the Internet.

Traditional Retail Operations: The exchange of value directly with consumers through store locations and facilities.

Value Chain: The visualization of an organization as a sequential array of processes or activities that convert unfinished inputs into finished outputs.

Category: Concepts, Trends, and Challenges

A Closer Look to the Online Consumer Behavior

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INTRODUCTION

Nowadays the Web comprises a significant advance in technology, and the rapidity of its acceptance has been remarkable. It is a powerful tool that has changed the way of conducting business, providing companies and customers with limitless options and opportunities. Online catalogs, 24/7 service availability, a cut down in transaction costs, reduction of customer service time, personalized features, and absence of paper and personalization features are only a few of the advantages. Companies, in an effort to stay competitive in the new global economy, are increasingly expanding their activities to this new communication channel, which features as a factor of major profit potential.

As a direct consequence of e-commerce spreading, we are witnessing the emergence of a new consumer type, the online consumer or e-customer that uses the Internet for purchasing products/services (Solomon, 2001). The online consumer is empowered with new, exciting capabilities: he can search globally for products/services, compare available options, find additional information, read the opinion of other people who have bought the product/service, or proceed with the transaction. All these options are available from his office or home and can be used conveniently and fast, while all alternative e-shops are only a few clicks away.

As in the case of trivial customers, ensuring e-customer satisfaction is not a simple task. To a certain degree, e-customers (expect to) behave online similarly to how they behave off-line (in traditional real-life shops); but in order to fully understand their behavior, one should explore issues like the reasons why people use the Internet for their purchases, the benefits/drawbacks of online buying, and the identification of clusters of customers who share common attitudes, behavior, and preferences online (Blackwell, Miniard, & Engel, 2000). According to Seybold and Marshak (1998), consumers prefer the Internet because it offers easier and faster shopping. Convenience, timesaving, moneysaving, greater options, and fun are among the top reasons, and this kind of knowledge is of great value for dictating efficient e-marketing strategies and motivating e-commerce use with twofold objective: turn non-shoppers into shoppers and increase shopping of current shoppers.

This article presents the overall consumer purchase decision cycle and investigates the issues that affect Web users, from selecting a specific e-shop to the delivery of the product and the overall assessment of the shopping experience. This process has been divided into 13 states referring to customer behavior: outside the e-shop, inside the e-shop, and after sales. Special focus is set on identifying the potential abandonment factors thus leading to practical guidelines for all those whose decisions and objectives affect the online shopping experience (e-shop owners, marketing specialists, Web site designers, and developers).

BACKGROUND

Understanding the process of decision making behind online shopping behavior is important for developing e-business strategies and can provide guidance for deploying adequate marketing tools for persuading visitors to buy online (Underhill, 2000). The traditional consumer purchase decision cycle has six stages according to Windham and Orton (2000): stimulate (realize the need), consider (collect ideas for potential solutions), search (choose category), choose (make selection), buy (make purchase transaction), and buy again (repurchase as needed). There also exist variations, since in some cases stages are merged, collapsed, or skipped. Adapted to the Web context, this cycle is merged to three stages: confidence building, where a consumer realizes that there is an alternative option for buying products or services; skirmish, when he purchases for the first time; and war, when he keeps on buying products or services (Zaltman, 2003).

Lee (2002) presented a behavioral model for the e-customer. The model is based on three distinct phases: building trust and confidence, online purchase experience, and after-purchase needs. The first phase examines issues connected to the Web site's brand name, authentication, reliability, credibility, privacy, and security. Intuitive navigation, searching facilities, product information, payment modes, usability, and convenience are among the consumer requirements that affect the second phase. The last phase relates to on-time delivery, customer support, technical support, availability of product warranty, and so forth. The combination of the three phases releases a behavioral model that increases consumer trust and leads to more online purchases. Different other cases have also been recorded in the international literature presenting parts of the behavior of the online customer (Mowen & Minor, 2000; McEnally, 2002).

ONLINE CONSUMER'S MODEL

The model in Figures 1, 2, and 3 describes the way an online consumer interacts with an e-shop. The whole process has been divided into the following 13 states.

Figure 1. From the purchase stimulus to entering an e-shop

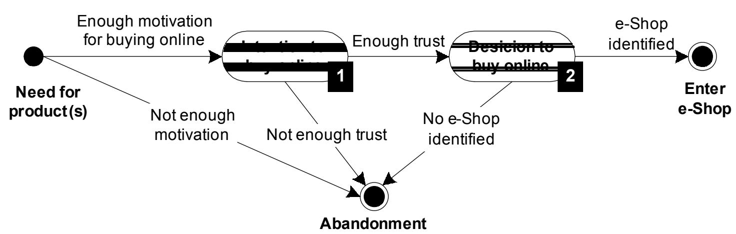


Figure 2. The shopping process from entering to leaving the e-shop

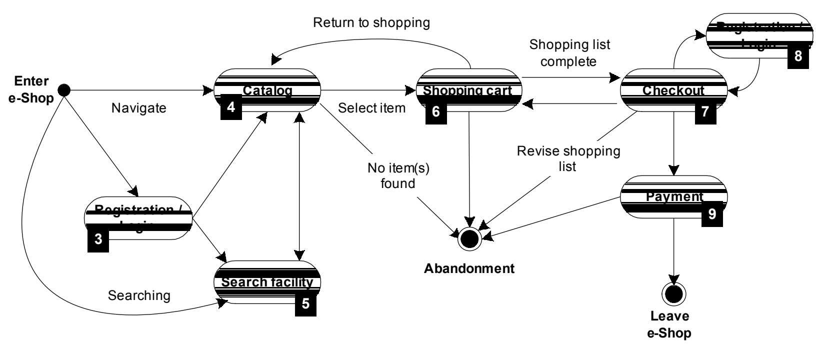
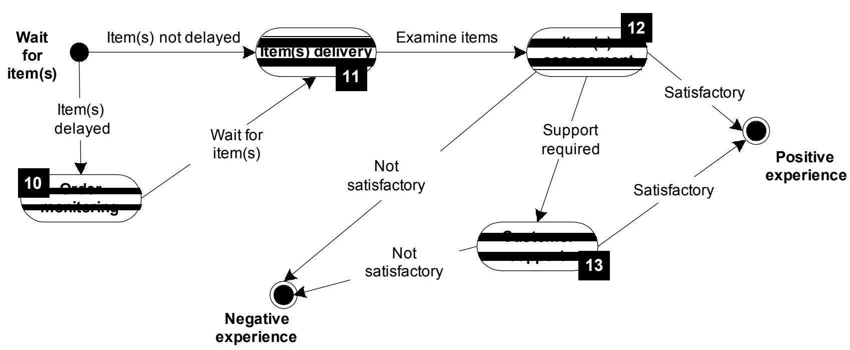


Figure 3. Product receipt, customer support, and overall assessment



State 1: Intention to Buy Online

Firstly, the motivation of the consumer should be defined. The need of a specific product can be the basic motivation for buying it. However, the choice of online shopping mode relates to the consumer's general attitude and familiarity with computers and the Web, prior personal experiences, experiences of others (friends, colleagues), or brand intimacy (motivation of trust).

State 2: Decision to Buy Online

When the consumer decides to buy online, the next step is to locate the e-shop. Generally, online consumers are: looking for a reliable and well-known brand behind the e-shop, attracted by an aesthetically and consistent Web site design, enjoying navigating through a well-structured and usable site, convinced when receiving accurate content, and feeling reassured by privacy statements and seals of secured transactions. Additional factors that influence them include pricing, quality of products/services, promotions, offers, after-sales support, personalization, and so forth. There are also customers who chose an e-shop because a search engine returned this link high in its results list. This forces companies to use multiple communication tactics for succeeding Web site awareness, such as affiliate programs with other sites, mass advertising, banner ads, links on related product pages, marketing e-mails, and search engine promotional actions. The aim is to give them an incentive to visit the Web site for the first time. For unknown customers a survey for identifying their characteristics could be helpful; however, direct contact is the most effective strategy. For users with prior e-shop purchase experience, the issue of trust extends to e-loyalty. Thus the Web site should try to capture as much data as possible in order to use them when users are revisiting the site. This allows companies to personalize the content and support online communities. Without significant motivation and trust, the potential customer fails to identify an e-shop and abandons the process of online shopping, before actually entering it.

States 3 and 8: Registration/Login

Registration is an optional state, but the majority of e-shops use it for tracking individual consumers. First-time visitors are asked to provide personal information such as name, age, sex, income status, educational background, occupation, marital status, and other demographics, as well as preferences, requirements, shipping address, billing details, and so on. Login is the process a user has to go through in order to be identified by the system in each subsequent visit (after registration). It is an effective and secure way to overcome the typical problems IT experts have in identifying the same user entering a Web site from different IPs or distinguishing different users from the same IP. The general guideline is to ask users to fill in as little information as possible, in a simple, straightforward manner, providing drop-down lists for those questions that have a limited and known range of answers (e.g., country of residence) in order to reduce typing and prevent spelling mistakes. Since Web site visitors are reluctant to reveal personal information and are insecure about its use, e-shops should provide clear statements on their policy for the use of the collected information (disclosure policies) and the security precautions they have taken (authentication seals). The registration/login state may be postponed for right before checkout (State 8). This way, consumers are able to browse anonymously and identify themselves only when it is absolutely necessary.

State 4: Online Catalog

The online catalog is e-shops' interactive front-end to potential customers. It offers a listing of all available products, combined with classification and retrieval support, in addition to interfaces to other e-shop services. Users spend most of their time looking for products and use the feedback from this process to decide whether they will go on with the payment, or leave their shopping cart at the cash register and exit. Failure to locate the item(s) means one less customer and a hard-to-estimate spreading of disrepute. Either way (by browsing the catalog or using the search utility of State 5), the customer sooner or later ends up at a product page (which in some cases may contain a group of products) with details, pictures, features, pricing, and even comparisons, offers, ratings from the customer community, ratings from experts, recommendations, and so forth.

State 5: Search Facility

Another way that consumers find interesting items to place in their shopping cart is through the search facility. It is true that Web users are familiar with the notion of searching and the typical mechanism of browsing through search results. Thus, regardless of how well structured and efficient the catalog is, an e-shop must also provide a search function, and keep it available and visible on all pages so that customers may resort to it whenever in need. The general guideline is that search should operate the way customers expect it to. It should be tolerant to minor misspellings, allow for synonyms and string keywords, and return an easily interpretable results page and links to product pages. Furthermore, in the case that a search fails, the response page should clearly indicate that no actual results are returned and, where possible, provide a way for customers to refine their search until they locate products (provided that the e-shop has them available). The combination of States 4 and 5 is of great importance, not only because selecting products is an integral part of every purchase, but also because it determines the user's impression and a first-level assessment of the e-shop.

State 6: Shopping Cart

The shopping cart refers to a single page in an e-shop listing the items the customer has chosen to purchase. On that page customers should be allowed to remove one or more items, change item quantities, and automatically recalculate costs. In addition, a "return to shopping" link should exist to transfer them back to where they were before adding the last item to the cart (Markellou, Rigou, & Sirmakessis, 2005b). This logic reflects the real-life paradigm exactly: while walking the corridors of a supermarket, we pick up items, put them in the cart, and keep on walking until we find the rest of the items in our shopping list. In fact, the real-life situation has a drawback: we cannot easily calculate the total cost of our cart contents, and we cannot change quantities and recalculate just by a mouse click. Thus, it is a good idea to construct an effective shopping cart taking advantage of all conveniences offered by IT, stressing this comparative advantage over traditional shopping.

State 7: Checkout

After looping through States 4, 5, and 6 as many times as required, customers proceed to checkout. This is the phase where they are asked to fill in information about delivery (recipient's mail address, date of delivery, packaging details, shipping options, etc.). If the user has not yet logged in (or is not obliged to login), the checkout phase asks for additional data that would otherwise be filled in automatically. Again, typing should be kept to a minimum, as in the previous cases, and all optional fields should be clearly and consistently marked.

State 8: Registration/Login

See "States 3 and 8: Registration/Login".

State 9: Payment

Payment involves filling in forms with the required data for charging customers with the cost of their order. It requires simplicity, clarity, certificates, reassurance, and a sense of professionalism and safety. Security in transactions is not negotiable. There must be detailed information about the measures taken to guarantee security, and be available on every page of the payment process for whomever wants to view it. Upon successful completion of payment, the customer should be informed about it, through a response page that provides a code number (which uniquely identifies the submitted order) and the estimated delivery time. This information may alternatively be sent via e-mail. Using the order code number, the customer should be able to trace the status of the order at any time before receiving the product(s).

State 10: Order Monitoring

In the typical scenario, after successfully leaving the e-shop, customers enter the state of waiting to receive the goods. In the case that the order is not delivered by the pre-specified time, the customer usually invokes the order monitoring procedure. It is also possible to have a customer that enters this state before any delay, just to check if everything proceeds according to the initial schedule. It is the e-shop's task to serve all customers that require feedback on the state of their order regardless of the reason why each one does so.

State 11: Order Delivery

In this state the consumer receives the product(s).

State 12: Item(s) Assessment

Upon receiving the order, the customer proceeds with assessing whether the products are in good condition and of satisfying quality. If the result of the assessment is negative, so is the impression of the online shopping experience and the specific e-shop. The e-shop has lost a customer and the same probably goes for those he shared this unpleasant experience with.

State 13: Customer Support

There are many cases of "merchandise" sold online (e.g., computer hardware or software) that require after-sales support. In such cases, the overall customer impression of the e-shop may be re-evaluated. It may prove that, even if the product itself has been satisfactory, the lack of adequate support results in unwillingness to repeat analogous purchases and thus the e-shop fails to keep the customer coming back to buy more.

FUTURE TRENDS

A user may abandon an e-shop for many reasons that do not necessarily have to do with the e-shop itself. However, the factors that are the e-shop's responsibility and can be controlled include:

- **Missing Product(s) or Product Details:** This is caused by either the fact that the shop does not actually sell the product (in which case the customer must be clearly informed), or that the product is misplaced and the search mechanism is either missing or not functioning well. Search should be provided in combination with the catalog in order to serve customers who know from the outset what to buy.
- **Unreliable/Inefficient E-Shop Operation:** The e-shop—as any Web application—should be a 24/7 system, able to function under extreme traffic conditions, providing fast interaction and effective navigation schemes.
- **Inconsistency in Function or Appearance, Out dated Technology, Bad-Quality Graphics, Hard-to-Read Text:** These are all indications that are interpreted as lack of professionalism and result in loss of trust on the customers' part.
- **Missing Seals of Approval, Non-Existent/Insufficient Details on Security and Disclosure Policy, Unclear Company Identification:** These factors amplify the security concerns that remain among the large obstacles towards the wider acceptance of e-commerce.

Avoiding the aforementioned abandonment conditions does not suffice for answering the actual challenge of providing quality of service and assuring customer satisfaction that leads to loyalty and long-term profits. Modern e-shops face the fierce competition of the global electronic market that raises the standards of customer services.

Personalization may play a central role towards enhancing the online shopping experience. Typically, a personalized Web site recognizes its users, collects information about their preferences (during State 3 or 8), and adapts its services, in order to match user needs. In the e-commerce domain, personalization has spread widely, and provides mechanisms to learn more about customer needs, identify future trends, and eventually increase customer loyalty. Personalization may be used in numerous ways for enhancing the online shopping experience (Markellou et al., 2005a). In the simplest scenario, the e-shop recognizes and salutes the user upon revisiting, or automatically pre-fills all data the user has already provided in registration (e.g., name, contact details, even credit card numbers) during checkout and payment. Using more sophisticated approaches (Markellou et al., 2005c), an e-shop may provide personalized product recommendations and marketing, personalized pricing, as well as personalized product configurations. The biggest challenges though remain the lack of trust on the customer side and the lack of customer data on the e-shop side to base the personalization decisions upon. Research in the area of mining Web usage data (Sirmakessis, 2004) should be accompanied by security preservation methods to increase consumer confidence in the use of the Internet for selling and buying.

In the cases of Web marts (large e-shops that sell a wide variety of products), consumers need intelligent tools to answer their product enquiries and speed up their decision-making process. Filtering tools are used for narrowing a large itemset down to a subset that satisfies a number of criteria (price ranges, brands, colors, sizes, etc.), a process that resembles the "search within search results" function. Nielsen, Farrell, Snyder, and Molich (2000) refer to this category of tools as "winnowing tools." Apart from filtering, there are cases of products that are difficult to compare, even when the list of similar products along with their attributes is available and thus the purchase decision needs further assistance. Comparison tools typically offer summarizing tables with similar products on one dimension and features on the other; the tools simplify comparisons on a feature-by-feature basis (e.g., Nokia phones at nokia.com).

Last but not least, an effective way to improve customer opinions about an e-shop is the formation and maintenance of a customer community that stores customer opinions about a purchased product, product ratings given by experts, or customer experiences with the helpdesk and the technical support of the e-shop. Such information is perceived well by customers, as it is considered to be less biased (compared to the features of a product as described by its manufacturer or trader). Moreover, ratings—and in general the opinion of other buyers or experts—are positive signs for the credibility of an e-shop, and the opinions of returning customers are considered important for visitors or new customers.

CONCLUSION

In this article we studied the behavior of online customers, assuming it is triggered by a stimulus to purchase a certain item or set of items. Based on this assumption we drew a set of recommendations for all those that relate to online shopping, including e-shop owners, marketing specialists, Web site designers, and developers. The diagrams presented, along with the investigation of the factors that determine the transition between states, also complied with this condition.

In conclusion, e-commerce has opened up a new spectrum of potential by expanding local markets to worldwide ones. E-loyalty is the key to making this huge step forward. Commerce on the Internet may be frictionless and remote, but it need not—and should not—be impersonal. E-loyalty aims at humanizing digital loyalty and developing intimacy. The question is how to gain customer loyalty. A bad first experience with an e-shop can kill the millions spent on the application of an e-loyalty strategy. No e-loyalty program though, regardless of its sound planning or execution excellence, can overcome a bad Web site design, poor product quality, or unreliable delivery.

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KEY TERMS

Customer Satisfaction: Measure or determination that a product/service meets a customer's expectations, considering requirements of both quality and service.

E-Community: A group of people sharing common interests, ideas, and feelings in the Internet or other collaborative networks. E-communities exist in discussion groups, chat rooms, newsgroups, and so forth.

Electronic Marketing: Using electronic means and the Internet to market products/services.

E-Loyalty: The degree to which online consumers are predisposed to stay with a specific e-shop and resist competitive offers.

Personalization: A set of techniques and services that aim to solve the information overload problems Web users face, by providing them with what they want or need, without having to ask (or search) for it explicitly.

Web Mining: The use of data mining techniques for discovering and extracting information from Web documents and services. It is distinguished as Web content, structure, or usage mining depending on which part of the Web is mined. Web usage mining examines usage data typically in the form of server logs.

Category: Concepts, Trends, and Challenges

Collaborative Commerce

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INTRODUCTION

In the past few years, collaborative commerce (c-commerce) has been widely touted by practitioners and has caught researchers' attention. The business press constantly reported successful stories of c-commerce in which companies in various industries employed collaborative technologies to reap potential benefits. A recent report on the software market for c-commerce indicated that software for creating c-commerce would be the next stage of growth in the enterprise application business (Bellini, Gravitt, & Diana, 2001). The report estimated that the size of the c-commerce market would grow from $5.8 billion in 1999 to $36.5 billion in 2004 (estimated by AMR and IDC). Another report (Ferreira, Schlumpf, & Prokopets, 2001) showed that about 60% of 356 survey respondents considered c-commerce as critically important to their businesses in the year of 2001-2002 and 78% of the companies planned to implement c-commerce to improve supplier and customer interaction. Meanwhile, findings of academic research on issues surrounding c-commerce have been sporadically reported. Welty and Becerra-Fernandez (2001) investigated the issue of managing trust and commitment in collaborative relationships. Kumar (2001) delineated the features of information and communication technologies for supporting c-commerce. Chuang and Nakatani (2004) identified different types of c-commerce and the driver for each type of c-commerce.

Extending the concept of inter-organizational collaboration (Himmelman, 1996), Chuang and Nakatani (2004) defined c-commerce as an IT-enabled process in which organizations share information and resources, adjust their activities and augment each other's capabilities in order to reap mutual benefits while assuming common responsibilities, risks, and rewards. Johnson and Whang (2002) used the term "e-collaboration" to refer to the collaborative activities between businesses; however, Johnson and Whang placed emphasis on the role of the Internet and the concept of sharing. It is worth noting that while there are overlappings between the boundaries of collaborative commerce and electronic commerce, the difference between both lies in the fact that c-commerce is focused on joint intellectual effort, but e-commerce is oriented to more transaction processing, such as selling/buying activities.

Even though c-commerce could be considered as one of ramifications of electronically conducting commerce over the Internet, its emergence is most likely driven by the globalization of economy, the competition, the need for efficient customer response, and the advent of collaborative technology. From the managerial perspective, globalization means that decisions on allocation and/or acquisition of resources are considered and made on a global scale. Thus, international sourcing is commonly considered as an option for improving organizational performance, which subsequently necessitates the need for collaborative planning (Fliedner, 2003).

The fierce competition on global economy spurs businesses on to create strategic partnership with complementary enterprises in which creating collaborative advantage is as, if not more, important as creating competitive advantage (Spekman, Kamauff, & Myhr, 1998). The proliferation of strategic partnerships has resulted in the appearance of competition between business networks or between supply chains (Kumar, 2001). In this context, paradoxically, the fiercer the competition is, the more important collaboration becomes. Meanwhile, fierce competition redirected businesses' energies toward the fulfillment of customer's needs and the reduction of operating cost accrued through the supply chain (Fliedner, 2003). Finally, the availability of greater bandwidth of telecommunication facilitates the use of network and the Internet to connect businesses and create a collaborative platform on which "advanced planning systems" are employed to analyze and optimize the flows of supply chain (Kumar, 2001). In brief, the emergence of c-commerce could be driven by business needs and sophisticated IT capability.

BACKGROUND

Although inter-organizational collaboration has long been a commonly studied topic among researchers in the areas of business and public policy disciplines (Himmelman, 1996; Spekman, Kamauff, & Myhr, 1998), research in c-commerce is in its early stage and its findings have been sporadically published. Existing literature of c-commerce is focused on two themes (Chuang & Nakatani, 2004): (1) presenting successful anecdotes and potential benefits of c-commerce, and (2) describing the prescriptive features of c-commerce software or information technology infrastructures for building c-commerce. Exceptions to these two themes include Welty and Becerra-Fernandez (2001), Kumar (2001), and Chuang and Nakatani (2004).

C-commerce technology could be employed in the project that involves highly intellectual activities. For example, Boeing improved its production productivity from 228 airplanes per year in 1992 to 620 expected in 2002 by using collaborative e-marketplace (Fingar, 2001). In order to build a new family of supersonic stealth fighter planes in four years, Lockheed Martin Aeronautics Co. created a collaborative platform in which more than 80 suppliers located at 187 locations cooperatively designed and built components of the Joint Strike Fighter (Keenan & Ante, 2002). Additionally, c-commerce has changed the way firms in the food industry conduct business. For example, by using collaborative planning, forecasting, and replenishment (CPFR), Nabisco and Wegman's significantly increased sales revenue, service level, and market share (Walton & Princi, 2000). In the manufacturing sector, Microsoft and Flextronics created a Web-based collaborative system in which personnel from design, manufacturing, and engineering departments worked together to develop and test the prototype of Xbox video game console (Keenan & Ante, 2002). These cases demonstrate that c-commerce is generally employed in projects that involve knowledge exchanging and management. While efficiency and cost reduction are two major benefits of c-commerce, even more importantly, c-commerce facilitates product and process innovations or the reduction of cycle time.

Extant literature of c-commerce also placed an emphasis on the discussion of applications and IT infrastructure that support the development of c-commerce. Bellini, Gravitt, and Diana (2001) classified the enterprise application software for c-commerce into three categories: supplier relationship management, knowledge management, and product life-cycle management. Fou (2001) considers c-commerce as a continuum of applications of information technology, ranging from Web-enabled single-dimensional and single-process c-commerce, to B2B exchanges-based, single-dimensional and multiple-process c-commerce, to Web service-based, multiple-dimensional and multiple-process c-commerce. The Web service-based collaborative architecture consists of four tiers: c-commerce vendors, Web services, business rule engine, and multi-dimensional c-commerce enterprise Web portal.

While the above documents focus on the role of information technology, Derome (2000) emphasized that c-commerce capabilities should be illustrated from a functional standpoint. He defined c-commerce as a three-layer architecture: free-form collaborative services, process collaboration layer, and the structured data exchange category. The IT environment, duration of collaboration, and goal of collaboration vary from category to category. Likewise, Ramachandran and Tiwari (2001) studied the air cargo industry and proposed a collaborative supply chain consisting of connectivity layer, knowledge layer, and functionality layer that could offer better economic global air cargo services.

Additionally, several studies were focused on the importance of business strategy, collaborative models, and relational development. Mulani and Matchette (2002) proposed a product development life-cycle collaboration framework that ties the mutual strategic objectives of trading partners to actual inter-company execution. Li and Williams (1999) found that companies that had cooperated at the transactional level tended to develop a collaborative partnership at the strategic level. Welty and Becerra-Fernandez (2001) presented a business interaction model in which interaction technology (i.e., c-commerce software) is adopted to nurture mutual trust between partners and in which customer satisfaction is integrated into business processes. It is customer satisfaction rather than the delivery of goods or the payment that closes a business transaction loop. Chuang and Nakatani (2004) also emphasized the importance of trust and commitment in c-commerce. They asserted that existing inter-organizational relationship (IOR) and the level of trust between collaborators might affect the establishment, structure, and conduct of a c-commerce.

DEVELOPMENTAL PERSPECTIVE, APPLICATIONS, AND CURRENT ISSUES OF C-COMMERCE

The Roadmap of C-Commerce

Although extant literature of c-commerce documents numerous benefits and delineates a prescriptive form of c-commerce, there are several barriers, including trust issue between trading partners (Spekman, Kamauff, & Myhr, 1998; Welty & Becerra-Fernandez, 2001), existing relationship between prospective partners (Chuang &

Nakatani, 2004), and application and system integration necessary for supporting c-commerce (Derome, 2000; Kumar, 2001; van der Aalst, 1999; Park, Suh, & Lee, 2004).

While several approaches, such as technological (Fou, 2001), functional perspective (Derome, 2000), and progressive approach (Chuang & Nakatani, 2004), could be adopted to overcome the barriers, the framework named c-commerce roadmap proposed by A. T. Kearney for Grocery Manufacturers of America (GMA/FMI Trading Partner Alliance & Kearney, 2002) explicitly delineates underlying technology and progressive commerce activities. This framework has been used to support UCCnet and Global Data Synchronization Network (GDSN) managed by two international standards development organizations: Uniform Code Council, Inc. (now called GS1 US) and EAN (European Article Numbering) International (now called GS1). The c-commerce roadmap has seven stages: (1) common data standards, (2) single item registry, (3) item synchronization, (4) collaborative transaction management, (5) collaborative supply chain management, (6) collaborative sales and promotion planning, and (7) collaborative insight and product development. These seven steps present a progressive path that collaborators could take as the mutual trusts grow. They also represent different forms of c-commerce, as suggested by others (Chuang & Nakatani, 2004; Derome, 2000).

The first three steps (i.e., common data standards, single item registry, and data synchronization) provide an essential technological foundation for global collaboration. The standards and data synchronization enable companies to cooperate at the simplest level: transaction-oriented collaboration. The companies who register their products in the global registry will be able to collaborate on global scale, the significance of which is that geographic proximity might not be a critical factor for collaboration. The standards allow companies to speak the "same language." Thus, the management of transaction-oriented collaboration becomes more efficient. With the collaborative transaction management in place, collaborators could expand their partnership to include third party logistics to form collaborative transportation/logistics management (Esper & Williams, 2003). Collaborative supply chain (logistics) management could improve the accuracy of fulfillment, reduce the frequency of out-of-stock, and reduce inbound and outbound logistic costs. Combining with RFID (Radio Frequency Identification) technology, real-time product tracking can be realized. Sales information collected at a POS system can be instantly shared with distributors and manufacturers for Collaborative Planning, Forecasting and Replenishment (CPFR) (VICS, 2004), which is the essence of collaborative sale and promotion management. The implementation of CPFR fosters high level of interdependence and information sharing between partners (Stank, Daugherty, & Autry, 1999) and consequently, requires a high level of trust and commitment between partners.

The essence of CPFR lies in the integration and sharing of multiple parties' intelligence in the planning and fulfillment of customer demand (VICS, 2004). The intelligence shared in CPFR is more about the understanding of the status quo of the market rather than the potential opportunity, such as new business or products. Thus, the next level of collaboration will be that partners share their insights of the business and cooperatively develop new products that serve a market opportunity. This form of c-commerce may demand sharing of "know-how" of production techniques or knowledge of product design. This form of c-commerce appears to be the highest possible level of collaboration because the sharing of such knowledge might result in negative reverse impact (Loebbecke & Van Fenema, 1998).

Applications of C-Commerce

Although the c-commerce roadmap presented above provides a prescriptive course that businesses could follow to reap the benefits of c-commerce, existing successful cases indicate that most, if not all, of companies that initiated c-commerce didn't follow the prescription. Instead, most of them would create a form of c-commerce suitable for their existing practices. Thus, those applications are relatively diverse and, on the surface, share very limited similarity. This section attempts to categorize those applications by adopting McGrath's task classification as a basis. It should be noted that by no means the classification is intended to be exhausted. Instead, we admittedly acknowledge that c-commerce is still in its infancy, so different applications and end products may emerge and when more applications are available, the classification should be revised.

McGrath (1984) classified the types of tasks performed by a group of people into four categories: generating alternatives, choosing alternatives, negotiating issues, and executing works. Under each of the four categories, McGrath further classified into two subcategories, as shown in the second column in Table 1. In each category, a few c-commerce examples from Phillips and Meeker (2000) and literature reviewed above are added to demonstrate the applicability of the classification.

While the definition of each category is self-explanatory, the category of execution might need further elaboration. The two subcategories of execution are contests/battles and performance. Contests/battles refer to resolving conflicts of power or competing for victory, while performance means undertaking psychomotor tasks to meet objectives or absolute standards of excellence. An example of battle is the relay race of 1600 meters, in which several teams of four members compete against one another for victory. While this type of activity is not entirely intellectual effort, the four runners of each team need to evaluate their strengths and weaknesses and then determine their positions in the race. In the context of c-commerce, an example of contest/battles would be the competition in some aspects (e.g., demand and supply planning, distribution, and fulfillment) or the whole of supply chain management between two or more camps led by a focal company (or "the lord of chain" in Kumar's words (2001)). Under such a circumstance, the basic assumption is that each supply chain has its own plan ready and what those supply chains compete on includes the excellence of their plans as well as how well they could execute their plans.

Key Issues in C-Commerce Research

There are several key issues that need to be addressed in order to further our understanding of c-commerce. We identified the following that deserves researchers' attention in the near future.

1. **Theoretic Development of C-Commerce:** As the topic of collaboration has been investigated in other disciplines, such as public policy and marketing, theoretic development has been underway (Wood & Gray, 1991). In contrast, because c-commerce is an emerging business practice, not much, if any, research has been done in the development of c-commerce theory. Since c-commerce is one special case of business-to-business e-commerce, researchers tend to adopt the transaction cost approach to examine issues surrounding c-commerce. However, due to the criticism to the transaction cost approach, several researchers have suggested that other perspectives, such as the business network (Johanson & Mattsson, 1987), should be employed to investigate c-commerce practice.
2. **Configurations of Collaborative Network:** Philips and Meeker (2000) claimed that the basic architecture of c-commerce is in the form of hub and spoke; however, Chuang and Nakatani (2004) suggested that there are, at least, three different configurations of collaborative network and that specific configuration varies depending on the nature of projects, the profile of participants, and the industry. The choice of configuration of c-commerce could be an issue to be addressed.
3. **Design and Implementation of C-Commerce Infrastructure:** Established software vendors are extending their products to incorporate features that would support c-commerce. Derome (2000) indicated that c-commerce should be defined from functional standpoints rather than from the technology; thus, a technology supporting c-commerce could be as simple as e-mail (Derome, 2000) or as sophisticated as "advanced planning systems" (Kumar, 2001). Therefore, an issue regarding the design and implementation of c-commerce infrastructure is the choice of an integrated solution vs. "the best of the breed." A relevant issue is the choice of generic collaborative technologies vs. specialized c-commerce solutions. While the consolidation of the c-commerce software market will certainly narrow down the space of choice, many options are available in the market.
4. **Coordination Mechanisms in C-Commerce (Chuang & Nakatani, 2004):** The c-commerce process involves communication, cooperation, and coordination among partners. The features of the IT infrastructures proposed by extant research might be sufficient for supporting communication and cooperation yet the issue of coordination has not be fully studied. Thus, another issue surrounding c-commerce is the conceptualization of coordination mechanisms.

Table 1. Products and examples of c-commerce

Category	Type	Definition	Examples in C-Commerce
Generate	Planning tasks	Generating plans for actions	Planning, scheduling and forecasting
	Creative tasks	Generating ideas	Product conception and development
Choose	Intellective tasks	Solving problem with a correct answer	Payment reconciliation, or complex pricing, route optimization
	Decision-making tasks	Dealing with tasks for which the preferred or agreed upon answer is the correct	Collaborative promotion planning, campaign management
Negotiate	Cognitive conflict tasks	Resolving conflicts of viewpoint (not of interests)	Resolving difference in the method used for forecasts of demand for products
	Mixed-motive tasks	Resolving conflicts of motive-interest	Contract negotiation and management
Execution	Contests/battles	Resolving conflicts of power	Supply chain management
	Performance	Competing against objective standards	Mortgage application processing

FUTURE TRENDS

Paradoxically, the fiercer the competition becomes, the more distinguished the value of collaboration will be. For a long time, businesses have been cooperated in one form or another. With the potential presented by information and communication technologies (ICT), businesses will certainly be creatively applying ICT to explore collaborative opportunities. In the future, a few trends are noteworthy.

First, more and more companies will apply c-commerce in higher level of c-commerce, such as joint product development. As indicated previously, joint product development is the form of c-commerce with the greatest benefit. As the mutual trust and commitment among partners increase along with their collaboration, they will certainly attempt to reap the greatest potential of c-commerce.

Second, the scope of c-commerce applications in terms of the number of partners or amount of expertise will be broadened. This trend could be attributed to economic globalization and outsourcing. In the context of c-commerce, globalization and outsourcing have two effects: one is that each business will focus on its core competence and the other is that in order to cope with the complexity of today's business environment, those companies with different core competences will need to collaborate. Thus, the scope of c-commerce applications will be broadened.

Third, as the bandwidth of telecommunication increases, multimedia and data visualization technologies will be employed in c-commerce. This trend is the result of two forces: pull from the market and push from the technology. The proliferation of higher level of c-commerce, such as joint product development, will demand multiple presentations and representations of data.

CONCLUSION

Several forces, such as the economic globalization, the competition, the need for efficient customer response, and the advent of collaborative technology have driven the emergence of c-commerce. This article reviews the current status of research in c-commerce, discusses the developmental framework of c-commerce, and attempts to classify c-commerce applications. As c-commerce is still in its infancy, more research is needed in order to improve our understanding of the new business practice. There are several issues of c-commerce that need to be addressed: the theoretical development of c-commerce, the configurations of collaborative network, the design and implementation of c-commerce infrastructure, and the coordination mechanisms in c-commerce. These issues present plenty of research opportunities.

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KEY TERMS

Business Network Approach: An approach to the research of strategic management that considers the firm embedded in social, professional and value exchange networks (Johanson & Mattsson, 1987).

Collaborative Commerce: An IT-enabled process in which organizations share information and resources, adjust their activities and augment each other's capabilities in order to reap mutual benefits while assuming common responsibilities, risks, and rewards (Chuang & Nakatani, 2004).

Collaborative Commerce Roadmap: A framework that prescribes the technological foundation for c-commerce and different forms of c-commerce (GMA/FMI Trading Partner Alliance and Kearney, 2002).

Collaborative Planning, Forecasting, and Replenishment: A business process in which multiple partners share and integrate their intelligence of the market in the planning and fulfillment of customer demand (VICS, 2004).

Collaborative Transportation Management: Is the process in which order forecasts developed via CPFR are converted into shipment forecasts and accurate fulfillments of them are assured (Esper & Williams, 2003).

Data Synchronization: The ability of making data describing entities (e.g., products or services) or activities (e.g., design, production, or delivery) in collaborative domain identical.

E-Collaboration: The Internet-enabled information sharing and joint decision making between businesses (Johnson & Whang, 2002).

Category: Concepts, Trends, and Challenges

Collaborative Filtering for Information Recommendation Systems

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INTRODUCTION

In order to draw users' attention and to increase their satisfaction toward online information search results, search-engine developers and vendors try to predict user preferences based on users' behavior. Recommendations are provided by the search engines or online vendors to the users. Recommendation systems are implemented on commercial and nonprofit Web sites to predict user preferences. For commercial Web sites, accurate predictions may result in higher selling rates. The main functions of recommendation systems include analyzing user data and extracting useful information for further predictions. Recommendation systems are designed to allow users to locate preferable items quickly and to avoid possible information overload. Recommendation systems apply data-mining techniques to determine the similarity among thousands or even millions of data.

Collaborative-filtering techniques have been successful in enabling the prediction of user preferences in recommendation systems (Hill, Stead, Rosenstein, & Furnas, 1995, Shardanand & Maes, 1995). There are three major processes in recommendation systems: object data collections and representations, similarity decisions, and recommendation computations. Collaborative filtering aims at finding the relationships among new individual data and existing data in order to further determine their similarity and provide recommendations. How to define the similarity is an important issue. How similar should two objects be in order to finalize the preference prediction? Similarity decisions are concluded differently by collaborative-filtering techniques. For example, people that like and dislike movies in the same categories would be considered as the ones with similar behavior (Chee, Han, & Wang, 2001). The concept of the nearest-neighbor algorithm has been included in the implementation of recommendation systems (Resnick, Iacovou, Suchak, Bergstrom, & Riedl, 1994). The designs of pioneer recommendation systems focus on entertainment fields (Dahlen, Konstan, Herlocker, Good, Borchers, & Riedl, 1998; Resnick et al.; Shardanand & Maes; Hill et al.). The challenge of conventional collaborative-filtering algorithms is the scalability issue (Sarwar, Karypis, Konstan, & Riedl, 2000a). Conventional algorithms explore the relationships among system users in large data sets. User data are dynamic, which means the data vary within a short time period. Current users may change their behavior patterns, and new users may enter the system at any moment. Millions of user data, which are called neighbors, are to be examined in real time in order to provide recommendations (Herlocker, Konstan, Borchers, & Riedl, 1999). Searching among millions of neighbors is a time-consuming process. To solve this, item-based collaborative-filtering algorithms are proposed to enable reductions of computations because properties of items are relatively static (Sarwar, Karypis, Konstan, & Riedl, 2001). Suggest is a top-*N* recommendation engine implemented with item-based recommendation algorithms (Deshpande & Karypis, 2004; Karypis, 2000). Meanwhile, the amount of items is usually less than the number of users. In early 2004, Amazon Investor Relations (2004) stated that the Amazon.com apparel and accessories store provided about 150,000 items but had more than 1 million customer accounts that had ordered from this store. Amazon.com employs an item-based algorithm for collaborative-filtering-based recommendations (Linden, Smith, & York, 2003) to avoid the disadvantages of conventional collaborative-filtering algorithms.

BACKGROUND

Collaborative-filtering techniques collect and establish profiles, and determine the relationships among the data according to similarity models. The possible categories of the data in the profiles include user preferences, user behavior patterns, and item properties. Collaborative filtering solves several limitations of content-based filtering techniques (Balabanovic & Shoham, 1997), which decide user preferences only based on the individual profiles. Collaborative filtering has been expressed with different terminologies in the literature. Social filtering and automated collaborative filtering (ACF) are two frequently referred-to terminologies. Collaborative-filtering-based recommendation systems are also referred as to as collaborative-filtering recommender systems and automated collaborative-filtering systems.

Several collaborative-filtering-based recommendation systems have been designed and implemented since the early '90s. Collaborative-filtering techniques have been proven to provide satisfying recommendations to users (Hill et al., 1995, Shardanand & Maes, 1995). The GroupLens project, a recommendation system for Netnews, has investigated the issues on automated collaborative filtering since 1992 (Konstan, Miller, Maltz, Herlocker, Gordon, & Riedl, 1997; Resnick et al., 1994). In the system design, better bit bureaus (BBBs) have been developed to predict user preferences based on computing the correlation coefficients between users and on averaging the ratings for one news article from all. MovieLens is a movie recommendation system based on the GroupLens technology (Miller, Albert, Lam, Konstan, & Riedl, 2003). Recommendation Tree (RecTree) is one method using the divide-and-conquer approach to improve correlation-based collaborative filtering and perform clustering on movie ratings from users (Chee et al., 2001). The ratings are extracted from the MovieLens data set. Ringo (Shardanand & Maes) provides music recommendations using a word-of-mouth recommendation mechanism. The terminology social information filtering was used instead of collaborative filtering in the literature. Ringo determines the similarity of users based on user rating profiles. Firefly and Gustos are two recommendation systems that employ the word-of-mouth recommendation mechanism to recommend products. WebWatcher has been designed for assisting information searches on the World Wide Web (Armstrong, Freitag, Joachims, & Mitchell, 1995). WebWatcher suggests to users hyperlinks that may lead to the information the users want. The general function serving as the similarity model is generated by learning from a sample of training data logged from users. Yenta is a multiagent matchmaking system implemented with a clustering algorithm and referral mechanism (Foner, 1997). Jester is an online joke recommendation system based on the eigentaste algorithm, which was proposed to reduce the dimensionality of off-line clustering and to perform online computations in real time (Goldberg et al., 2001). The clustering is based on continuous user ratings of jokes.

One of the most famous recommendation systems nowadays is the Amazon.com recommendation (Linden et al., 2003). This recommendation system incorporates a matrix of the items' similarities. The formulation of the matrix is performed off line. Launch, music on Yahoo!, Cinemax.com, Moviecritic, TV Recommender, Video Guide and the suggestion box, and CDnow.com are other successful examples of collaborative-filtering-based recommendation systems in the entertainment domain.

Many methods, algorithms, and models have been proposed to resolve the similarity decisions in collaborative-filtering-based recommendation systems. One of the most common methods to determine similarity is the cosine angle computation. The Amazon.com recommendation system (Linden et al., 2003) uses this cosine measure to decide the similarity between every two items bought by each customer and to establish the item matrix, which contains item-to-item relationships. Several algorithms that combine the knowledge from artificial intelligence (AI; Mobasher, Jin, & Zhou, in press), networks (Chien & George, 1999), and other fields have also been implemented in recommendation systems. The genetic algorithm along with the naïve Bayes classifier is used to define the relationships among users and items (Ko & Lee, 2001). The genetic algorithm first completes the clustering for discovering relationships among system users in order to find the global optimum. On the other hand, the naïve Bayes classifier defines the association rules of the items. Then, similarity decisions can be performed to match the clusters of users or clusters of items, and the system can decide the final user profiles. The user profiles only consist of associated rules. The expectation maximization (EM) algorithm (Charalambous & Logothetis, 2000) provides a standard procedure to estimate the maximum likelihood of latent variable models, and this algorithm has been applied to estimate different variants of the aspect model for collaborative filtering (Hoffman & Puzicha, 1999). The heuristics of the EM algorithm can be applied to latent class models to perform aspect extracting or clustering.

Meanwhile, hierarchical structures are employed to describe the relationships among users (Jung, Yoon, & Jo, 2001). The preferences of each user can be described in a hierarchical structure. The structure represents the index of categories, which are the labels of the nodes. Matching one structure to another with all category labels results in each node containing a group of users with similar preferences. Hierarchical structures can also be applied to similarity computations for items (Ganesan, Garcia-Molina, & Widom, 2003). Edges in the structure clearly define how items are related for the item-to-item relationships. A hierarchical structure, a tree specifying the relative weights for the edges, provides information on how much two items are related. A method of the order-based similarity measurement has been proposed for building a personal-computer recommendation system (PCFinder; Xiao, Aimeur, & Fernandez, 2003). Instead of using 0/1 for the search, this method uses the concept of fuzzy logic to estimate the similarity.

Two popular approaches, the coefficient correlation computation and the nearest-neighbor algorithm, have limitations in scalability and sparsity. Clustering (Breese, Heckerman, & Kadie, 1998), the eigentaste algorithm (Goldberg et al., 2001), and singular value decomposition (SVD; Sarwar et al., 2000b) are introduced to collaborative-filtering-based recommendation systems to break these barriers. The eigentaste and genetic algorithms enable constant-time computations for online processes. Item-based collaborative-filtering algorithms are proposed to further decrease the computation time (Linden et al., 2003).

MAIN THRUST OF THE ARTICLE

Privacy Issues and User Identification

Do users always agree on being monitored by systems? Not every user is comfortable if each page he or she visits is recorded. Some users even disable the cookies in their browsers. Recommendation systems usually require user registrations in order to utilize user data for future recommendations. There exist users that prefer not to log onto systems every time they visit. Can the behavior patterns of random users be included in data-mining processes? It depends on the properties of the similarity models. Unregistered users only provide few continuous behavior patterns. These data may hardly be useful if the similarity models require the quantity of the behavior patterns to reach a certain level. At the same time, these data may be treated as neighbors and be included in the clustering processes for the recommendation computations. The computational time will be increased when more neighbors are included. The necessity to include the data of segmental user behavior patterns depends on the following: If enlarging the data coverage enables an increase in prediction accuracy, there is a trade-off between the computation-time length and the coverage scale.

Drawbacks

There are still several drawbacks of collaborative filtering. First, the lack of information affects the recommendation results. For relationship mining, new items not yet rated or not yet labeled can be abandoned in the recommendation processes. The second problem is that collaborative filtering may not cover extreme cases. If the scales of the user profiles are small or the users have unique tastes, similarity decisions are unable to be established. The third problem is the update frequency. If any new information of users has to be included in the recommendation processes in real time, data latency will increase the waiting time for the query result. The complexity of the computation for the recommendation affects the waiting time of the user directly. Synchronization is another issue of profile updating in the systems. When hundreds of users query the system within a very short time period, two new problems occur: who should be considered in one certain clustering process, and how to pipeline the computational power of the system server.

Hybrid Methods

A new approach is designed to comprise both content-based- and collaborative-filtering techniques in order to provide the accurate prediction of user preferences. How accurate the predictions are depends on the subjective opinions from the users. A recommendation system including both technologies is a hybrid recommendation system (Balabanovic & Shoham, 1997). Hybrid methods solve the problem of extreme-case coverage that collaborative-filtering techniques are unable to handle.

The Next Evaluation Tool for Information Retrieval

Precision and recall are two conventional measurements of data accuracy. User satisfaction has become an important issue in the information-retrieval (IR) area since a decade ago. Recommendation-system developers need to focus on what the users prefer and avoid what the users dislike. Evaluating user satisfaction is not an easy job. There are two ways to perform the evaluation of user satisfaction. The first one is to survey the users. The problem of this approach is that frequent surveys would cause a lot of disturbance in the online searching experience. The second approach is to decide the criteria to quantify the degrees of user satisfaction. One criterion is the involvement-time length for the search result. However, the starting- and ending-time points are hard to be determined in the Web environment (Shahabi, Zarkesh, Adibi, & Shah, 1997).

FUTURE TRENDS

An ideal recommendation system should be dynamic, which indicates that the updates on profiles can be performed approximately in real time. Although innovations in hardware design advance computational speed, algorithms and techniques with low-time computational complexity are expected in recommendation-system developments. User data flow every second. In order to keep the profiles up to date, online computations require many resources, such as memory and computational power. Therefore, it is important to maximize the off-line computations. The computation time depends on two factors: the number of items and the number of users in the database. The impact of the first factor, the number of items, may be reduced. The items usually are not added into the databases continuously (the opposite is the data stream, e.g., a video stream). However, the decision on the frequency of updates on user profiles is more complex. How often should the updates be performed in order to keep track of the user preference trends? If the updates are required to be performed approximately in real time, an algorithm or a technique with low-memory computational complexity is essential to reduce system loading and eliminate the potential effects on system synchronization.

CONCLUSION

Different collaborative-filtering techniques have been proposed to decrease processing time and data latency. The results from different recommendation systems indicate that collaborative-filtering techniques afford the systems enough ability to provide recommendations to users. Consequently, the recommendation systems can predict user behavior patterns without any knowledge of the user in advance, and can evaluate accuracy by comparing the prediction and the reality. If clustering is performed by the genetic or nearest-neighbor algorithms, or the algorithm developed is based on any of these two, the gaps among the data affect the accuracy of the prediction a lot. This means that missing data lowers the accuracy of the prediction. The situation is the same for EM approaches. This is because EM approaches perform better when the probability space is more complete. The accuracy of predictions performed by hierarchical approaches may also be affected since the recommended items would be too general due to the lack of detailed categorizations. These statements indicate that the reduction of missing or insufficient data is not simple, and that some approximations are required to be performed in order to provide better predictions of user preferences.

An approach to decrease online computational time is to allow recommendation systems to perform clustering off line (Chee et al., 2001). Several algorithms and techniques proposed perform computations in constant time (Goldberg, Roeder, Gupta, & Perkins, 2001; Lemire, 2003). These algorithms and techniques provide the possibility of real-time updates on profiles in the recommendation systems.

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KEY TERMS

Clustering: A task that segments objects into groups according to object similarity.

Collaborative Filtering: An approach to provide recommendations based on the preferences of similar users.

Content-Based Filtering: An approach to provide recommendations based on the individual's preference.

Data Latency: An experienced time delay when a system or an agent sends data to a receiver.

Nearest-Neighbor Algorithm: An algorithm that determines and ranks the distance between a target object and any other available object.

Profile: An organized data set of information on users or items.

Recommendation System: A system that retrieves information based on users' preferences.

Similarity Model: A set of schematic descriptions that specify the measurement standard for the degrees of being similar.

Comparative Shopping on Agent Web Sites

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INTRODUCTION

The enormous amount of commercial information available on the Internet makes online shoppers overwhelmed and it difficult to find relevant information. The recent development of shopping agents (bots) has offered a practical solution for this information overload problem. From the customer's point of view, a shopping agent reduces search complexity, increases search efficiency, and supports user mobility. It has been proposed that the availability of agent Web sites is one of the reasons why e-markets should be more efficient (Mougayar, 1998).

Shopping bots are created with agent software that assists online shoppers by automatically gathering shopping information from the Internet. In this comparative shopping environment, shopping agents can provide the customer with comparative prices for a searched product, customer reviews of the product, and reviews of the corresponding merchants. The agent will first locate the merchants' Web sites selling the searched product. Then, the agent will collect information about the prices of the product and its features from these merchants. Once a customer selects a product with a merchant, the individual merchant Web site will process the purchase order and the delivery details. The shopping agent receives a commission on each sale made by a visitor to its site from the merchant selling the product on the Internet.

Some auction agent Web sites provide a negotiation service through intelligent agent functions. Agents will represent both buyers and sellers. Once a buyer identifies a seller, the agent can negotiate the transaction. The agents will negotiate a price and then execute the transaction for their respective owners. The buyer's agent will use a credit card account number to pay for the product. The seller's agent will accept the payment and transmit the proper instructions to deliver the item under the terms agreed upon by the agent.

BACKGROUND

The software agent with roots in problem solving and knowledge representation was not a new concept, but had not grown until the past decade when the Internet created a perfect environment for e-commerce. Dr. Pattie Maes, founder of the MIT Media Lab Software Agent Group, and other researchers have developed a number of intelligent shopping agents. Based on the customer buyer behavior (CBB) model, Maes and Guttman (1999) identified and implemented six stages of the buying process: need identification, product brokering, negotiation, purchase and delivery, product service, and evaluation. Need identification characterizes the buyer's need. Product brokering includes retrieval of product recommendations to help determine what to buy. Merchant brokering utilizes merchant ratings to help determine whom to buy from. Negotiation considers how to settle on the terms of transactions. Purchase and delivery signal termination of the transaction process. Product service and evaluation involve post-purchase services and evaluation of satisfaction with the overall buying experience and the decision.

Shopping agent technology has been accepted by a large number of e-commerce practitioners in recent years. The popular shopping bots are bestWebBuys, bizRate, dealTime, kelkoo, mySimon, nextTag, and priceGrabber. A 2002 report from bizRate.com found that 77% of U.S. online shoppers said that they use comparison shopping bots when shopping online (Laudon & Traver, 2003). More and more merchants have subscribed to agent Web sites to attract online shoppers. The number of listed member merchants has increased exponentially. PriceGrabber, which added software agents and raised the standard for online shoppers' comparison Web sites on November 8, 1999, had 1,050 subscribed merchants by the end of October 2003 and 5,925 subscribed merchants by May 2005. PriceGrabber achieved a fifth place standing in the 2004 Deloitte Technology Fast 500, a ranking of the 500 fastest growing technology companies in United States. Rankings are based on the company's percentage revenue growth over five years, from 1999-2004.

SHOPPING AGENT ESSENTIALS

Most shopping agent Web sites currently offer online shoppers three features: customer reviews of a product, competitive prices of the product, and ratings of the merchant who sells the product. These features help customers select an appropriate product within a reasonable price range and choose merchants they can trust and feel comfortable shopping with.

Issues

Product Reviews

The product reviews on an agent Web site are contributed by customers shopping on the agent Web site. The product review system is able to provide a large volume of product reviews. Avery, Resnick, and Zeckhauser (1999) studied the potential of a market for evaluations and indicated that personal experience with products is enormously powerful in forming the customers' decisions.

Behavioral research suggests that consumers view recommendations of unfamiliar products negatively (Park & Lessig, 1981). Ganesh and Amit (2003) focused their research on how product review systems affect customer preferences of unfamiliar products since recommendations of unfamiliar products represent an important new source of business. The result demonstrates that positive contextual recommendations based on a customer's prior purchase interest do not always produce positive effects on the sale of new products. Contextual recommendations may be beneficial when they are known to be attractive to the customer and are likely to be perceived as similar to the target item. The context can be provided in a manner that makes it salient when customers first encounter the unfamiliar recommendations. Conversely, new recommendations should be presented when little is known about the shopper and when familiar recommendations are likely to be perceived as different from the unfamiliar recommendations. It is important that designers of shopping agent Web sites create contexts judiciously and offer tentative guidelines for product review systems.

Competitive Price

Internet technology has increased price transparency of a product. Online customers are likely to compare prices to other Web sites and traditional stores. Most shopping agents claim to eliminate search necessary to identify the right product at the best price offered by each of the merchants. They take a query, visit their member e-tail stores that may have the product sought, bring back the results, and present them in a consolidated and compact format that allows for comparative shopping at a glance. The impact of this comparative price system lowers the search cost not only for consumers, but also for merchants who wish to find out what prices their rivals are charging. This makes it more difficult for merchants to undercut each other secretly (Vulkan, 1999).

Merchant Reputation Ratings

In addition to obtaining competitive prices and product recommendations, many shopping bots have developed systems to keep track of merchant reputation ratings as well as service quality, simply because consumers want to know that the merchant with whom they are transacting an order is reliable, will deliver the product as specified in the delivery schedule, will maintain confidentiality, and will have appropriate product packaging and handling arrangements. So far, the merchant reputation system is best known as a technology for building trust and encouraging trustworthiness in e-commerce transactions by taking past behavior as a publicly available predictor of likely future behavior (Dellarocas, 2003).

Resnick, Zeckhauser, Friedman, and Kuwabara (2000) have defined a reputation system as one which collects, distributes, and aggregates feedback about merchants' past behavior. Though few producers or consumers of the ratings know one another, these systems help people decide who to trust and also encourage trustworthy behavior. The merchant reputation has significant impact on customers' trust and on their intentions towards adopting e-services (Ruyter, Wetzels, & Kleijnen, 2001). In February 2003, Jeff Bezos, the CEO of Amazon.com, decided to cancel all plans for any television or general print advertising because he believed that his company was better served by word-of-mouth generated through the Internet than by paid advertising.

Problems

Despite its undeniable importance and widespread adoption of agent technology, the current shopping agent Web sites still encounter problems: fraud risk management, rating consistency, and biased rating. These problems are discussed in the following section.

Fraud Risk Management

Key facets of the usefulness and successful adoption of emerging reputation systems are their accuracy, consistency, and reliability. A group of academic scholars conducted research on the risk management of merchant reputation systems. Kollock (1999) states that online rating systems have emerged as an important risk management mechanism in the e-commerce community. Dellarocas (2000) identified several scenarios ("ballot stuffing," "badmouthing," positive seller discrimination, negative seller discrimination, and unfair ratings "flooding") in which buyers and sellers can attempt to "rig" an online rating to their advantage. One party could blackmail another by threatening to post negative feedback unrelated to actual performance. Friedman and Resnick (1998) discuss risks related to the ease with which online community participants can change their identity. They conclude that the assignment of a lowest possible reputation value to newcomers of agent Web sites is an effective mechanism that discourages participants from misbehaving and, subsequently, changing their identity.

Some important management mechanisms have been developed. Most agent Web sites have developed countermeasures to counteract the above potential threats in various ways. Some have created registration systems to restrict online evaluation writers only to its member customers. Member customers have to log on to their accounts before they evaluate their merchants. Some agents have claimed that they are able to detect and eliminate fraudulent ratings by using a combination of sophisticated mathematical algorithms and a large number of reviews from a variety of sources that have been checked for consistency.

Rating Consistency

As an increasing number of online reputation systems become available in the shopping agent Web sites, one customer may be exposed to multiple online merchant reputation systems for the same merchant. Since different reputation systems may provide different ratings for the same merchant, customers may get confused. Thus, questions are raised on the consistency of the ratings provided by different reputation systems. It is crucial for online customers to get to know the reliability ratings of merchant service quality from merchant reputation systems before they make a purchase decision. Consistent ratings are able to provide more reliable evaluations of a merchant. Wang and Christopher (2003) conducted an empirical study on the rating consistency of reputation systems using three sets of data collected online from two popular merchant reputation systems. The results of the study showed that individual customer ratings are not consistent for the same set of merchants across reputation systems. However, the averaged customer ratings are consistent on the same merchant across different merchant reputation systems. The averaged customer ratings on different occasions in the same reputation system are consistent, too.

The solution to the rating discrepancy problem across different reputation systems is to develop a new agent Web site listing the averaged rating for each merchant on different reputation systems as a comparison-at-a-glance reference resource for customers.

Biased Rating

Customers with exceptionally positive or negative views of merchants are more likely to respond than the general customer population. The implication is that those customers who wrote an online comment are strongly opinionated. This results in a biased response that would be more likely to identify current quality problems than a controlled survey of equal sample size. The customers who remained neutral might not be motivated to rate the online store. People may not bother to provide feedback at all, since there is little incentive to spend another few minutes filling out the form. Most people do it because of their gratitude or their desire to take revenge. Some people do it because some reputation systems reward them. Further research needs to be done on the portion of customers who did not choose to either express or share their post-shopping satisfaction.

Table 1 presents a frequency distribution of 106 overall star ratings classified by customers' post-shopping satisfaction level. This exhibit lists the frequency of occurrence of each classification of rate. The total number of given ratings was 106. The percent of the total was computed by dividing the number in each level by the total number of ratings.

Table 1. Overall rating classified by satisfaction level

Level of Satisfaction (Overall Rating)	Number of Overall Rates at Satisfaction Level	Percent of Total
Very Satisfied	53	50.0
Somewhat Satisfied	9	8.5
Neutral	0	0.0
Somewhat Dissatisfied	3	2.8
Very Dissatisfied	41	38.7
Total Reviews	106	100.0

FUTURE TRENDS

Future agents could automatically build models of shoppers, recommend products to shoppers, and negotiate on behalf of shoppers through the development of intelligent agent functions. These intelligent agent functions take the concept of the shopping agent beyond that of a purpose-built search engine. The future agents will reside on individual computers, create personal accounts for the owners, learn about their owners' shopping preferences, create a personalized "virtual store," and perform more efficient inquiries and purchases in subsequent requests.

Much of the relationship between merchants and customers in the future may be conducted via handheld mobile devices such as palm computers and cellular phones. PDAs already are combined with mobile phones from which users can log on to the Internet. Mobile agents are well suited for e-commerce, since a commercial transaction may require real-time access to remote resources. Lang and Oshima (1999) specified seven main benefits for using mobile agents. They reduce the network load, overcome network latency, encapsulate protocols, execute processes asynchronously and automatically, react autonomously to changes, provide optimal conditions for seamless system integration, and are robust and fault tolerant. Therefore, the design and development of the future mobile shopping bots should suit the need of m-commerce.

CONCLUSION

Shopping bots represent the newest trend in e-marketing technology and have been accepted by a large number of e-merchants and online shoppers. Recent research has shown that consumers prefer to shop and buy on the Internet for three major reasons—convenience, time savings, and comparative shopping (Oz, 2002). Shopping bots provide online customers with an informative, convenient, and comparative shopping environment. The development of agent technology makes it possible for online shoppers to search hundreds to thousands of merchants' stores from a single Web site efficiently. The shopping agent Web site is built with customers' shopping experience and comments. The comments on products and merchants from previous customers are a valuable asset to other prospective customers. Customers who have finished shopping with merchants listed on the agent Web sites are invited to post product reviews and merchant evaluations. In response, the agent Web site will display them online.

Merchants can benefit from shopping bots as well. Merchants can receive feedback in the form of online evaluations from customers posted on merchant reputation systems. Positive evaluations will draw more customers to the evaluated merchants. Negative evaluations will help them to learn lessons and to improve their service quality. Member merchants who have registered on a shopping agent Web site can receive the shopping agent's market report. The report provides brands, price trends, market share, and customer buying habit information based on real-time data from the database that monitors actively traded products.

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KEY TERMS

Comparative Shopping Environment: Offers three features: customer reviews of a product, competitive prices of the product, and ratings of the merchant who sells the product. These features help customers select an appropriate product within a reasonable price range, and choose merchants they can trust and feel comfortable shopping with.

E-Marketing: Achieving marketing objectives through use of electronic communications technology.

Merchant Reputation System: A system that collects, distributes, and aggregates feedback about merchants' past behavior from customers. Though few consumers of the ratings know one another, these systems help people decide whom to trust and also encourage trustworthy behavior.

Mobile Commerce (M-Commerce): Electronic transactions and communications conducted using mobile devices such as laptops, PDAs, and mobile phones, and typically with a wireless connection.

PDA (Personal Digital Assistant): A small handheld wireless computer.

Shopping Bots: Also called shopping agents; programs that search the Web and find items for sale that meet a buyer's specifications. These shopping bots take a query from an online customer, search online stores, and then report back on the availability and pricing range in a consolidated and compact format that allows comparison shopping at a glance. Not only do these shopping bots bring comparative product and price information from individual merchants' Web sites, but they also provide the online merchants' ratings.

Software Agents: Software programs that assist humans by automatically gathering information from the Internet or exchanging data with other agents based on the query provided by users.

Comparison–Shopping Agents and Online Small Business

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BACKGROUND OF SMALL BUSINESS

Since the commercialization of the Internet in the 1990s, online retailing has increased steadily. According to the most recent Department of Commerce Census Bureau report,[1] retail e-commerce sales in the first quarter of 2004 were $15.5 billion, up 28.1% from the first quarter of 2003. E-commerce sales in the first quarter of 2004 accounted for 1.9% of total sales, compared with 1.6% of total sales for the first quarter of 2003.

An important trend in this growth in B2C (business-to-consumer) e-commerce is the participation of small business on the Web. Considering that in the United States small business comprises more than 99% of employer firms,[2] this trend is significant.

Though the Web offers huge potential to these small businesses for growth and prosperity, and also offers them a very low entry cost, Web visibility becomes the major barrier for them. Small businesses often have difficulty putting up enough funding to compete with brand-name businesses in promotion. So small businesses are desperately in need of a less costly channel for increasing their Web visibility.

In the past 4 years and especially since the economic slowdown in 2000, comparison shopping has become more and more popular among online shoppers. Because of the low cost of being listed on comparison-shopping Web sites and the relatively high conversion rate for online shoppers who use comparison shopping, many small businesses found this an ideal channel to increase their Web visibility. As a result, many early participating small businesses gained a customer base in the competition by displaying their products and service prices on comparison-shopping Web sites.

Now, it is more and more clear that comparison shopping provides a unique opportunity for small businesses to reach a large customer population with relatively little cost. To help readers better understand this phenomenon, we give a comprehensive introduction to comparison-shopping agents and summarize recent research on their impact in e-commerce.

DESCRIPTION OF COMPARISON-SHOPPING AGENTS

Definition

Comparison-shopping agents, also called shopbots, are those Web-based intelligent agents that can collect product and service information, especially price-related information, from multiple online vendors, aggregate them, and then provide value-added service to online shoppers to assist their online shopping.

Comparison-shopping agents are information intermediaries. They play the role of information brokers in the information supply chain that connects online vendors to consumers on the Web (Etzioni, 1997; Haubl & Trifts, 2000). Comparison-shopping agents are intelligent software applications (Wooldridge & Jennings, 1995; Wooldridge, Müller, & Tambe, 1996). There is a general three-tier design for these agents (Kushmerick, Weld, & Doorenbos, 1997). Based on the information they provide, comparison-shopping agents can be classified into three categories: differentiation agents, evaluation agents, and preference-identification agents (Wan, Menon, & Ramaprasad, 2003).

Technical Review

The efficiency and effectiveness of comparison-shopping agents are mainly determined by their technical rationality, which is manifested through two aspects: their ability to extract and aggregate information from heterogeneous data sources (online vendors), and their ability to provide appropriate information and information-processing support to consumers. These two aspects are implemented in their three-tier design as described below.

Data-Retrieval Tier

The data-retrieval tier is responsible for collecting data from external heterogeneous data sources on the Web or proprietary partner network.[3] Because the data format of the information the comparison-shopping agents retrieve is HTML (hypertext markup language), which is a semistructured language, we have to employ a "wrapper" technology (also called "screen scraping" in the popular press) to retrieve data and transform it from an incompatible data format into a format that can be understood by the agent (Adelberg, 1998; Ashish & Knoblock, 1997; Firat, Madnick, & Siegel, 2000; Kushmerick et al., 1997; Madnick, 1999). XML (extensible markup language) and other more structured solutions may transform the design of this tier in the near future (Rosenthal, Seligman, & Costello, 1999).

Information-Processing Tier

The information-processing tier, the heart of the agent, performs three major tasks: filtering the data retrieved, categorizing them, and indexing them.

This tier is needed to make the data format consistent. For example, to compare price information for the same book from two vendors in two countries, we have to convert one country's currency into the other's by using the current exchange rate (Zhu, Siegel, & Madnick, 2001). Sometimes, certain products may be queried repeatedly, so a cache database could be utilized to store the most frequently requested information for fast retrieval. The categorization of information is important because it is also an indexing process and makes the retrieval of records more efficient.

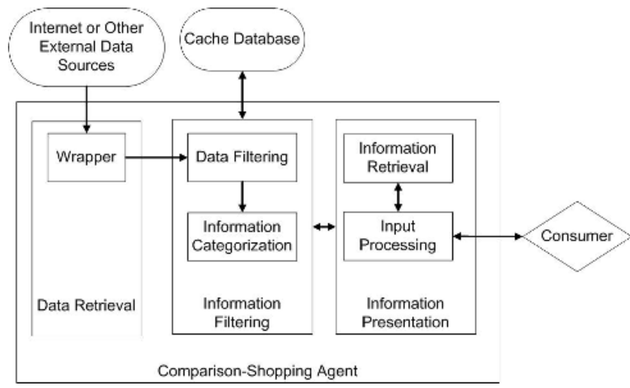
Information-Presentation Tier

The information-presentation tier is the interface between consumers and the agent. It provides the interaction interface for consumers and translates the consumer's input into a query for internal processing.

This tier is able to present the information in a customer-friendly format that will assist consumers in the product-comparison process. There are two core functioning parts in this tier: the information-retrieval part and the input-processing part. The information-retrieval part is responsible for processing the consumer query and getting it back to the consumer; the input-processing part will collect the consumer input and translate it into a query to the information-retrieval part.

Figure 1 is a demonstration of the internal structure of a comparison-shopping agent with the three tiers we described above.

Figure 1. Structure of comparison-shopping agent



Historical Review

BargainFinder was the first comparison-shopping agent to catch media attention and was later widely regarded as the predecessor of the Web-based comparison-shopping agent. It could search and retrieve prices from up to nine online music stores (Krulwich, 1996).

BargainFinder was developed by Andersen Consulting's research lab and Smart store to measure the market reaction to comparison. It was implemented via the wrapper technique (Doorenbos, Etzioni, & Weld, 1997; Krulwich, 1996).

Pricewatch.com, a contemporary of BargainFinder though it received almost no media attention, was one of the first commercial comparison-shopping agents that could retrieve computer-product pricing information from hundreds of small online vendors. Compared with the short presence of BargainFinder, Pricewatch.com has grown steadily through the years and has become one of the major comparison-shopping portals.

From 1996 to 1998, several innovative comparison-shopping agents like Jango, Junglee, and CompareNet emerged. However, soon almost all of them were acquired by already-established portals. For example, Jango, based on the prototype of ShopBot designed by three researchers at Washington State University (Doorenbos et al., 1997), was acquired by Excite for $35 million in October 1997. Others were acquired in like manner: Junglee by Amazon in 1998, CompareNet by Microsoft in 1999, and mySimon.com by CNET in 2000. Only a few remained independent; Pricescan.com was among them (Anonymous, 1998) and it survives through the revenue generated from advertisement on its Web site.

Comparison shopping came into mainstream B2C business in 2000 with the emergence of new agents like Dealtime.com or the now Shopping.com.[4]

From 2000 to 2004, intensive marketing, and frequent merging and acquisition by their peers characterize comparison-shopping agents. Dealtime.com was among the first group of comparison-shopping agents to use intensive marketing efforts to build the concepts of comparison shopping in consumers (White, 2000). It also acquired resellerratings.com, an evaluation agent, in February 2003, and epinion.com, a preference-identification agent, in March 2003 to increase its service coverage. In Europe, Kelkoo engaged in multiple mergers with other small comparison-shopping agents to become Europe's largest e-commerce Web site after Amazon and eBay, and the largest e-commerce advertising platform both in the United Kingdom and Europe.

Meanwhile, the comparison-shopping population had risen from less than 4% (Baumohl, 2000) of online shoppers before 2000 to 15% in 2003.[5] And popular comparison-shopping portals began to rank among other established online portals. For example, Shopping.com ranked fourth (behind eBay, Amazon, and Yahoo Shopping) among U.S. multicategory e-commerce sites in November 2003 in terms of unique monthly visitors. During Mother's Day week in 2004, the number of unique visitors to comparison-shopping site mySimon.com increased 14% from 274,000 to 311,000.[6]

So, we can expect that in the near future comparison-shopping agents will gradually become a major channel for online shopping, which has significant implications for online vendors.

IMPACT OF COMPARISON-SHOPPING AGENTS ON SMALL BUSINESS

Depending on how small businesses react to the emergence of comparison-shopping agents, the impact of these agents on small business could go either direction.

On one hand, the emergence of comparison-shopping agent provides a potential channel for small online vendors to increase their Web visibility so as to compete head-to-head with brand-name online stores. As a result, we can observe significant price drops due to competition. For example, through an empirical study, Brown and Goolsbee (2000) found that the rise of comparison-shopping sites reduced average insurance prices for the group by as much as 5% in the 1990s. However, prices did not fall for insurance types that were not covered by the comparison Web sites. This study indicates that the growth of the Internet has reduced term life prices by 8 to 15% and increased consumer surplus by $115 million to $215 million per year and perhaps more. However, this trend is not consistent in other product categories. Iyer and Pazgal (2003) collected pricing data from up to seven comparison-shopping sites for homogeneous products like CDs (compact discs) and books. They found that the emergence of comparison-shopping agents did not lead to intensive pricing competition among online vendors because the purposes of participating in comparison shopping among online vendors varied. Brynjolfsson and Smith (2001) confirmed the findings: They found that online shoppers were not absolute bargain finders; many visitors to the Web site chose to buy from the brand-name stores instead of those unknown stores that offered the lowest prices. Based on their calculation, branded bookstores on average command a $1.41 price premium over unbranded retailers for each book.

Thus, the impact of comparison-shopping agents on competition between small business and brand-name portals is still not clear in terms of different product categories, which may serve as one future research direction.

On the other hand, the emergence of comparison-shopping agents puts considerable pressure on small businesses that are not participating in comparison shopping. These businesses previously may have survived with their small loyal customer base. However, when a customer is equipped with a comparison-shopping agent, he or she may easily identify a number of similar small businesses to buy from; thus, the chance of switching increases dramatically. This means small businesses have to make the decision to deal with this new environment. If they choose to participate, how to compete with other small businesses becomes critical. Through the collection of the daily price data of uVision, a comparison-shopping agent for CDs, Crowston (1997) found that most small vendors might not benefit from comparison shopping because a few vendors consistently have the lowest price for all products. Later, Crowston and MacInnes (2001) confirmed the "cheapest-for-all" phenomenon. They also found that the prices converge over time for comparison-shopping participants.

Apart from the direct impact on small business, comparison-shopping agents also have the potential of fundamentally changing the online shopping behavior of consumers, thus reshaping the landscape of the B2C electronic market. Several studies found that using comparison shopping increases the efficiency and effectiveness of decision making significantly (Alba, Lynch, Weitz, Janiszewski, Lutz, Sawyer, & Wood, 1997; Benbasat & Todd, 1996; Clark, 2000; Haubl & Trifts, 2000). So online shoppers have the incentive to use comparison-shopping agents whenever they are available.

With large numbers of small businesses participating in comparison shopping, we can expect a differentiation of the market by comparison-shopping agents. For example, pricegrabber.com has already adopted programs like having a featured merchant to place those small businesses that pay a premium price in prominent positions in the comparison list. This manipulation of comparison information could subtly change consumers' decision outcomes, as confirmed by a controlled experiment by Haubl and Murray (2003).

Thus, more investigations are needed to understand how consumers make decisions when choosing to use comparison shopping instead of going to a brand store directly, as well as how they use comparison-shopping agents in making decisions. Several new studies in this direction provide us with some preliminary results. For example, Montgomery, Hosanagar, Krishnan, and Clay (in press) found that consumers might still choose to use the brand-name store instead of the comparison-shopping agent because using a comparison-shopping agent may incur additional costs, like waiting for a response and so forth. So a better designed comparison-shopping agent is a necessity to success.

For the time being, the limitations of recent studies include the following:

- First, the scope of the product and agents they covered is highly restrained. The e-commerce field of comparison-shopping agents developed swiftly in the past 4 years. The product coverage being compared has already extended from homogeneous commodities like books and CDs to almost all categories of products one can find in any online shopping center. Coverage also extended to services like finance, tourism, and so forth. However, few research projects systematically study the impact of comparison shopping in these new areas. It is possible that the pricing behavior for book and CD vendors might be different from pricing behaviors for airline tickets (Allen & Wu, 2003).
- Second, most of the studies in this area failed to capture the dynamic nature of comparison-shopping agents, though some of them tried to develop some innovative models (Jin, Suh, & Lee, 2003). For example, a considerable number of studies make the prediction that comparison shopping may not prosper because it only provides price information. However, it took less than 2 years for almost all comparison-shopping agents to provide online vendor ratings and product quality review information. Thus, how to make a better Web-based business model that could predict the development trend of comparison shopping becomes relevant.

CONCLUSION

Comparison-shopping agents as a new technology have increasingly influenced the behavior of small business. Research in this area is still in its infancy stage. For the time being, empirical research indicates comparison shopping may not necessarily result in Cournot equilibrium (Cournot, 1838). Brand-name portals can charge a premium price because of their reputation. Small businesses are pressured to participate in this channel, and they need to compete not only in price but also in other strategies.

Relatively more research in the behavior aspects of consumers using comparison-shopping agents has been conducted. We found that comparison-shopping agents can improve decision efficiency and effectiveness in general, especially in reducing searching costs. However, we also found that comparison-shopping agents can influence the decision outcome by manipulating the format of information or overloading the consumer by providing too many choices. These findings may provide strategic aspirations for small businesses.

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KEY TERMS

Comparison-Shopping Agent: A Web-based service that can collect product and service information, especially price-related information, from multiple online vendors, aggregate them, and then provide value-added service to online shoppers to assist their online shopping.

Differentiation Agent: Comparison-shopping agent specializing in collecting price-related, impersonal information, for example, Pricewatch.com.

Evaluation Agent: Comparison-shopping agent specializing in collecting product and service rating information, for example, Bizrate.com.

Intelligent Software Agent: A software agent that uses artificial intelligence (AI) in the pursuit of the goals of its clients.

Preference-Identification Agent: Comparison-shopping agent specializing in collecting personal product and service review information, for example, epinion.com.

Web Visibility: The popularity of a Web site among online shoppers.

Wrapper: An application routine that can retrieve and transform data from one format into another.

ENDNOTES

1. Details about the data could be obtained from the Census Bureau at http://www.census.gov/mrts/www/current.html
2. See "FAQ of Small Business Administration" at http://app1.sba.gov/faqs/faqindex.cfm?areaID=2
3. For those agents who have a partnership program with online vendors
4. Here we use Media Metrix's 200,000 minimum measurements as the benchmark for qualification as a major e-commerce Web site.
5. Data obtained from http://www.nielsen-netratings.com/pr/pr_040223_us.pdf
6. Data obtained from http://www.nielsen-netratings.com/pr/pr_040507.pdf

Computer Security in E-Learning

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INTRODUCTION

Although the roots of e-learning date back to 19th century's correspondence-based learning, e-learning currently receives an unprecedented impetus by the fact that industry and universities alike strive to streamline the teaching process. Just-in-time (JIT) principles have already been adopted by many corporate training programs; some even advocate the term "just-enough" to consider the specific needs of individual learners in a corporate setting.

Considering the enormous costs involved in creating and maintaining courses, it is surprising that security and dependability are not yet considered an important issue by most people involved including teachers and students. Unlike traditional security research, which has largely been driven by military requirements to enforce secrecy, in e-learning it is not the information itself that has to be protected but the way it is presented. Moreover, the privacy of communication between teachers and students.

For a long time students and faculty had few concerns about security, mainly because users in academic areas tended not to be malicious. Today, however, campus IT-security is vital. Nearly all institutions install firewalls and anti-virus software to protect campus resources. Even the most common security safeguards have drawbacks that people often fail to see. In Stanford the residential computing office selected an anti-virus program. However, the program can be set to collect data that possibly violates students' privacy expectations; therefore many students declined using it (Herbert, 2004).

Whenever servers that store personal data are not well protected, they are a tempting target for hackers. Social security numbers and credit card information are valuable assets used in identity theft. Such attacks were successful, for instance, at the University of Colorado (Crecente, 2004). A similar incident happened at the University of Texas; the student who committed the crime was later indicted in hacking (Associated Press, 2004).

The etymological roots of *secure* can be found in *se* which means "without", or "apart from", and *cura*, that is, "to care for", or "to be concerned about" (Landwehr, 2001). Consequently, *secure* in our context means that in a secure teaching environment users need not be concerned about threats specific to e-learning platforms and to electronic communication in general. A secure learning platform should incorporate all aspects of security and dependability and make most technical details transparent to the teacher and student. However, rendering a system "totally secure" is too ambitious a goal since no system can ever be totally secure and still remain usable at the same time. The contribution of this chapter is to

- Define and identify relevant security and dependability issues.
- Provide an overview of assets, threats, risks, and counter measures that are relevant to e-learning.
- Point to publications that address the issues in greater detail.

BACKGROUND

While there a many definitions of the primary requirements of *security*, we will start with the classical *CIA requirements*. CIA is the acronym for confidentiality, integrity, and availability. All other requirements can be traced back to these three basic properties. Confidentiality is defined (Avizienis, Laprie, Randell, & Landwehr, 2004) as *the absence of unauthorized disclosure of information*, integrity as *the absence of improper system alterations* and availability as *readiness for correct service*.

Dependability is a broader concept that encompasses all primary aspects of security save confidentiality:

- Availability
- Reliability refers to the continuity of correct service
- Safety is defined as the absence of catastrophic consequences on the user(s) and the environment
- Integrity
- Maintainability is the ability to undergo modifications and repairs

For many universities e-learning systems have become production critical assets. It is therefore essential that all of the aforementioned generic requirements are evaluated during a process of risk assessment. The first step in such a process is to understand security and dependability as enabling technology. Only when systems work reliably will users trust and use them.

The obvious ultimate goal of an assessment is to implement cost-effective controls to avoid faults. Looking at all possible threats of a given application and subsequently mitigating the most important ones is a process that is called *threat modeling* (Swiderski & Snyder, 2004). The first step is to *decompose* the application and to determine how data is processed. This can best be done by creating data flow diagrams (Baskerville, 1993).

The second step is to *enumerate all threats*. There are eight dimensions along which faults can be categorized (Avizienis et al., 2004). Even though it is not required to categorize threats in this stage the eight dimensions are helpful to cover many different aspects and to avoid forgetting some.

1. **Phase of Creation:** Development faults vs. operational faults
2. **System Boundaries:** Internal faults vs. external faults
3. **Phenomenological Cause:** Natural faults vs. human-made faults
4. **Dimension:** Hardware faults vs. software faults
5. **Objective:** Malicious faults vs. non-malicious faults
6. **Intent:** Deliberate faults vs. non-deliberate faults
7. **Capability:** Accidental faults vs. incompetence faults
8. **Persistence:** Permanent faults vs. transient faults

The third step is to *rank the threats* according to the probability and potential damage. The forth and final step is planning and implementing *mitigation strategies* (Swiderski & Snyder, 2004).

RELEVANCE TO E-LEARNING

In this section we will first look at all requirements and highlight typical threats that are relevant in the context of e-learning. The final subsection highlights solutions and points to publications that address specific areas in greater detail.

Requirements

Availability

Attacks by insiders on servers delivering e-learning content are not as likely as on servers used for examinations. Students are in general interested in learning and will thus have little incentive to actively attack the system; non-malicious faults, however, might still occur. Obviously this does not mean that students will never attack an e-learning system used for studying, but examination systems are certainly more attractive targets. During learning, availability is not as important as, for instance, during online exams. A downtime of a few hours is acceptable for content servers but clearly not for exam servers.

For exams, the threat profile is different because students are likely to attack the system once they realize they might fail the exam. If they could crash the server their exams cannot be graded and they will have a second chance. Even if students cannot crash the server they might try to attack the availability of the local PC they use during the exam. Briefly unplugging it will cause a reboot and give them a good excuse for not being graded.

Reliability

When exams or assignments are graded automatically reliability is important; while multiple choice questions can be evaluated easily, reliability is more difficult to address the more sophisticated the evaluation algorithm is.

Keyword-based grading of free text answers will generally work well for technical exams that require precise answers but not for subjects with long and very free answers such as studies of literature.

Safety

In most cases there will be very little safety considerations required when introducing e-learning programs unless the subject taught is inherently critical. For instance, wrong instruction on how to operate certain machinery will in consequence create safety hazards once people operate the machinery.

Confidentiality

In many cases confidentiality is not a major requirement when creating e-learning content. The knowledge taught is generally widely available in text books. It is the way the content is presented and the effort of creating simulations and other interactive learning environments that are worth protecting.

For exams and assessments, confidentiality, however, is essential. Exam questions need to be kept secret until the exams commences; the correct answers need to be concealed until the exams are handed in.

Even if learning content contains few secrets, there are still elements that require protection against unauthorized read access. Discussion boards and forums are commonly used not only to discuss organizational issues but also course content. When controversial topics—such as pro-life vs. pro-choice—are discussed students' privacy needs to be protected.

Integrity

Data integrity is one of the most important requirements. During the learning process content should not be modified by unauthorized people as minor modifications might be difficult detect. For exams the integrity of questions, students' answers and correct answers clearly needs to be protected—before, during, and after the exam.

Secondary security attributes such as non-repudiation require system and data integrity. Non-repudiation refers to the fact that users cannot plausibly deny having performed an operation. For instance, students should not be able to deny having handed-in an exam.

Maintainability

As e-learning systems become part of the critical infrastructure maintainability is important. Not only needs the system to be maintained but also exit scenarios are required. Once a lot of e-learning content has been created it is too late to evaluate whether a migration can be made to another platform. It makes little difference whether a commercial or an open-source e-learning platform is used, one has to carefully plan how content can be extracted and migrated to another platform. Even if both the new and the old platform support e-learning standards such as SCORM a migration is not necessarily easy.

Human-Made Faults

Since the majority of system faults are human-made it is necessary to distinguish them further. Human-made faults are either *non-malicious* or *malicious*. All malicious faults or obviously deliberate.

Non-malicious faults can be either caused by mistakes (*non-deliberate*) or by bad decisions (*deliberate*). Non-deliberate mistakes can occur because of accidents or incompetence. Deliberate faults can also be traced back either to accidents or incompetence (Avizienis et al., 2004).

Solutions and Related Publications

Being aware that security and dependability are relevant is the first important step. However, all the mentioned issues need to be addressed in detail. In this section we will point to related publications that touch all of these issues in the context of e-learning. Since Web-based e-learning applications all run on a server, we assume that security measures typical for any server maintenance are implemented. This includes software updates and installing patches, data backups, and redundant hardware.

Security Risk Analysis

Weippl (2005b) provides a first introduction to a security risk analysis for e-learning. Similarly, (Weippl, 2001c) argues why security is an enabling technology in the move to m-commerce. With the rise of m-learning the rationale for improving security for mobile devices is important for e-learning as well. Even though e-learning may in many aspects be seen as just another form of e-commerce there are special requirements regarding security. In (Weippl, 2005a) the requirements specific to e- and m-learning are elaborated in detail.

Privacy

In Weippl and Essmayr (2003) an improved model to manage security and privacy of personal data on mobile devices is presented. The main idea is to keep data separated in different compartments and only allow a limited number of system functions to transfer data between these compartments. Threats to students' privacy when using e-learning applications are analyzed in Weippl and Tjoa (2005).

Mobile Security

As mobile devices are being widely used by students and faculty, they can also be used as authentication tokens. In Weippl, Essmayr, Gruber, Stockner, and Trenker (2002) a concept for mobile authentication is proposed that allows personal devices with wireless connectivity to identify and authenticate their owners to other services.

Database Security

With the proliferation of PCs in all departments of universities, local databases are used by numerous staff and faculty to manage students, courses, registrations, etc. It may seem very inefficient to store data multiple times and disregard integrity.

However, unlike tightly controlled companies, universities should enable and even promote decentralized and heterogeneous environments, even for organizational processes. Nonetheless, central administration, registrar's offices, etc., require some information on students' activities (e.g., which courses a student really attends).

When integrating databases, it is advantageous if administrators of existing databases are not required to change the schema of their local database. As owners of databases (i.e., individual lecturers, professors, etc.) are most probably not willing to give up their autonomy, they want to have control over who has access to which information in their database (Weippl, 2003a).

Database agents (Weippl et al., 2003) can be used to solve this problem (i.e., to integrate heterogeneous databases). Agents are especially well suited to address the issue of security which is even more relevant in distributed environments. While migrating, DB agents are wrapped into Java agents that take care of many issues regarding security and migration.

Role-Based Access Control

Role-based access control (RBAC) is a widely used in database systems. In programming environments, however, RBAC and other access control models are often not well supported. Application programmers regularly have to implement the controls from scratch. The GAMMA framework allows programmers to specify arbitrary access control policies in XML. Programmers only need to derive their classes from specific base classes to automatically protect access to restricted method calls.

Weippl (2001a) proposes to wrap content in cryptographic containers and use RBAC mechanisms to permit or deny operations such as reading, printing, modifying, or distributing content. Weippl (2001b) goes into detail and shows an architecture to securely distribute course content and enforce access control even when distributing content over the Internet.

If different systems are integrated as described in Weippl et al. (2003) it is essential to provide a way of mapping identities and roles of one system to another system. The challenge is to correctly map groups and roles into (legacy) systems that do not support such mechanisms and vice versa. To minimize user errors when setting up access rights, mandatory access control mechanisms can be used. In Weippl (2005a) a security model for e-learning is introduced to model a MAC approach in an RBAC environment—similar to Osborn et al. (2000).

Availability

When delivering e-learning content for asynchronous studying, availability is not as important as during real-time interaction (i.e., chats, broadcast sessions, online exams, etc.).

To avoid frustrated users, downtime of self study section should obviously not be too high. Nonetheless, by clearly communicating how long a site might be unavailable user will usually accept this without problems. For periods with real-time communication, other channels of communication should be provided as a backup. By giving students, for instance, a telephone number to call when they experience problems during a chat or broadcast session user acceptance can be greatly increased.

Backups are essential to ensure availability of data after system failures. While backups are a routine task of server maintenance there are some specific requirements in the context of e-learning. Typically an entire server is backed up and monthly backups are archived for quite some time. For effective learning, however, privacy of personal communication in e-learning platforms can be essential (Weippl & Tjoa, 2005). Backups and log files are threats to the individual learner's privacy. By clearly stating the privacy preferences of a system, users know how personal data is used and for how long it is archived; they can thus decide what information to post on the platform and when to use other means of communication.

FUTURE TRENDS

Recently, security in the context of learning and teaching receives more attention. In most cases security of campus networks is improved to protect personal information of students and faculty and to discourage copyright infringements through P2P file sharing.

Moreover, Moodle, a major open-source e-learning platform, recently launched a security initiative[1] that makes systematic code reviews to improve code security. Increasingly, researchers and practitioners attend tutorials on security in e-learning.[2] The author of the chapter anticipates that within the next few years security considerations will be essential when decisions about implementing e-learning programs will be made.

CONCLUSION

During the last few years, e-learning systems became widely-used system not only to support distance learning but also to supplement and improve presence teaching. Increasingly, users and administrators become aware that large e-learning systems need be secured and dependability is an issue. Many requirements are similar to those of other Web-based services; however, privacy and freedom of academic research and teaching also requires new approaches. Content authors want to protect their e-learning content from copyright infringements, while teachers need to protect systems from students who may undermine their evaluation system by cheating. Students should not be too closely monitored by their teachers when using e-learning software. Since these intertwined requirements are not met by existing systems, new approaches are needed; this article provides many references for interested readers to follow. The book *Security in E-Learning* (Weippl, 2005c) contains many more details.

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KEY TERMS[4]

Dependability: Is a broader concept that includes availability, reliability, safety, integrity, and maintainability but not confidentiality. A system is *available* if it is ready to perform a service. It is *reliable* if it continues providing a correct service. *Safety* refers to the absence of catastrophic consequences for users and the environment. A system's *integrity* guarantees no unauthorized modifications. When systems can be modified and repaired easily they are *maintainable*. *Confidentiality* means that information is not disclosed to unauthorized subjects.

E-Learning: Dating back to the hype of the term e-commerce, e-learning is widely used in different ways; for instance, E-Learners Glossary[3] defines e-learning as any form of learning that utilizes a network for delivery, interaction, or facilitation. E-learning covers a wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via Internet, intranet or extranet, audio- and videotape, satellite broadcast, interactive TV, and CD-ROM. The "e" in e-learning stands for electronic and thus all forms of learning that involve electronic components should be considered to be e-learning in the broadest sense; obviously e-commerce mainly refers to commerce conducted via electronic networks, and e-learning therefore has strong ties with communication networks. Because computers no longer exist without networks, however, these stand-alone learning applications will eventually cease to exist. For instance, today, even the simplest CD-ROM courses contain links to the Web. Trainings can either be *self-based* or *instructor-led* (ILT). E-learning is *computer-based* (CBT) if a computer is used. If the computer is connected to the Internet and a Web browser is used to access the e-learning platform, it is considered to be *Web-based* (WBT).

Exploit: An exploit is a program that uses a vulnerability to attack the system's security mechanisms. Exploits usually compromise secrecy, integrity or availability and often lead to elevation of privilege.

Risk: A risk is the relative likelihood that a bad thing will happen (Schneier, 2003). In other words, risk is defined as the probability that a vulnerability is exploited and results in a damage.

Security: Encompasses the primary aspects of availability, integrity, and confidentiality.

Threat: A threat is a bad thing that can happen (Schneier, 2003), such as a server being stolen.

Vulnerability: A vulnerability is system's weakness or error that might allow to penetrate the security barriers.

ENDNOTES

1 http://security.moodle.org/
2 http://www.e-learning-security.org/
3 http://security.moodle.org/
4 The most recent authority for definitions of security- and dependability-related concepts is Avizienis et al. (2004).

Consumer Trust in E-Commerce

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INTRODUCTION

The lack of trust toward different elements of e-commerce has been recognized as one of the main causes of the collapse of a large number of dot-com companies. The concept of consumer trust has since been the object of many studies in the field of e-commerce. These studies permitted a better understanding of the role of trust in e-commerce, but an examination of the literature reveals that our understanding is limited due to important gaps in the ontological aspects of the trust concept, among which are (a) a lack of consensus concerning its definition, (b) a unidimensional as opposed to a multidimensional conceptualization of the construct, and (c) a confusion between trustworthiness and trust. The goal of this article is to identify these gaps and present ways of reducing their size and impacts.

BACKGROUND

In spite of the youth of this knowledge field, a review of the literature on trust in e-commerce is interesting because of its richness, probably because of the interest raised by trust in the e-commerce scientific community as well as in others. The background of consumer trust is looked through the definition, the dimensionality, and the conceptualization given to the concept in research.

Definition

Trust was traditionally difficult to define (Rousseau, Sitkin, Burt, & Camerer, 1998), particularly because of its many different meanings (McKnight & Chervany, 2001a). For this reason, and in spite of many significant efforts in research, there is not yet a universally accepted definition of trust (Chen & Dillon, 2003) and the state of the definitions of trust belongs to what Lewis and Weigert (1985) call a "conceptual confusion."

In the field of e-commerce, definitions of trust abound and are mostly borrowed from the fields of marketing and information systems. In turn, these fields draw their definitions from disciplines such as psychology, sociology, and economics, thus leading to contradictory conceptualizations harming research that is carried out (Bhattacherjee, 2002; Gefen, Karahanna, & Straub, 2003a). Moreover, according to Bigley and Pearce (1998), efforts made to propose a consensual definition of trust led to even more meaningless and diverse conceptualizations of trust with little empirical utility.

Each discipline identifies many different factors influencing the level of trust and produces its own concepts, definitions, and results. The definitions are adapted to their context, and each discipline has its own paradigm that enables it to understand certain things and that also acts like blinkers in certain circumstances (Rousseau et al., 1998). Thus, psychologists define trust as a propensity to trust, sociologists and economists broadly define it as a characteristic of the institutional environment or as a calculus-based evaluation, and social psychologists define it as reasoning in connection with another party. This proliferation of types of trust encouraged several researchers to develop composite definitions of trust (Doney & Cannon, 1997; Mayer, Davis, & Schoorman, 1995; McKnight & Chervany, 2001a, 2001b; McKnight, Choudhury, & Kacmar, 2002a; Rousseau et al., 1998).

Dimensionality

Trust is studied by several disciplines because it is a phenomenon of which nature is cognitive (reasoning), emotional (affect), and conative (tendencies) (Lewis & Weigert, 1985). It is a multidimensional phenomenon, it is related to the idiosyncratic perception of risk, and it is dependent on the context of the individuals and the implied objects. Moreover, the construction of trust is a dynamic process including several stages (Shapiro, Sheppard, & Cheraskin, 1992). On this subject, Lewicki, McAllister, and Bies (1998) say that trust is a multifaceted, changing concept, with few of its interrelationships being static and its dynamics being modified with the passage of time. Consequently, the understanding of trust is only partial and, as sociologist Uslaner (2002) states, it is in fact to the social reports what chicken soup is to influenza: It has positive effects, but the reasons for this are enigmatic.

As a result, trust is considered to be a complex phenomenon. The situation is not different in an e-commerce context, and that makes its study as much complex. This is why it is difficult for the study of trust in e-commerce to hold account of all the aspects of this complex phenomenon. Papadopoulou, Andreou, Kanellis, and Markatos (2001) add that because of this complexity and owing to the fact that research on trust in e-commerce is recent, trust is studied from various points of view and on different levels of analysis, which contributes only partially and in a fragmented way to our understanding and makes it thus difficult to apprehend its extent and its complexity. Moreover, this difficulty of apprehension makes its definition (Hosmer, 1995; Rousseau et al., 1998) and conceptualization (Gefen, Karahanna, et al., 2003a) problematic.

Because of this complexity, there is an important tendency in e-commerce research to treat trust as being unidimensional (Gefen, Rao, & Tractinsky, 2003; Papadopoulou et al., 2001). A result of this is, first, that the notion of process is often evacuated from the creation of trust and, second, that its study often leaves the experiential nature of trust beside to lean only on initial trust and institutional credibility. Another consequence is that the studies often present a reductionistic view of trust because of the fragmented vision they offer of it and of its antecedents, and because of the lack of consideration they have for the dynamics of trust building.

Conceptualization

There is an important problem of conceptualization concerning trust and trustworthiness in e-commerce. Trustworthiness is clearly a factor of trust (Lee & Turban, 2001), but there is often confusion between the two (Corritore, Kracher, & Wiedenbeck, 2003; Einwiller, 2003; Gefen, Rao, et al., 2003; Lee & Turban; March & Dibben, 2003; Mayer et al., 1995). Mayer et al. formulate the difference between the two in indicating that trustworthiness is a characteristic attributed by the truster to the trustee, based upon extrinsic cues about the trustee, whereas trust is referred to as an attitude of the truster toward the trustee, based upon how the truster perceives the trustworthiness of the trustee. This distinction between trust and trustworthiness is related with the theory of planned behavior (Azjen, 2001) that differentiates between attitudes and beliefs as different factors of a person's intention to perform a certain behavior.

Only a limited number of the numerous models of trust proposed in e-commerce research clearly establish the distinction between trust and trustworthiness (among those is Lee and Turban's model, 2001). As Gefen, Rao, et al. (2003) and Mayer et al. (1995) underline, this problem of conceptualization is reflected in the confusion that often exists with regard to the two parties involved in the transaction, that is, the truster and the trustee. This creates difficulty with the recognition of the parties involved in the relation. But since trust and trustworthiness are two different concepts and the antecedents and consequences of trust are indeed not the same as those of trustworthiness, to confuse both inevitably leads to problems of modeling and of between-model comparison if their conceptualizations are different. If there is confusion between the two concepts or if both are depicted as being one, the logic behind the relations in the models is disturbed and the models lose both their comparability and credibility.

ONTOLOGICAL ASPECTS OF E-TRUST

As discussed earlier, the fact that the studies concerning e-trust are carried out and influenced by many disciplines and fields does not have only positive effects. Indeed, the review of ontological aspects of e-trust presented in Table 1, which shows the definitions, the dimensionality, and the conceptualization given to consumer trust in e-commerce in selected studies realized and published since the year 2000, reveals that there are also negative effects.

Definition

As reported in Table 1, 32 different definitions of trust were found among the 24 identified e-commerce papers, each comprising at least 1 definition of the trust concept. Most definitions are contextual and seem adapted to the papers' goals. Furthermore, they come either from marketing or IS, or directly from other reference disciplines. As can been seen in Table 1 as well, most definitions differ in their level of completeness, bringing difficulties in their reuse in other empirical studies. The addition of reference disciplines above marketing and IS in e-commerce research speaks to the issue of the complexity of trust per se and recognizes the need to refine our view of the construct.

Dimensionality

Despite the important tendency in e-commerce research to treat trust as being unidimensional, trust has clearly more than one dimension, according to Mayer et al. (1995). These dimensions can be summarized in three sets of characteristics: those of the truster, those of the trustee, and those linked to the context. Characteristics of the truster are factors that affect his or her propensity to trust, and are thus linked to psychological, personal, experien-

Table 1. Ontological aspects of consumer trust in e-commerce

Definitions of consumer trust in e-commerce	Source (field)	Taken/inspired from	Propensity	Evaluation	Risk
A bet about the future contingent actions of others	So & Sculli (2002) (information systems)	Sztompka (1999) (sociology)		X	
A general belief that another party can be trusted	Gefen, Karahanna, et al. (2003b) (information systems)	Moorman, Deshpandé, & Zaltman (1993) (marketing) Gefen (2000) (information systems) Hosmer (1995) (management) Zucker (1986) (sociology)	X	X	
A generalized expectancy held by an individual that the word of another can be relied on	So & Sculli (2002) (information systems)	Rotter (1971) (psychology)		X	
A mechanism to reduce the complexity of human conduct in situations where people have to cope with uncertainty	Grabner-Kräeuter (2002) (ethics)	Luhmann (1979) (sociology)	X		X
A psychological state comprising the intention to accept vulnerability based upon a positive expectation of the intensions or behavior of another	Yousafzai et al. (2003) (information systems)	Rousseau et al. (1998) (management)	X	X	X
A set of beliefs that other people will fulfill their expected favorable commitments	Gefen (2000) (information systems)	Blau (1964) (sociology) Deutsch (1958) (sociology) Luhmann (1979) (sociology)		X	
A set of expectations shared by those in an exchange	So & Sculli (2002) (information systems)	Misztal (1996) (sociology)		X	
A set of specific beliefs dealing primarily with the integrity, benevolence, and ability of another party	Gefen, Karahanna, et al. (2003b) (information systems)	Doney & Cannon (1997) (marketing) Ganesan (1994) (marketing) Giffin (1967) (psychology) Larzelere & Huston (1980) (sociology)		X	
A truster's expectations about the motives and behaviors of a trustee	Jarvenpaa, Tractinsky, & Vitale (2000) (information systems)	Doney & Cannon (1997) (marketing)		X	
A willingness to be vulnerable to the actions of another person or other people	Gefen (2002) (information systems) Gefen, Karahanna, et al. (2003b) (information systems)	Mayer et al. (1995) (management)	X		
A willingness to rely on a third party	Koufaris & Hampton-Sosa (2004) (information systems)	Jarvenpaa & Tractinsky (1999) (information systems) Jarvenpaa et al. (2000) (information systems) Ganesan (1994) (marketing) Gefen (2002b)(information systems)	X		
Affect reflected in 'feelings' of confidence and security in the caring response of the other party	Gefen, Karahanna, et al. (2003b) (information systems)	Rempel, Holmes, & Zanna (1985) (social psychology)		X	X

Table 1. Ontological aspects of consumer trust in e-commerce (continued)

Definitions of consumer trust in e-commerce	Source (field)	Taken/inspired from	Propensity	Evaluation	Risk
Occurs when one party has confidence in an exchange partner's reliability and integrity	Yousafzai et al. (2003) (information systems) Einwiller (2003) (marketing) Warrington et al. (2000) (marketing)	Morgan & Hunt (1994) (marketing)		X	
Perceptions about others' attributes and a related willingness to become vulnerable to others	McKnight et al. (2002a) (information systems)	Rousseau et al. (1998) (management) Zand (1972) (management)	X	X	
The belief that a party's word or promise is reliable and a party will fulfill his/her obligations in an exchange relationship	Warrington et al. (2000) (marketing) Yousafzai et al. (2003) (information systems)	Rotter (1971) (psychology) Blau (1964) (sociology)		X	
The confidence a person has in his or her favorable expectations of what other people will do, based, in many cases, on previous interactions	Gefen (2000) (information systems)			X	
The dimension of a business relationship that determines the level to which each party feels they can rely on the integrity of the promise offered by the other	Kolsaker & Payne (2002) (marketing)			X	
The expectation that commitments undertaken by another person or organization will be fulfilled, especially in relationships where the trusting party lacks control over the trusted party	Gefen (2002) (information systems)	Deutsch (1958) (sociology) Rotter (1971) (psychology) Hart, Capps, Cangemi, & Caillouet. (1986) (management) Hosmer (1995) (management)		X	X
The expectation that other individuals or companies will behave ethically and dependably, and will fulfill their expected commitments under conditions of vulnerability and interdependence	Gefen (2000) (information systems) Gefen, Karahanna, et al. (2003a) (information systems)	Hosmer (1995) (management) Kumar (1996) (marketing) Luhmann (1979) (sociology) Rotter (1971) (psychology) Schurr & Ozanne (1985) (marketing) Rousseau et al. (1998) (management)		X	X
The expectation that other individuals or companies with whom one interacts will not take undue advantage of a dependence upon them	Gefen, Karahanna, et al. (2003a) (information systems)			X	X
The extent to which one is willing to ascribe good intentions to and have confidence in the words and actions of other people	Tan & Thoen (2002) (information systems)	Cook & Wall (1980) (psychology)	X	X	
The perceived credibility and benevolence of a target of trust	Einwiller (2003) (marketing)	Doney & Cannon (1997) (marketing)		X	
The reliability and dependability of the vendor offering products or services	Chen & Dhillon (2003) (information systems)			X	

Table 1. Ontological aspects of consumer trust in e-commerce (continued)

Definitions of consumer trust in e-commerce	Source (field)	Taken/inspired from	Propensity	Evaluation	Risk
The subjective assessment of one party that another party will perform a particular transaction according to his or her confident expectations in an environment characterized by uncertainty	Ba & Pavlou (2002) (information systems) Yousafzai et al. (2003) (information systems)	Gambetta (2000) (sociology) Bhattacharya, Devinney, & Pillutla (1998) (management) McKnight & Chervany (2000) (information systems)		X	X
The subjective probability by which an individual expects that another individual will perform a given action on which his or her welfare depends	Tan & Thoen (2002) (information systems)	Gambetta (2000) (sociology)		X	
The subjective probability with which consumers believe that a particular transaction will occur in a manner consistent with their confident expectations	Chellappa & Pavlou (2002) (information systems)			X	
"[T]he willingness of a consumer to be vulnerable to the actions of an Internet merchant in an Internet shopping transaction, based on the expectations that the Internet merchant will behave in certain agreeable ways, irrespective of the ability of the consumer to monitor or control the Internet merchant" (p. 79)	Lee & Turban (2001) (information systems)	Mayer et al. (1995) (management)	X	X	X
The willingness of a party (truster) to be vulnerable to the actions of another party (trustee) based on the expectation that the other (trustee) will perform a particular action important to the truster irrespective of the ability to monitor or control that other party (trustee)	Bhattacherjee (2002) (information systems) Murphy & Blessinger (2003) (information systems) Roy, Dewit, & Aubert (2001) (information systems) Tan & Thoen (2002) (information systems) van der Heijden, Verhagen, & Creemers (2003) (information systems)	Mayer et al. (1995) (management)	X	X	X
The willingness to make oneself vulnerable to actions taken by the trusted party based on the feelings of confidence and assurance	Yousafzai et al. (2003) (information systems)	Gefen (2000)	X	X	
The willingness to rely on a specific other based on confidence that one's trust will lead to positive outcomes	Chopra & Wallace (2003) (information systems)	Mayer et al. (1995) (management) Blomqvist, (1997) (management) Rousseau et al. (1998) (management) Lewicki et al. (1998) (management)	X	X	
The willingness to rely on an exchange partner in whom one has confidence	Mukherjee & Nath (2003) (marketing) Einwiller (2003) (marketing) Warrington et al. (2000) (marketing)	Moorman et al. (1993) (marketing)	X	X	
Trusting behavior (occurs) when a person relies on another, risks something of value, and attempts to achieve a desired goal	So & Sculli (2002) (information systems)	Giffin (1967) (psychology)		X	X

tial, or cultural traits affecting the likelihood of the party to trust other parties. Characteristics of the trustee are those factors that make possible a subjective evaluation from the truster of how another party is trustworthy. These factors of trustworthiness are recognized to be the ability, the benevolence, and the integrity of the trustee. Finally, characteristics linked to the context are those factors that are inherent to the perceived level of risk and vulnerability, and that depend on elements such as the balance of power in the relationships, information asymmetry, and alternatives available to the truster.

Table 1 identifies the three dimensions of trust (propensity to trust, evaluation of the trustee, and perceived risk) the definition should include in order to be exhaustive (Mayer et al., 1995), and shows that most of the definitions of consumer trust in e-commerce include only one or two of these three dimensions. In fact, 16 (50%) of the 32 identified definitions contain only one dimension, while 13 (41%) contain two; only 3 definitions (9%) contain the three required dimensions. This means most of these definitions consider trust as a uni- or bidimensional phenomenon but not as the complex concept it is. This simplification prevents them from considering the conative, cognitive, and emotional nature of trust to which its three dimensions of propensity, evaluation of the trustee, and perceived risk in the context are respectively related.

Conceptualization

The e-commerce research community takes its inspiration from other fields. Some of these fields, such as management, seem to distinguish trust and trustworthiness, while others, such as marketing, do not seem to clearly make the distinction between the two. As reported in Table 1, the presence of the concepts of integrity, benevolence, and ability in definitions of trust (Chen & Dhillon, 2003; Einwiller, 2003; Gefen, Karahanna, et al., 2003b; Kolsaker & Payne, 2002; Warrington, Abgrab, & Caldwell, 2000; Yousafzai, Pallister, & Foxall, 2003) shows indications of a defective conceptualization of the idea since these are rather factors of trustworthiness. Consequently, there are problems of conceptualization among some definitions took from the marketing field, where antecedents of trust are confused with factors of trustworthiness. In this way, it induces a conceptual framework where trust and trustworthiness make one unique concept whereas the antecedents, moderating factors influencing them, and consequences are different elements.

FUTURE TRENDS AND DIRECTIONS

Research on the understanding of the phenomenon of consumer trust in e-commerce suffers from problems dependent on the definition, the dimensionality, and the conceptualization of the concept. This reflects the fact that the e-commerce knowledge field is still on its way to reach maturity, and this is why researchers, according to the goals of their study and by whom and by what field they are influenced, still favor a particular definition of trust and the dimensions behind it.

Definition

If the studied concept was the same from one study to the other, a better convergence between the definitions would ensure a better comparability of the models. By agreeing on a single definition of e-trust, the e-commerce research community could address the problem of relying on different definitions. Such a definition needs to reflect the parties and the context in which e-commerce transactions take place and, as such, address the elements studied by psychology, sociology, economics, and social psychology.

The result of this exercise would be a shared definition of trust in the e-commerce research community, a definition inspired from other disciplines but applied to the e-commerce context. It is a necessary step toward both the reinforcement of a certain paradigm in this field of research and its maturation. It could resemble the one used by Lee and Turban (2001, p. 79): “the willingness of a consumer to be vulnerable to the actions of an Internet merchant in an Internet shopping transaction, based on the expectations that the Internet merchant will behave in certain agreeable ways, irrespective of the ability of the consumer to monitor or control the Internet merchant.”

This definition reflects the complexity of the concept of trust and can adapt to most of the studies undertook in the e-commerce field.

Dimensionality

Because trust is a multidimensional concept, its definition also needs to take into account the three dimensions behind it: those of the truster, those of the trustee, and those linked to the context. Such a definition would ensure a better completeness of the concept. Because it incorporates those three sets of characteristics, the definition cited just above and proposed by Lee and Turban (2001) meets this need. It reflects the three dimensions of propensity, the evaluation of the trustee, and perceived risk in the context of an e-commerce transaction and, as such, is complete.

Conceptualization

The conceptualization problem of trust is linked to the confusion between trust and trustworthiness, their antecedents, and their consequences. The e-commerce community can address this problem by taking care not to use integrity, benevolence, and ability as antecedents of trust unless it is made clear they are factors of trustworthiness. Furthermore, this gives the opportunity to better reflect the dynamics of trust building by allowing the introduction of moderators between trust and trustworthiness, and by clearly identifying the two parties committed in the transactions.

The recognition of the confusion between trust and trustworthiness also leads to an important observation: In many cases, instead of speaking of trust building in e-commerce, one should speak of trustworthiness building, which, according to the way it is perceived by the consumer, has a more or less positive effect on his or her trust feelings concerning the merchant, with trust being understood here as a psychological state toward the other party. In the same way, one should not conceive trust as perceived trust since perception rather applies in this case to trustworthiness, and because the psychological state of trust depends partially on the perceived trustworthiness of the other party. An important consequence of this distinction between the two concepts would be better and more comparable models of trust-building dynamics.

CONCLUSION

The weaknesses in the conceptualization of the concept of consumer trust in e-commerce research is being more and more recognized as a problem that prevents, to a certain degree, a better understanding of the topic by this knowledge field. The issues of the number of definitions, the lack of dimensionality, and the confusion between trust and trustworthiness discussed in this article offer many insights that are likely to help in reducing the size and impacts of gaps identified in the conceptualization of the trust phenomenon in e-commerce. First, there is a need to agree on a single definition of trust in the research community, a definition that would correctly reflect the context of e-commerce. Second, this definition should incorporate the three dimensions attributed to trust: those of the truster, those of the trustee, and those linked to the context. The definition proposed by Lee and Turban (2001) is suggested. Third, there should be no confusion between trust and trustworthiness and, from there, no use of the factors of trustworthiness as direct antecedents of trust.

With greater emphasis being placed on a better conceptualization, consumer trust on the Internet will be easier to understand and easier to address.

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KEY TERMS

Ability: A group of skills, competencies, and characteristics that enable a party to have influence within some specific domain (Mayer et al., 1995).

Benevolence: The extent to which a trustee is believed to want to do some good to the truster, aside from an egocentric profit motive (Mayer et al., 1995).

E-Commerce: The carrying out of business activities that lead to an exchange of value where the parties interact electronically using network or telecommunications technologies (Jones, Wilikens, Morris, & Masera, 2000).

Integrity: The truster's perception that the trustee adheres to a set of principles that the truster finds acceptable (Mayer et al., 1995).

Propensity to Trust: A general tendency to trust others (Rotter, 1971).

Risk: A consumer's perceptions of the uncertainty and adverse consequences of engaging in an activity (Dowling & Staelin, 1994).

Trust: "[T]he willingness of a consumer to be vulnerable to the actions of an Internet merchant in an Internet shopping transaction, based on the expectations that the Internet merchant will behave in certain agreeable ways, irrespective of the ability of the consumer to monitor or control the Internet merchant" (Lee & Turban, 2001, p. 79).

Trustee: The e-merchant in which trust is placed.

Truster: The individual who willingly enters into a commercial transaction and expects the trustee to fulfill the contract underlying the transaction.

Trustworthiness: The perceived likelihood that a particular trustee will uphold one's trust (Chopra & Wallace, 2003).

Context and Concept of Web Services

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INTRODUCTION

Web Services Defined

The term Web services has as many definitions as there are people who have worked on it. The different definitions, in general, stress various aspects of Web services. The diverse nature of these definitions confirms the diverse interpretations of Web services ("Evolution of Integration Functionality," 2001; Freger, 2001; Infravio, 2002; Ogbuji, 2002; Stal, 2002; Wilkes, 2002). The big computer giants such as Microsoft and IBM promote Web services, and the definitions offered by them are as follows.

- **IBM:** "A Web Service is a collection of functions that are packaged as a single entity and published to the network for use by other programs...[They are] self-describing, self-contained, modular applications..." (Glass, 2000).
- **Microsoft:** "Web Services are a very general model for building applications and can be implemented for any operating system that supports communication over the Internet and represent black-box functionality that can be reused without worrying about how the service is implemented...[They use] building blocks for constructing distributed Web applications..." (Kirtland, 2001).
- **World Wide Web Consortium (W3C):** "A software system identified by a URI [uniform resource indicator], whose public interfaces and bindings are defined and described using XML [extensible markup language]. Its definition can be discovered by other software systems. These systems may then interact in a manner prescribed by its definition, using XML based messages conveyed by internet protocols" (W3C, 2002).

This article attempts to clarify these generic definitions into language that is tangible and meaningful to the reader. To do so, background is given on the systems, applications, and architecture that led to the need and development of Web services.

BACKGROUND

The advancement of technology in computer systems and business applications in the current era are unprecedented. The rapid pace of application development has led to the development of disparate applications and services. In an era of mergers, acquisitions, and virtual integration, there is an increasing need to link disparate applications and services. The information needs to be shared not only within a business, but between businesses. We are moving from an era of working within applications intraenterprise to working between applications interenterprise. Employees, customers, and partners require easy access to information and services whenever they need it.

Considering the risks involved, technology integration is one of the principal challenges in enterprises (Raczkowski, 2002). Web services promise a new level of interoperability between applications and enable the integration of enterprise applications. Web services are expected to get a major share of business-integration expenditures and are expected to grow in the next 5 years (Raczkowski). Web services, being a subset of the application-integration market, will experience high growth and, according to *IDC* ("Cautious Web Services Software Adoption," 2004), spending on Web-services projects will reach $11 billion by 2008.

MAIN THRUST OF THE ARTICLE

Web services, while still in their infancy, show potential. However, they are not a panacea to all the business problems today, and some issues remain needing resolution. In this article, the historical context of Web services positions them with previous technologies. Web services are not the first approach to streamlining enterprise application integration. There is a history of numerous approaches to integrating enterprise applications. After positioning Web services in their proper context, the article discusses the concepts that underlie Web services and how they are applicable. The architecture and protocols used in Web services are discussed next. Finally, future Web-services issues are identified.

Object-Oriented Paradigm

The procedural programming paradigm emerged in the 1970s because of intricacies in understanding assembly language programs. Though procedural programming proved useful, it fell short of providing the necessary tools needed to model real-world entities; thus, the software-development process became enormously cumbersome, which led to the development of object-oriented programming. Programmers could now reuse the software units by implementing a packaging scheme. This scheme focused on application areas, facilitated the reuse of software components, and led to the development of distributed systems and distributed object models.

Distributed Computing Systems

The technological advances in the computer engineering discipline resulted in the emergence of powerful computers and computer networks. Computing was distributed over the networks instead of being performed on a single, centralized computer. This led to the development of the two-tier architecture, more commonly known as the client-server architecture. In the two-tier architecture, the operations were decomposed into two parts, with one part, the client, initiating a distributed activity, and the other part, the server, carrying out the activity.

The centralization of activities presented some problems in terms of scalability and flexibility. Thus, the three-tier architecture was proposed by adding an additional tier to separate the application tier into the presentation and data tiers (Gunzer, 2002). The three-tier architecture imparted unprecedented flexibility and provided a feasible alternative to deal with the issue of scalability. This formed the basis for distributed application development and distributed computing. Some of the popular middleware technologies are discussed below.

Common Object Request Broker Architecture (CORBA)

CORBA is an open-standards-based solution to distributed computing. The Object Management Group, an industry consortium, developed the specifications for CORBA. The primary advantage of CORBA is that clients and servers can be written in any programming language. That is possible because the objects are defined with a high level of abstraction provided by the interface definition language (IDL). After defining an IDL file, a compiler takes care of the mapping of the IDL file to a specific programming language. Though advantageous, compatible object request brokers are needed on both of the connections to make the client and the server objects communicate (Gunzer, 2002; Ogbuji, 2002).

Distributed Component Object Model (DCOM)

Microsoft's DCOM has a layer that sits on the top of a remote procedure-calling (RPC) mechanism and allows calls to remote objects that interact with the COM run-time services. The DCOM server publishes its methods to the clients by supporting multiple interfaces. These are written in the interface definition language, which is similar to C++ (Gunzer, 2002; Ogbuji, 2002).

Remote Method Invocation (RMI)

RMI enables one to create Java-to-Java applications, in which the methods of remote Java objects can be invoked from other Java virtual machines. A Java program can make a call on the remote object once it obtains a reference to the remote object. Programming with RMI is straightforward once the programmer has gained some experience with the Java and distributed applications. On the other hand, RMI may only be used when Java exists on both sides of the connection (Gunzer, 2002; Infravio, 2002; Ogbuji, 2002).

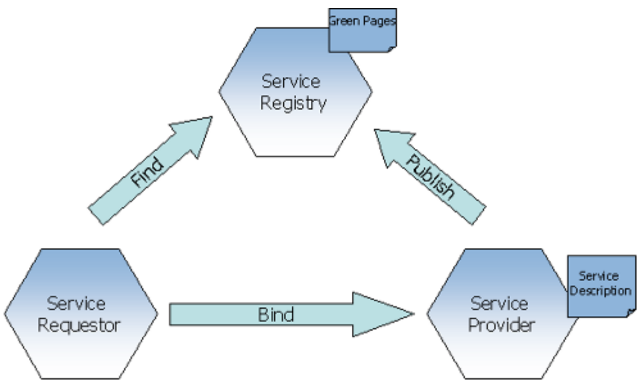
World Wide Web

The advancements in the distributed object models proceeded in parallel with the development and establishment of the World Wide Web architecture. This gave rise to some standard protocols that were widely accepted. The transmission control protocol/ Internet protocol (TCP/IP) formed the common base protocol for connectivity. This was followed by the advent of various protocols like the hypertext transfer protocol (HTTP), file transfer protocol (FTP), and Gopher for specific needs.

HTTP became the common communication protocol. The emergence of the World Wide Web brought about the acceptance of a standard Web architecture. Thus, a platform was set in terms of standards, and the advancements in distributed object models saw the surfacing of Web services.

In terms of presentation, the hypertext markup language (HTML) established itself as the standard. The capabilities of HTML were very limited and did not provide any structure or programming ability. To counter these deficiencies, XML was created. XML provided the ability to program over the Web as an addition to presentation.

Figure 1. The Web-services architecture



Web Services Architecture

Web services are based on the service-oriented architecture (SOA; Leymann et al., 2002). All agents or participants are identified as service modules. A requestor is a software agent requesting a service, and a provider is the owner of a service who is willing to offer the service to requestors. Thus, the roles in the Web services architecture can be described as follows (Freger, 2001).

- **Service Requestor:** This is the agent that requests a service. From the business perspective, this is the entity requiring certain functions to be satisfied. From an architectural perspective, this is the application that is looking for and invoking or initiating an interaction with a service.
- **Service Provider:** This is the owner of the service. From the business perspective, this is the business that is the owner of a service, willing to share that service with others.
- **Service Registry:** This is a registry that contains all available services. The service providers publish the services. The requestor may search for specific service descriptions.

The service operations of the service roles are as follows:

- **Publish:** For a service to be accessible, a service description needs to be published so that the service requestor can find it. The requirements of the applications determine where the service description is published in the public service registry or the service registry of the vertical industry.
- **Find:** During the find operation, the service requestor retrieves a service description directly or queries the service registry for the type of service required. The goal of this operation is to get the service description of the service as required by the service requestor. The find operation generally involves two phases for the service requestor: one to get the service description of the service provider, and another at run time to retrieve the binding information and the location description for invocation.
- **Bind:** Once the service requestor has the service description of the service provider, he or she needs to invoke the service on the service provider. This generally occurs during run time using the binding details in the service description to locate, contact, and invoke the service.

Web Services Protocols

Web services use the following protocols for specific operations.

- **Service Invocation and Communication:** Simple object access protocol (SOAP)
- **Service Description:** Web services description language (WSDL)
- **Service Discovery:** Universal description, discovery and integration (UDDI)
- **Standard Transport Protocol:** HTTP
- **Underlying Protocol:** XML

Understanding Web Services

Web services can be viewed from two different aspects: Web aspects and service aspects (Fremantle et al., 2002). The Web aspects of Web services are the following attributes.

- **Web-Based Protocols:** Web services are based on HTTP and thus are designed to work over the public Internet.
- **Interoperability:** The XML-based protocols used for communication in SOAP define a common standard that allows differing systems to interoperate.

The service aspect has the following attributes (Fremantle et al., 2002).

- **Modular:** The service components are useful, are reusable, and can be combined to form larger components.
- **Available:** Services are available to systems that wish to use them.

- **Described:** Services have service descriptions, which are also machine readable to identify the interface of the service.
- **Implementation Independent:** The service interface must be available in a way that is independent of the ultimate implementation.

Simple Object Access Protocol

Web services are run in a heterogeneous environment, and the protocols should be independent of the run-time environment and implementations. SOAP is the communication protocol that satisfies the required characteristics and thus is used in Web services. SOAP is based on XML and also has the GET and POST capabilities of HTTP.

SOAP provides a simple and lightweight mechanism for exchanging structured and typed information between peers in a decentralized and distributed environment using XML. SOAP does not itself define any application semantics such as the programming model or implementation-specific semantics; rather, it defines a simple mechanism for expressing application semantics by providing a modular packaging model and mechanisms for encoding data within modules. This allows SOAP to be used in a large variety of systems ranging from messaging systems to RPC.

SOAP consists of three parts (Apache Software Foundation, 2005):

- **SOAP Envelope Construct:** Defines an overall framework for expressing what is in a message, who should deal with it, and whether it is optional or mandatory.
- **SOAP Encoding Rules:** Define a serialization mechanism that can be used to exchange instances of application-defined data types.
- **SOAP RPC Representation:** Defines a convention that can be used to represent RPCs and responses.

The use of SOAP allows software processes to change without requiring changes to the other party. A Web-service implementation can change with no impact on the users of the service as long as the request and response messages do not change. The first implementation of the service provider could be a thin wrapper around legacy code, allowing a planned replacement to be developed over time. When the new code is ready, the change is invisible to users of the service.

Web Services Description Language

WSDL provides documentation for distributed systems and has the goal to enable applications to communicate with each other in an automated way. SOAP provides the communication between the requestor and a provider, and WSDL describes the services offered by the provider and is used as a means to generate the proper SOAP messages to access the services. The information definition language provides the same functionality as WSDL for Web services. WSDL consists of two groups of elements: abstract definitions (types, messages, and port types) and concrete definitions (bindings and services).

Universal Description, Discovery, and Integration

UDDI is a standard designed to facilitate a searchable directory of service providers. This resides at the service registry. Thus, service requestors search for the available services at the service registries. UDDI contains support for the following (Freger, 2001; Gunzer, 2002).

- **Yellow-Pages Taxonomies:** Here, searches can be done according to a particular industry, sector, or product category.
- **White Pages:** This contains address information, contact information, and the phone numbers of service providers.
- **Green Pages:** This contains the technical details about the service provider. It tells the service requestor the details as to how to invoke the request with that particular service provider.

FUTURE TRENDS AND WEB-SERVICES ISSUES

Web services growth is driven by the emergence and mainstreaming of service-oriented business applications (SOBAs; Smith & Abrams, 2004). With that growth emerges popularity. A recent Yankee Group survey revealed that CIOs (chief information officers) say implementing Web services is their number-one priority (LaPlante, 2004), while The Butler Group predicts that "Web Services are the future of IT and can deliver cost savings within months" (Huber, 2004).

Though Web services show much promise and CIOs now believe them to be their main focal point, how much they actually deliver is unclear. Rapid growth in a technology usually creates some problems. Web services are no different. Security, reliability, and standardization are some of the main issues in implementing Web services.

- **Security Issues:** Web services operating on Web standards are accessible by anyone; thus, the traditional security measures have to strengthen. Web services security must be addressed at three levels: identity management, authentication, and confidentiality. Identity management refers to the issue of who uses those Web services resources. Authentication guarantees that a sender of a Web services is who they say they are. Web services must provide authentication of both the sender and the receiver of the service. Confidentiality provides a guarantee that information will only be seen by the authorized party and will not be visible to unauthorized parties (Infravio, 2002; Malhotra, 2001; Ogbuji, 2002).

- **Reliability Issues:** The performance of the service is dependent on the traffic and the bandwidth available. Converting applications into Web services by the use of a wrapper layer is no longer the same as the native component, and the response time is much greater (Malhotra, 2001; Ogbuji, 2002). In business applications, the response time is very crucial, especially when doing business online.
- **Standard Protocol Issues:** With the flexibility that Web services bring, complexity follows, and, potentially, chaos ensues. The simplicity of programming in standard HTML led to the rapid adoption of HTML as a Web standard early in the Internet growth stage. Thus, the adoption of a standard protocol is critical to the rapid implementation of Web services.

CONCLUSION

Placing Web services in their historical context reveals that they are the result of an evolution of Web technologies. As connectivity increased and presentation became more complex, programming the Web became a necessity. Thus, Web services were created. The emergence, visibility, and impact of Web services are not in doubt. Solving the security, reliability, and standardization issues could make Web services more widely adopted.

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KEY TERMS

Common Object Request Broker Architecture (CORBA): An open-standards-based distributed computing solution.

Distributed Computing Systems: Computing distributed over networks instead of on single computers.

Distributed Component Object Model (DCOM): Sits on top of the remote procedure-calling mechanism and allows calls to remote objects interacting with COM services.

Remote Method Invocation (RMI): Enables the creation of Java-to-Java applications in which the methods of remote Java objects can be invoked from other Java virtual machines.

Simple Object Access Protocol (SOAP): The communication protocol that satisfies the required characteristics used in Web services. It is based on XML and has the GET and POST capabilities of HTTP.

Universal Description, Discovery and Integration (UDDI): A standard designed to facilitate a searchable directory of service providers. UDDI resides at the service registry.

Web Services (IBM Definition): "…[A] collection of functions that are packaged as a single entity and published to the network for use by other programs…[They are] self-describing, self-contained, modular applications…" (Glass, 2000).

Web Services Description Language (WSDL): Provides documentation for distributed systems and has as its goal to enable applications to communicate with each other automatically.

Coordination of a Service Oriented Architecture

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INTRODUCTION

As e-commerce models and applications have been widely employed in today's business environment, a new movement to so-called *dynamic e-business* has been urged to advance e-commerce applications to the next level: simplifying business interaction over the Web through effective and widely accepted messaging and data encapsulation standards (Chen, Chen, & Shao, 2003). Gisolfi (2001) defined *dynamic e-business* as the next generation of e-business focusing on the integration and infrastructure complexities by leveraging the benefits of Internet standards and common infrastructure to produce optimal efficiencies for intra- and inter-enterprise computing.

Infrastructure for both inter- and intra-organizational computing has undergone a significant maturation process from centralized mainframe computing to early distributed client/server environments, and most recently taking on a service orientation (Roure, 2003). Service-oriented architecture (SOA) represents the framework for the latest generation of service-based computing where once proprietary and monolithic applications are broken down into components and exposed through open standards for use by both internal and external enterprise partners. The SOA paradigm is argued to include in its list of benefits a higher return on investment, increased software reuse, and the capability to support dynamic service assembly (Stevens, 2005).

An increased return on investment is achieved through the componentization of application capabilities. The argument goes that the usefulness of a component (defined here as bounded by its functional capabilities to one distinct business domain) outlives the usefulness of an application (since applications are developed to support a subset of processes in a domain while a component is not constrained, by definition, to any particular process set).

Within the SOA paradigm, the development of applications to support a set of business processes is replaced with the connecting of components from distinct business domains in order to address the computational needs of a particular process. It is clear, then, that SOA has a positive impact on software reuse as components are leveraged across many configurations to address the specific computational needs of many different processes. To this end, one can map the reusability of components in an SOA context to the third argued benefit—dynamic service assembly.

Dynamic service assembly means that components are not developed with the complete set of application scenarios in mind. Instead, components are created to exemplify the information and computational contribution of a specific business domain. The choice of how these components are used later on is therefore not limited to assumptions of usage made at the development stage. Indeed, it is possible that the most valuable use for any given component may not exist at the time of component development. As business processes evolve dynamically over time and business needs for information and computational support change, a service orientation leveraging components that are developed in the absence of constraints for how they might be utilized allows for dynamic reconfiguration of services in order to adapt to changes in the business processes themselves. This ability to reconfigure increases reuse and extends the lifetime (from a value perspective) of the components that are developed. This, in turn, feeds back to an increased return on the investment in software development which is typically the primary motivation for buy-in to the SOA paradigm.

Similar to the shift from a mainframe to a client/server architecture (Malone & Smith, 1988), however, the shift to a service-oriented architecture requires consideration of costs associated with coordinating activities in this new environment. Management of these coordination costs will be necessary in order to preserve the purported increases in return on investment. Put simply, if the return on investments in software development increases but the costs associated with leveraging the developed information technology artifacts for business value also increases, then it is possible that the value created will be diminished or even overrun by the operational expense of coordinating use. In order to ensure that this is not the case, this article leverages a coordination theory approach to first understand the impact that a shift to service-oriented architecture will have on the cost of coordinating activity both within and across the firm, and second to make recommendations for how these coordination costs can be addressed to preserve the return on investment from a shift to service-oriented architecture.

BACKGROUND

Client/Server and Associated Shifts in Cost

In order to understand the impact of a fundamental shift in information technology architecture, one can observe an historical shift of this type in that of mainframe computing to client/server models. The client/server computing paradigm came about as a response to the need for computational flexibility to support changing environments (Kavan et al., 1999). In this sense, the historical goals motivating a shift to client server map well to the contemporary goals that motivate a shift to SOA. In the client/server context, it was noted early on that the purported cost savings in terms of infrastructure were frequently overrun by management, support, and training costs (Diamond, 1995). History has shown, however, that the increased management costs were characteristic of early client/server adoptions, while best practices for management of the new architectural paradigm were being discovered in real time (Borthick & Roth, 1994).

Critical to the understanding of how a shift such as this impacts costs and organizational effectiveness, coordination theory has much to say regarding the movement from mainframe to client/server architectures (Malone, 1987; Malone & Smith, 1988; Malone & Crowston, 1994; Shin, 1997). In essence, mainframe computing flourished in the era where computational power was expensive and should therefore be conserved and used efficiently. By centralizing computational power, demand for computation was aggregated and benefited from a smoothing effect due to the pooled variance of computational requests. This allowed firms to run their computational resources efficiently by making capacity decisions that minimized unused processing power, since the demand for processing held relatively stable.

The trade-off to a centralization of computational power preserving on computing costs was an increase in the cost of coordinating computation and communicating across the organization. Examples of these costs include the cost of transmitting data and processing requests to a distant centralized processor, latency in the time between request submission and receipt of computational results, overhead related to scheduling and planning the execution of processing requests, and the existence of centralized computer centers to oversee scheduling, governance, and maintenance of a large and centralized computing platform. The emergence of the personal computer signaled a dramatic decrease in the per-unit cost of processing. Suddenly, the importance of efficiently managing processing capacity in order to minimize processing costs became relatively insignificant. Organizations found themselves in a new environment where processing power was cheap and could be spread across the firm to support the computational needs of individuals with reduced latency for the execution of a processing need.

But early adopters, as mentioned above, suffered from cost *increases* with the switch to a client/server model. Coordination theory suggests that the process of driving out such cost increases began with the realization that focus must shift from processing costs to coordination costs. Management practices and organizational design and governance must adapt along with the architecture in order to balance the trade-offs between processing and coordination costs. As processing became less expensive, focus turned towards the coordination of processing, and firms came to realize the value potential for a client/server model by adjusting their management and governance structures and policies to economize on coordination costs.

The Emergence of SOA

Service-oriented architecture represents the next major architectural shift for organizations currently existing in a client/server model of computation. In order to understand the cost, management, and governance implications of such a shift, it is first necessary to understand the current state of SOA as an emerging technology. Papazoglou and Georgakopoulos (2003) identify a set of service layers which can be considered a foundation for the SOA stack, as depicted in Figure 1.

Web services have become the foundational technology for the service-oriented architecture paradigm

Figure 1. SOA technology stack

Architecture Management (SLA enforcement, service support, etc.)
Component Composition and Process Mapping (Coordination, search & discovery, monitoring, etc.)
Component Foundational Technologies (Web Services: UDDI—Discovery WSDL—Dynamic Coupling SOAP—Standardized Data Format TCP/IP—Standardized Communication Platform)

Figure 2. UDDI improvements across versions (Software Research and Development Center, 2005)

VERSION	DATE	KEY OBJECTIVE
1.0	September 2000	Create foundation for registry of Internet-based business services
2.0	June 2001	Align specification with emerging Web services architectures and provide more flexible taxonomy
3.0	July 2002	Support wide interaction of private and public implementations

(Leymann & Roller, 2002). In brief, Web services represent an open set of standards for the development of loosely coupled components or services, including specifications for how data should be formatted (SOAP), how the invocation of components should be described (WSDL), and how components can be discovered for use (UDDI). The component foundational technologies layer of the SOA stack is the most complete of the three layers in the current state of the evolution of SOA.

The ability to develop and dynamically invoke components, however, is only part of the SOA vision. This vision is completed by a level of abstraction for component composition to support business processes, and further abstraction for management and support across compositions spanning the complete architectural landscape. Component composition (layer 2 in the SOA stack) is currently the area of primary focus for continued efforts to improve the SOA value proposition. Two critical areas for support in this layer include execution management across compositions and evaluation of composition alternatives for supporting business processes. The former seeks to improve the management of existing compositions through the introduction of fault or error recovery, the evaluation of performance across defined alternative services in order to improve composition execution, and the orchestration of message passing between services that make up a composition. An example of technology developed to fill these needs is IBM's Business Process Execution Language for Web Services (BPEL4WS) (Weerawarana & Curbera, 2002). The latter involves evaluation of alternative means to support a business process through heterogeneous compositions of services that may differ in the number of services included, the type or domain of each service, and the characteristics of each service including but not limited to performance data. To date this capability remains unaddressed. Figure 2 provides a depiction of the evolution of UDDI as an effort to begin to meet these needs.

Initially, UDDI was developed to support simple search for services through a centralized repository. Through versions 2 and 3, the standard has been improved to provide greater flexibility with regards to the metadata describing services and the ability to map repositories together for interaction. While these improvements have provided much-needed enhancements for the search and instantiation of an individual service, the ability to search a repository of services to identify potential *compositions of services* that would serve to provide the needed support for a business process has not been addressed. The analysis of composition alternatives is currently a manual process. As the size of a repository grows, discovering suitable service compositions to transform a given input to a required output becomes a combinatorially difficult problem. As will be shown in the following section, composition search and discovery to support emerging business process needs represents a critical factor for coordination that will preserve returns on an SOA investment as the implementation matures.

The third layer of the SOA stack, architecture management, is also relatively unaddressed in today's instantiations of SOA. This level of abstraction looks to automate the enforcement of service level agreements (SLAs) and provide support for the use of a component in an execution composition. Currently, these aspects of the SOA environment are handled manually and represent an additional maintenance and monitoring overhead cost for SOA implementations.

COORDINATION IN SERVICE ORIENTED ARCHITECTURES

By analyzing the SOA stack, one can observe that a major trend in the shift from client/server to SOA is that client/server coordination issues, such as application development and maintenance to satisfy a set of business users, have been replaced with the costs of coordinating components into compositions for utilization in emerging business requirements. To understand this shift, consider a mature SOA implementation. The number of components is likely to be very large, and just as business domains overlap in some ways, capabilities of components may overlap as well. However, the approach to any given capability is likely to vary across components as a function of the approach taken in that component's mapped business domain. These components are not, therefore, homogeneous in the sense that one can be replaced for the other seamlessly. The exchange of one component for another may require additional manipulation or transformation through the invocation of additional components to map the output of one component to another. In this case, the output of one component may be equivalent to the output of a composition of different components. That composition represents an alternative to the original component of interest. The coordination process of identifying and evaluating execution alternatives to support business processes becomes critical to allocate resources effectively in an SOA context, as well as to map emerging business requirements into existing components through dynamic composition discovery in order to avoid unnecessary component development to meet business demands.

Early work in coordination and SOA includes that of Pankaj et al. (2003), who leverage a service modeling approach to search for redundant service components that can be seamlessly swapped into a composition. While this approach allows for the dynamic evaluation of compositions based on performance data, it does not address the ability for heterogeneous service compositions to be interchangeable as it focuses on redundant homogeneous services. The identification and comparison of heterogeneous service compositions that support a common business process remains an unaddressed SOA capability that will increase in importance as an SOA implementation grows and matures.

As an SOA implementation matures, the return on investment of SOA adoption can only be preserved to the extent that layers 2 and 3 of the SOA stack support low-cost identification of alternative compositions, as well as identification of configurations that support emerging business needs. If this support does not exist or is expensive or complex from a coordination perspective, then reuse will diminish as redundant components are developed to address business needs that could have been met through a composition of preexisting components. As this occurs, the return on investment for a shift to service-oriented architecture is reduced because the develop-to-order paradigm of the client/server architecture reemerges due to the complexity and cost associated with discovering and coordinating execution alternatives in a very large SOA environment. From a coordination theory perspective, the actual cost of development (i.e., the cost of creating compositions from preexisting components) is reduced in an SOA context. However, the cost is reallocated to the process of composition search and discovery, making this the primary target for systems, management, and governance adaptation in order to fully realize the purported return on investment of the SOA paradigm. The success of a SOA implementation is therefore dependant on the ability of an organization to address this new composition search and discovery issue as the SOA architecture grows large, representing the incarnation of coordination cost in an SOA context.

FUTURE TRENDS

Ongoing work in service-oriented architecture research will likely begin to recognize the importance of the composition search and discovery issue in SOA stack layer 2 as a critical enabler to SOA implementation success. Industry has already begun to recognize this need in its increased utilization of metadata and centralized service description repositories in order to facilitate component composition and process mapping. However, as the size of the SOA infrastructure grows, the need for system-level automated support for search and discovery will become apparent. Successful implementations will address this issue and continue to achieve the returns on their architectural investment that convinced them to convert from a client/server model. Implementations that grow significantly in size and complexity, but fail to address this issue, will likely see their costs return to that of client/server as they adopt a develop-to-order component model and their return on investment slips away.

CONCLUSION

While the foundational technologies for the base layer of the SOA stack are approaching maturity, the higher layers of the SOA stack require additional support. The grand vision of Web services-oriented architecture is that Web services can be composed and invoked dynamically to support business processes within and across enterprises. Hence, the component composition and process mapping layer of the SOA stack is particularly important and is the focal point of this article. This layer consists of standards that specify how individual Web services can be composed to support business processes. A number of new standards have been introduced to address this Web services composition issue, including BPEL4WS

(Business Process Execution Language for Web Services), WSCI (Web Services Choreography Interface), and BPML (Business Process Modeling Language). On the other hand, further efforts should also be spent on the architecture management layer, which is relatively unaddressed in today's instantiations of SOA.

The transition from mainframe to client/server reduced the cost of processing power and reoriented management focus towards coordination costs. SOA promises to do the same for development costs, but only to the extent that composition search and discovery, the new cost of coordination in an SOA context, is supported by systems, management, and governance. Composition search and discovery represents the critical incarnation of coordination cost in the new era of service-oriented computing. Service-oriented architecture can provide firms a continued return on investment if the focus shifts from reducing development costs to reducing the cost of composition search and discovery.

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KEY TERMS

Coordination Theory: Assumes that the introduction and use of information technology will modify both the structure of the interaction between human agents and the overall organization of work. Organizations should understand the nature of coordination, establish what kinds of structures of organizations already exist, and discover the appropriate coordination processes.

Service-Level Agreement: A formal agreement (between a service provider and its customers) describing the level of service quality (e.g., availability, performance, timeliness) that will be provided.

Service-Oriented Architecture: Represents a computational paradigm wherein services (commonly Web services) become the basic building blocks for service compositions that address specific business process needs. The service-oriented paradigm consists of three layers of technology addressing requirements from low-level technical specification to high-level service management.

SOAP: Simple object access protocol is the messaging protocol that facilitates Web services to invoke software method in remote systems.

UDDI: Universal description, discovery, and integration is a registry standard for Web services providers to publish their Web services. It may be used by a Web services consumer to discover (search) Web services developed by Web services providers.

Web Services: Self-contained, self-describing, modular applications that have open, Internet-oriented, standards-based interfaces and can be published, located, and invoked across the Web.

WSDL: Web services description language defines Web services for distributed systems to support the automatic creation of client-side stubs or proxies, and the binding to the Web services. It describes the interfaces to a Web services implementation in terms of format of the messages, binding of the abstract messages to a concrete protocol, and address of the endpoint.

Customer Goals Online

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INTRODUCTION

Marketing managers charged with developing effective e-marketing strategies need to understand the implications of goal-directed behavior online. Traditionally, the marketer's job has involved capturing the customer's attention and communicating a message about products or services. The customer is essentially a passive receiver of the marketer's message with little control over the marketing messages they are exposed to. Contrast the traditional approach to marketing with a Web site. Online the customer arrives at the marketer's Web site with a goal. The customer has something that he or she wants to accomplish, whether it be to acquire information about a product, to make a purchase, or to just be entertained. By understanding the customer's purpose for a Web site visit, the Web marketer is in a position to develop a Web site that provides significant value. Furthermore, a failure to deliver a Web site that enables customers to accomplish their goals is likely to result in dissatisfaction and defection to other more useful Web sites.

Understanding customer online goals is critical because it gets at the heart of what the Web site should or could "do." The challenge for e-marketers is that for most businesses, there are likely to be multiple goals that represent the "reason why" customers could come to the Web site. For example, an e-tailing site might be very effective for customers who already know the specific product they want to purchase. However, there are likely to be many other goals that could lead people to visit the site, such as selecting the appropriate product form a large product line, selecting an appropriate gift, or perhaps receiving customer service. If important customer goals are not supported by the Web site, the firm is at risk of losing a significant amount of business. Other times businesses compete in markets where there may be little apparent reason for a consumer to visit a Web site. As a result, and because firms feel they should have an online presence, many e-marketing sites are created that offer little more than online reproductions of the marketer's off-line advertising. The purpose of this article is to help e-marketers better understand the nature of customer goals online so that they may be prepared to create the types of Web site experiences that provide value to their customers.

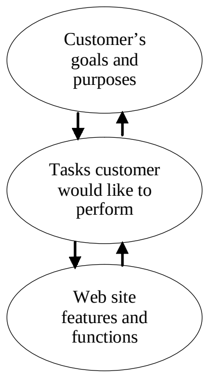
BACKGROUND

A growing number of Web design professionals, committed to the principles of user-centered design, seem to truly understand how to create highly usable, customer-centered Web sites. User-centered design (UCD) is an approach to designing computer interfaces that places the user of the system at the center of the design effort (Karat & Karat, 2003). UCD practitioners strive to improve the usability of a system by focusing on the various tasks and activities users would like to perform when interacting with a system. Focusing on users is critical in design because systems appropriate for one user group may be completely inappropriate for another set of users. For example, a travel Web site created for frequent business travelers wanting a fast and easy way to schedule business trips would not be appropriate for a person planning a vacation and wanting to learn about various vacation package options. By emphasizing users and their tasks, UCD aims to create systems that provide the appropriate functionality and are easier to use (Henneman, 1999).

Usability is the ultimate goal for Web designers who are practitioners of UCD. Creating a highly useable Web site means that the Web site matches what the site visitors need and want. Usability as defined by the ISO 9241 (ISO, 1997) standard is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." As can be seen from this definition, the concept of user goals is central to understanding usability.

Customer value (Levenburg, 2005; Adelaar, Bouwman, & Steinfield, 2004) is a concept from the marketing literature that is conceptually similar to usability when considered within a value-in-use perspective. The value in use perspective (Woodruff & Gardialm, 1996) emphasizes the instrumentality of products in achieving the customer's goals. As a result, value in use involves an evaluation of the effectiveness of a product within a particular usage context. The work of Woodruff (1997) on value hierarchies is particularly relevant for understanding customer behavior online. Web sites are used by site visitors to accomplish their goals. Thus using a means-end approach to conceptualize online value provides a way to explain how online customers derive value from their usage experiences. Building on the work of Woodruff, Porter (2005) defined online value as:

Figure 1. Perceived Web site value (Porter, 2005)



…a customer's perceived preference for and evaluation of those Web site features and functions that facilitate (or block) the performance of the tasks that are instrumental in achieving the customer's goals and purposes associated with the Web site visit.

Porter's model of perceived Web site value (see Figure 1) integrates concepts from user-centered design and marketing using means-end theory. The perceived value of a Web site is assessed based on the extent to which it allows the customer to achieve his or her online goals. Likewise the perceptions of the effectiveness of goal accomplishment are influenced by the degree to which the Web site supports the necessary tasks or subtasks the consumer would like to perform in order to accomplish the goal. Finally, the effectiveness of task accomplishment is related to the features, functions, and characteristics of the Web site. An implication of the model is that consumer perceptions of Web site value are related to the consumer's expectations regarding what the Web site should do and what they would like to accomplish online. The more knowledge the e-marketer has about the customer's goals, the better chance he or she has of creating a Web site that is truly valuable to the consumer.

ONLINE CUSTOMER GOALS AND TASKS

A key challenge for Web marketers is to understand the customer's goals that motivate (or could motivate) a Web site visit. Research on goals suggests that goals occur in the form of a hierarchy with more abstract, higher-order goals closely related to an individual's personal values at the top and specific action-oriented subgoals at the bottom (Bagozzi & Dholakia, 1999). For example, an individual has the goal of meeting the right person and getting married. This higher-order goal represents a "problem" that is somewhat unwieldy. Therefore to address this goal, the customer develops more concrete goals that can be used to help accomplish the higher-order goal. Thus, to achieve the goal of "finding a partner for a committed relationship," the individual sets more action-oriented subgoals like socializing with friends more often, keeping in shape, or visiting an online dating Web site. Thus a goal hierarchy serves as a way for a customer to break down a complex problem into a series of smaller, easier-to-manage problems (Pieters, Baumgartner, & Allen, 1995).

The goal a site visitor has when arriving at a Web site tends to be very action oriented. If the visitor has never visited the site before, the goal may simply be to evaluate the Web site and figure out what the site is and if it is of interest. On the other hand, if the visitor has reached the site as the result of a directed search or is a repeat visitor, the customer's goal is likely to be specific and functional. For example, Wolfinbarger, and Gilly (2001) found 71% of online purchases were planned.

The online goals that customers have when arriving at a Web site are clearly related to the concept of tasks in the UCD literature. Just as goals can be understood in the form of a hierarchy, tasks can also be represented hierarchically. The hierarchical levels associated with tasks can be seen in the design methodology of task analysis (Richardson, Ormerod, & Shepherd, 1998). By breaking down the various tasks a user would perform in pursuing a goal into finer grained subtasks, the system designer begins to understand how a user would like a system to perform. The process occurs iteratively, because subtasks can in turn be further decomposed until the system designer can capture all the different steps that the user would want to perform in accomplishing the task. By understanding the specific tasks and subtasks that would be performed, the system designer can identify the features and functions the system needs to support.

Identifying Online Goals

The responsibility of the Web marketer is to understand the goals that could motivate a Web site visit. Sometimes this appears fairly straightforward because the nature of the business almost dictates the different types of goals that consumers have when visiting the site. Thus the nature of the business may largely dictate the critical goals that consumers have when arriving on the Web site. For example, a large percentage of the visitors to ticketmaster.com go there with the goal of finding and purchasing tickets to a particular musical or sporting event. Clearly ticketmaster.com needs to make its site as suitable as possible for the accomplishment of this goal. However, finding and purchasing tickets is not the only goal that might bring customers to the site. A certain number of site visitors may be seeking to return tickets, track down missing tickets, or receive some other type of customer service. Some visitors may "use" the ticketmaster.com site in unanticipated ways, such as to find out who will be appearing at various venues. Designing the Web site to make it useable for all the critical goals motivating a Web site visit is the key to developing a Web site that provides value to customers.

For other businesses it can be difficult to identify a goal that would compel a significant number of customers to the Web site. Take a restaurant as an example. Many restaurants have developed sites with the objective of promoting their businesses online. These Web sites typically include information such as location, photographs of the facilities, hours, and menus. While there are many very attractive restaurant Web sites of this type, few generate a significant volume of traffic. The problem is an inherent mismatch between the design of these sites and customer goals. The design of these sites would be appropriate *if* there were a group of customers looking to learn about the restaurant online. However, unless the restaurant were new to an area or located in a tourist destination, few customers would have that kind of goal. This does not mean that restaurants should not have Web sites, but rather that to provide value to customers, restaurant Web sites needs to consider the types of goals that would prompt a Web site visit. Some restaurants have created high-value Web sites by supporting customer goals such as to place takeout orders, make reservations, track customer rewards programs, or to learn about catering and banquet facilities.

Another example of a business in which it can be difficult to think of a meaningful online customer goal is consumer packaged goods companies. Yet many popular branded consumer goods have Web sites. Often these sites receive little traffic because there are few obvious customer goals that prompt visits to these sites. To provide value, e-marketers might consider the higher-order goals of their customers. For example, Kraft foods knows that a significant number of their core customers have the higher-order goal of providing healthy meals at home. As a result Kraft has created a Web site designed to help time-pressed meal planners find tasty and nutritious recipes for a family dinner. Because the site provides customers with the opportunity to accomplish a meaningful goal, Kraftfoods.com is one of the most highly trafficked consumer packaged goods Web sites.

Customer Goals across the Customer Services Life Cycle

In order to avoid developing Web sites that capture only a subset of the goals that customers might have, researchers suggest it may be useful for the Web designer to consider how the needs of customers change as they move from being a non-customer to an existing loyal customer (Saeed, Hwang, & Grover, 2003). One framework for understanding the changes in customer needs over time is the customer service life cycle (Ives & Mason, 1990). The customer service life cycle (CSLC) suggests that customers go through a four-stage cycle in purchasing and using products and services: requirements, acquisition, ownership, and retirement.

In the requirements stage, customers make decisions about their product requirements. Customers coming to a Web site while in the requirements stage will have goals related to acquiring information. They will want to learn about the product or service, its benefits, and the merits of a particular service provider. Almost every firm has the need to bring in new customers, therefore designing the site to address requirements stage goals is fundamental to most Web sites.

In the acquisition stage, customers attempt to select their preferred product, pay for it, and if relevant get it delivered. Customers in the acquisitions stage know what they want, and they want to use the Web to facilitate the transaction. Frequently, customers will browse off-line but purchase online to take advantage of potential cost savings. Clearly online retailers must address the acquisition stage goals of potential customers. However, the acquisition stage is relevant for many service providers as well. For example, new online banking customers may have the goal of setting up an account online to avoid having to drive to a brick-and-mortar facility.

In the ownership stage customers have previously purchased a product. Customers in the ownership stage have often encountered some kind of problem with relation to their utilization of the product or service. These customers arrive at the Web site with the goal of finding solutions to their problems. Not all ownership stage goals are customer service related though. Some companies have found the Web a viable way to enhance the product-ownership experience by offering product-related news and events, and a way to interact with other customers. For example, the Harley Davidson Web site includes an "experience" section which allows customers to join a Harley Users Group, learn about upcoming events, or sign up for a rider's education course, among many other things.

Ultimately, creating a Web site that allows customers to accomplish their goals is not enough. The Web site should also allow the firm to accomplish important business objectives, such as to increase sales or enhance customer relationships. Fortunately, creating a Web site that allows customers to accomplish their goals usually provides benefits to the marketer. For example, if a firm makes it easier to shop and buy online, the result should be more completed online sales. However, the goal-directed nature of online customer behavior means that the marketer may not be able to use the Web to accomplish some of its most important marketing objectives. For example, one of the challenges for a business might be that advertising costs have spiraled. In response a marketer might want to place marketing materials online. However, most customers are unlikely to go online just to see a firm's promotional materials. The implication is that Internet marketers need to set the objectives of their Web sites to be consistent with the goals that customers bring to the site.

FUTURE TRENDS

Marketing and UCD have a great deal in common. Both emphasize understanding and serving human needs as part of their discipline's core philosophy. Furthermore, both the marketing and UCD literatures characterize human behavior as purposeful. Despite the similarities, there has been remarkably little cross-pollination between the two disciplines. Porter's (2005) model of perceived Web site value incorporates insights from both disciplines. In addition to the theoretical contributions that the field of user-centered design can offer marketing, there are practical contributions as well. User modeling tools (Clemmensen, 2004) such as customer personas, customer scenarios, and task analysis, which are based on the notion that consumers are goal directed, hold significant promise for Web marketers as practical means of developing Web sites that provide value to customers. Ultimately, both disciplines would profit from further integration of knowledge, theory, and techniques designed to understand and meet the needs of goal-directed customers.

CONCLUSION

There is a high degree of consensus among marketing academics and practitioners that online customer behavior is goal directed. However, the implications of the goal-directed nature of customer behavior online are less well understood. As a result, a large percentage of commercial Web sites fail to truly take advantage of the opportunities that technology allows for providing value to customers. While marketers have been struggling with creating effective Web sites, UCD professionals have taken the lead in creating Web sites that meet the needs of goal-directed Web customers. The model presented here represents an attempt to bridge the gap between two disciplines with the same agenda—better serving the needs of people.

The model of perceived Web site value conceptualizes customer online value as a means end chain that integrates the customer's goals, tasks with the tangible features, functions, and content of the Web site. The model has significant implications for Internet marketers. By understanding the consumer's online goals and related tasks, the Web marketer is in a position to create a Web site that delivers value to customers and provides high usability for the tasks that online visitors want to perform. Since customer online goals represent the starting point for Web design efforts, this article has attempted to highlight the nature and types of goals that e-marketers might consider when planning what their Web sites should do in order to create online customer value.

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KEY TERMS

Customer Services Life Cycle (CSLC): A framework that describes the stages (requirements, acquisition, ownership, and retirement) that a customer goes through when purchasing and using a product or service.

Goal-Directed Behavior: The concept that individuals are motivated to expend time and energy to achieve some desired objective (the goal). A significant amount of online consumer behavior is goal directed.

Means-End Theory: A theoretical framework based on the idea that consumers seek out or prefer specific products and product attributes because they serve as a *means* to achieve desired *end* states.

Online Customer Value: A customer's perceived preference for and evaluation of those Web site features and functions that facilitate (or block) the performance of the tasks that are instrumental in achieving the customer's goals associated with the Web site visit.

Online Goal: The customer's objective or purpose of the Web site visit.

Tasks: "The activities undertaken to achieve a goal" (Maguire, 2001).

Usability: "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO, 1997).

User-Centered Design: An approach to the design of system interfaces that seeks to ensure technology matches users' needs and supports the tasks that users would like to perform.

Cyber–Identity Theft

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INTRODUCTION

Internet technology facilitates "faceless" transactions. At the same time, a new set of risks arises. In this article, we focus on the Internet-related risks associated with identity theft. Specifically, our objectives are to explain electronic-based identity theft (i.e., cyber-identity theft) and to explore the impact of cyber-identity theft on consumers, businesses, organizations and public policies. Our article makes two specific contributions to the identity theft literature: (a) it explains identity theft as it relates to the Internet and (b) it defines key methods of cyber-identity theft.

BACKGROUND

We first present a brief background on this emerging issue. Identity theft is broadly defined as the practice of using the identity of another to obtain credit (Sovern, 2004). Specific to U.S. federal law[1], identity theft is the "unauthorized use of another person's identification with the intent to commit another crime" (U.S. Code, Chapter 47, Title 18). Any individual who violates federal identify law and obtains money or property valued at or over $1,000 over a one year period may be sentenced to up to 15 years in prison.

In extant studies, attention primarily focuses on legal aspects and avenues for future legislation and policy. Linnhoff and Langenderfer (2004) review the Fair and Accurate Credit Transactions Act (FACTA). As the 2003 Act currently stands, most of the financial risk is borne by the victim (Sovern, 2004). Simply stated, identity theft victims bear most of the costs of reestablishing their "good names" after an identity theft. Notably, some purchases made by identity thieves show up on the victim's credit report and may be difficult to remove. Critics claim that, at present, the law provides insufficient incentives for financial institutions to take preventative measures against identity theft (Lee, 2001; Sovern, 2004). Sovern (2004) argues that consumers should stand up to credit bureaus and creditors who fail to delete fraudulent transactions from victims' credit reports.

Identity theft has the potential to wreak havoc on consumers' social and financial lives. At present, U.S. consumers have rather extensive access to public records (e.g., birth certificates, marriage certificates, tax documents), and consumers may be reluctant to sacrifice these rights. For instance, a survey conducted at Washington State University finds that a majority of individuals in the state of Washington support continued individual access to public records (Cuillier, Passey, & Hinz, 2003), despite the presence of identity theft. Similarly, business organizations do not welcome laws concerning their security policies (Knowledge at Wharton, 2005; Lacey & Cuganesan, 2004).

Next, we explore how identity theft relates to the Internet. *Cyber*-identity theft involves the use of electronic (e.g., via the Internet) means to carry out any form of identity theft. Close et al. (2004, p. 48) define cyber-identity theft as "the online or electronic acquisition of personal information with the purpose of utilizing such information for deceitful activity either on the Internet or offline."

Currently, cyber-identity theft is the most common Internet-related crime reported to the U.S. Federal Trade Commission (FTC). Victims of cyber-identity theft often suffer socially, psychologically and financially. Businesses and organizations are also victimized by this type of Internet crime.

Academic research is beginning to emerge on the topic of identity theft; however, to date scholars have published relatively few studies specific to Internet-related identity theft. Close et al. (2004) present an overview of cyber-identity theft with an emphasis on the implications for public policy. Policy and online behavior must change to combat cyber-identity theft. Internet-related identity theft is, in part, a function of an individual's risky online transactions (Milne, Rohm, & Bahl, 2004). Consumers' online behaviors may increase or even decrease the risk of becoming a victim of identity theft (Milne et al., 2004). Each consumer differs in the extent to which he or she protects his or her online identity and privacy. This difference may be attributed to the Internet user's demographics, attitude, and online behaviors (Milne et al., 2004).

CYBER-IDENTITY THEFT: KEY METHODS

Common methods of cyber-identity theft include: (a) phishing, (b) employee abuse, (c) mass rebellion, (d) disposal, (e) pranking/posing, (f) spyware, and (g) a scam within a scam. In Table 1, we define and provide examples of these methods. In the table, we use the term *broad scope* to refer to methods that have a negative, simultaneous effect on *multiple* consumers. Broad scope methods often make use of automated tools to facilitate identity theft (McCarty, 2003). In the table, we also describe "narrow scope" methods, which refer to methods that affect *individual* consumers (see Table 1).

Table 1 reveals a number of implications for policymakers; in order to protect consumers it is necessary: (a) to inform consumers about related dangers, (b) to provide safe environments for conducting electronic exchanges, (c) to assist victims, and (d) to implement public policy remedies and legal action. Unfortunately,

Table 1. Key methods of cyber-identity theft (Reprinted with permission from Enhancing knowledge development in marketing*, published by the American Marketing Association, edited by Bernhardt, Boles, and Close, written by Zinkhan, and Finney, 2004, pp. 48-55)*

Method	Definition	Example
Broad Scope*		
Hacking	Breaking into a computer database personal or business/organization/government	Wiring another's funds
Employee Theft	Employees utilizing or selling their company database for fraudulent means or without permission	Pilfering office files
Dictionary Programs	Automatically search all dictionary words for a possible password	Checking all works A to Z
Spyware	Software, often disguised, that may install itself with other legitimate or free downloads, to collect personal information	Weather-bug, Gator
Skimming	Copying information from a magnetic strip, and subsequently using the information to create a duplicate	Credit cards
Tapping	Monitoring computer systems to extract key information	Restaurant computers for credit card numbers
Pre-approved	Taking another's per-approved credit and SSN to open an unauthorized account	Mailed credit card offers
Mass Rebellion	Peer-to-peer networks built to exchange music or media files. At present, the future of such sites is unclear, and some users are being taken to court (e.g., by the music and film industry)	peer-to-peer sites (e.g., Kazaa, Napster)
Narrow Scope		
Carelessness	Prowling for users who use their computer or Internet access carelessly	Saved Passwords, logoff may not go through
Disposal Abuse	Obtaining information from another's disposed / sold hardware or software	Dumpster-diving, leaving personal information on old computer via junk-yard, garage sale
Autofill Abuse	Obtaining information from computer programs that "memorize" and complete typing on another's machine	Type in a few letters until cleared
Phishing	Establishing a fake Web site designed to look like a company's actual site or sending official-looking messages	"Official" request for SSN
Phony	A phony machine that copies personal information	ATM
Pre-text	Calling a prospective victim, posing in an attempt to obtain personal information	Bank. Credit card company
Posing	Unrightfully representing another individual	Bank rep., computer exams
Pranking	Posing as another online to play a joke or for fun	E-dating
Fraudulent Job Posting	Posting a job that does not exist to collect personal information	"Manager Wanted: Apply Online"
Shoulder Surfing	Peeking for information as another enters it on a computer screen; physically watching passwords	Passwords, Account numbers
Intercepting	Receiving online traffic intended for another	IM (Instant Message), E-mail

the number of cyber-scams is limited only by the considerable imagination of cyber-thieves. Thus, cyber-crooks constantly invent new ways to steal identities. As a result, consumers and organizations should constantly invent new ways to protect consumers' identities from the creative crooks and cyber-crooks.

FUTURE TRENDS

From a business perspective, organizations implement a strategy of customer relationship management (CRM) to collect, maintain, and use information on their current customers. Accurate customer information and timely retrieval of this information is an asset and a source of competitive advantage for a firm. Organizations frequently exchange consumer information among themselves, in order to create databases pertaining to customers' purchasing habits and lifestyles. While these databases may assist organizations in becoming more "customer-centric" (e.g., by providing personalized purchase recommendations, by electronically storing shipping addresses, by remembering consumer preferences), this "everyday" business practice also creates risks because such databases increase the probability of large-scale identity theft.

Organizations are also potential victims of cyber-identity theft. For example, an identity thief may acquire a company's CRM database and contact the customers under false pretenses. As a result, the onus is on customers to decide whether or not electronic communications emanate from legitimate sources. Consumers need not be vulnerable (Langendefer & Shimp, 2001). In the future, customers may look to third-parties to provide authentication. In many aspects, combating cyber-identity theft is a cost of modern business (Hemphill, 2001). In the age of information technology, identity theft and customer privacy are likely to remain major concerns (Thompson, 2002).

CONCLUSION

For 21st-century consumers, cyber-identity theft is a fact of life; identify theft is unlikely to disappear in the foreseeable future. Human identification is often based on an association of data with a given human being (LoPucki, 2001). This is a key premise of human identity theory (LoPucki, 2001). We note that understanding human identity as it relates to the Internet is much more complex. On the one hand, consumers can harness new technologies to create multiple identities via chat rooms, e-dating services, e-mail, and other virtual spaces (Close et al., 2004). On the other hand, all Internet users must be mindful of the potential downside of going online and exchanging electronic information.

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KEY TERMS

Cyber-Identity Theft: The online or electronic acquisition of personal information with the purpose of utilizing such information for deceitful activity either on the Internet or off- line.

Disposal: Even disconnected computers may lead to cyber-identity theft. Careless handling or disposal of discarded computers can lead to identity theft. Furthermore, disposed hardware and software may lead to cyber-identity theft. If a user fails to take precautions such as data deletion or physical destruction of a machine, the data are readily accessible for the next user—whoever may find it.

Employee Abuse: Employees, especially those employees who believe that they are treated unjustly, may provide the data necessary for cyber-identity theft. With e-mail and databases full of consumer information, an employee or other insider can pass spreadsheets along to thieves. Employees may divulge personal information unintentionally, or intentionally. Also related to cyber-identity theft and the workplace is the possibility of phony job-listings online in order to obtain consumer information.

Hacking: Hacking, or entering another's computer, is a common method of the cyber-identity thief. Saunders and Zucker (1999) note that the most common (cyber) identity theft tactic is to hack into a computerized database and take personal information. Hacking has evolved to "phishing."

Mass Rebellion: Cyber-identity thieves may use decentralized, mass rebellion sites. These peer-to-peer environments (e.g., Kazaa Media Desktop) allow individuals to share files over the Internet. Cyber-identity thieves may use such peer-to-peer networks to install virus software, which records data such as Web site visitation and any information that is entered to a nonsecure site.

Phishing: With phishing, identity thieves establish a fake Web site designed to look like a company's actual site; unsuspecting customers are drawn to the site and asked to disclose personal information.

Pranking/Posing: Cyber-identity theft may also include seemingly "lighthearted" pranks—a less sinister form of identity theft. Such instances have occurred where the e-prankster registers (complete with photograph) a friend or colleague to an e-dating site (e.g., match.com) (Close & Zinkhan, 2004). Phony e-dating profiles may be a result of an online prank, causing false expectations for interested e-daters. Posing as another on instant messenger (IM) is another prank where users misidentify themselves- often to obtain information not privy to the cyber-identity thief.

Scam within a Scam: Our final mention of methods of cyber-identity theft involves a scam within a scam. For instance, a cyber thief may pose as an attorney or a governmental employee and mass e-mail a database of past identity theft victims, requesting personal information for evidence to assist them in a potential court case. In this way, some theft victims may be victimized in more ways than one.

Spyware: Personal information is sometimes collected via spyware. Spyware is a group of programs that are (sometimes inadvertently) downloaded along with legitimate or free programs (e.g., Weatherbug, Gator). Spyware then runs in the background and functions whenever the Internet user is online for market research purposes.

ENDNOTE

[1] Title 18, U.S.C..§ 1028(a)(7) became effective October 30, 1998.

Data Warehousing and Data Mining Lessons for EC Companies

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INTRODUCTION

Internet companies are now in the second stage of evolution in which the emphasis is on building brands (Campman, 2001) and retaining customers rather than just transactions. There is also an imperative for multidimensional Web performance monitoring (Earls, 2005) and a continual fine-tuning of sites for optimal navigation, increased stickiness and transactional efficiency. Such research as the relationship between customer profiles and navigational characteristics (Garatti, Sergio, Sergio, & Broccab, 2004) and techniques for seamlessly aggregating Web data with corporate data (Wood & Ow, 2005) also testify to the importance of holistic data analysis for knowledge discovery. The technologies that are becoming critical in this fight for customer retention are data warehousing, data mining and customer relationship management.

This article presents two case studies, one on data warehousing and the other on data mining, to draw some very specific lessons about management support, organizational commitment and overall implementation of such projects. These lessons complement past recommendations that these technologies are more about organization change (Kale, 2004), about a single unified view of the business and, ultimately about building a shared data model of the enterprise.

We start with a brief overview of data warehousing and data mining. The two cases are discussed next, using a similar analytical structure to facilitate comparison among them. In the conclusion, we describe the key lessons learned from the two cases and implications for future research.

Data Warehousing and Data Mining

Data Warehousing

Data warehousing is the process of creating an integrated and summarized copy of an organization's transactional data for the purposes of data analysis and decision support. The Data Warehousing Institute (TDWI) has played an active role in highlighting and popularizing best practices in the industry. It has produced a Data Warehousing Roadmap (Barquin & Edelstein, 1997) to guide would-be implementers. Another methodology exists, called the Metis Methodology (Kelly, 1997), developed by Sean Kelley, founder of the Data Warehouse Network. This has been further refined into the Hadden-Kelly Methodology.

A key aspect of data warehousing development is rapid application development (RAD) that is best used when it is impossible to fully specify the system's requirements accurately. However, this does not mean that no part of the system is fixed. Key high-level components, such as warehouse architecture, data model, data dictionary and other logical and conceptual components, should remain reasonably stable, standard and well defined. What evolves continuously are the applications and the data in the warehouse. A useful metaphor is that of shipbuilding, where the design of the hull remains immutable, but various ships (e.g., aircraft carriers, cargo haulers) are built on the same hull. Benefits of the rapid application development approach include the ability to manage the inherent risk of a data warehousing project, the ability to prioritize resources and the continuous delivery of business functionality.

Another way to mitigate risks is to build data marts, which are essentially smaller, more focused data warehouses that cater to the needs of a single business line or function. Data marts are often marketed as quick fixes to an organization's data management problems, and many organizations implement them as part of a longer-term plan to roll out a data warehouse.

Data Mining

Once an organization has an integrated data warehouse, its members can use a variety of tools, such as online analytical processing (OLAP) applications and SQL, to query and analyze the data (Inmon, 1996). OLAP refers to the technique of performing complex, multi-dimensional analysis in an ad-hoc manner and ranges from basic navigation and browsing (often referred to as "slice and dice") to more complex modeling and calculations. SQL analysis requires users to have a requirement or hypothesis that provides a clear and bounded focus to the data exploration.

Data mining can be done in a variety of ways, and these are often applied jointly (Chan & Lewis, 2002). Association is a method that aims to find affinities among records in a data set and is used in applications such as Market Basket Analysis. Sequential patterns are used, among other things, to detect buying patterns of individual customers. If records in a data set have been divided into various classes, classification can be used to describe the characteristics of each class. If, on the other hand, the records are not classified, clustering can be used to segment the records according to some criteria. Some of the mathematical techniques employed include rule induction, artificial neural networks, fuzzy logic and decision trees.

DESCRIPTION OF PROJECTS

Case: Data Warehousing

Company Overview

The project was implemented at the regional center of a multinational bank that employs 30,000 people globally in more than 50 countries. Its regional center was started in 1859, employs more than 2,000 people and provides the full range of Consumer Banking, Corporate and Institutional Banking and Global Markets products and services. The bank offers a complete range of Internet banking services, where users can set up personalized home pages, choose financial consultants, open online accounts, and select a variety of banking information.

Goals and Scope

The bank turned to data warehousing due to the increasingly competitive environment that had resulted in thinning profit margins. It came to the conclusion that it had to identify its most valuable customers and leverage them to use a broader range of banking services. Developing customer profiles, one of the key drivers of Internet banking as well, was important. Moreover, the bank would also need to use data mining techniques to discern trends and forecast the success of its marketing campaigns.

But customer information was scattered among various departmental databases and it was difficult to identify and profile these customers. A system called customer information management (CIM), which was meant to give each customer a unique ID, existed side-by-side with the various departmental databases. However, not every department used it and customers had different IDs in different systems; thus, CIM was reduced to mapping its IDs to the IDs in the other databases.

The IT Department of the bank decided on a data warehouse package called *Collage*. It was decided that *Collage* would only hold the customer IDs from CIM. Data from various sources would first be mapped to a customer ID in CIM and then loaded into a separate database. The data would be transformed to standardize the naming conventions and then it would be stored in the data warehouse to allow individual applications and departments to pull out whatever data was required.

Project Development and Management

The objectives of the development process were fourfold: (1) to understand the data available, (2) to prove that banking indicators—for example, credit limits—could be integrated around customers, (3) to demonstrate inconsistencies in the current data, and (4) to create an all-encompassing data warehouse with a few data marts around it. These data marts would provide the necessary subsets of information required by individuals or groups and would be located in closer proximity to the users. The deliverables included a logical data model, a data dictionary, the physical database structures in the data warehouse, a sample set of data instances for validation purposes, a validation of the database schema and integration methodology, and an action plan to address any issues that arose.

Once the project was accepted, a task force was formed and given 4 months to develop the data warehouse. The project team decided to build a prototype to test the robustness and validity of the underlying assumptions. It spent a significant amount of time evaluating various hardware and software combinations. As a result, planning itself took 4 months and it was another 2 months before data could be loaded into the warehouse. A prototype containing data for the top 30 customers was evaluated and considered successful. Full-scale development followed, and it went smoothly, according to the schedule drawn up.

Implementation

Though the system was complete, no one came forward to use it! After a period of time, the Marketing Department showed an interest in it. But while their data mart contained customer details such as reference, revenue and balances, they required customer segmental information. Modifications, thus, had to be made, and to better articulate requirements, Marketing actually assigned its own staff member to the development team. In about 2 months, the data mart was redesigned according to new specifications. An important reason, beyond user involvement, why the IT group was able to modify the data mart quickly was because much time had been spent on planning the first iteration of the data warehouse project.

After the success of the Marketing data mart, other departments began to come forward. Subsequently, two other data marts were created relating to customer profitability and the tracking of customer liability. Aggregated weekly and monthly transaction-level information was also added to the data warehouse. It is worth noting that since its inception, the main logical data model has remained intact. This success can be attributed to the detailed planning done by the development team and the selection of the right tools for data warehousing.

Case: Data Mining

Company Overview

The data mining project was undertaken by the regional headquarters of a prominent international bank with European roots. In Asia, the bank has a 175-year history and in the country where the project was implemented, it is the oldest foreign bank.

The bank has one of the most sophisticated Internet banking facilities, with all customers given a personal handheld portable device that generates dynamic passwords for added second-level access authentication. It has also rolled out a number of online products catered to high net-worth individuals and niche segments.

Goals and Scope

The data mining project was driven by two changes. First, the business model of banking was changing from product- and revenue-centered to customer- and profit-centered. This transformation required implementing new technology to support the changes in business processes. Second, the role of managers had changed with the times and they were now required to think multi-dimensionally, and not focus only on their own narrow lines of business. Hence, rather than rely on dedicated analysts to provide them with reports, it was more effective for them to do their own analysis. This had not only freed up the analysts but also managers who could now create tailored reports suited to their needs rather than be tied to the same standard reports every financial period.

Reporting within the bank had to change to keep abreast of these changes, and business intelligence applications, which displayed information multi-dimensionally, were needed urgently. Combined with the knowledge that there were "sweet spots" of information (the most valuable bits of information) available in the company's data that management had to get at to improve its decision-making, the stage was set for the bank to implement data mining.

Project Development and Management

The initial champion for the project was the Finance department. Financial analysis had primarily focused on the production of routine reports and discovery of discrepancies between reports. This department saw only a limited slice of the business and, hence, could only guess at what was driving the discrepancies. This meant that the ROI on analysis was very low and managers could not receive prompt replies to ad-hoc queries.

The solution proposed was a redesign of the report data as five data cubes. These cubes included the multi-dimensional income statement and balance sheet, the profit drill-down statement, the financial ratio listing and the cash flow statement. The redesign allowed any manager to perform most analyses quickly and easily. Moreover, managers could explore previously unconsidered business angles, thereby increasing productivity.

Implementation

The development team began by creating a prototype. They chose the profit drill-down cube for this project and were given a time frame of 90 days. The cube was to have dive dimensions and two reports—income stream and costs—both to be analyzed by markets and products.

Once the application was successfully implemented locally, the next step was to roll it regionally. This meant educating users to first change their view of data from a geographic one to a functional one and then implementing the cubes in their offices. The team began by building small applications and, as users became familiar with the technology, their information needs expanded, resulting in a steady increase in the applications, as well.

The throughput of the Finance Department increased dramatically as a result of the simplification of the analysis process. Tedious manual steps, such as re-keying data from paper reports into spreadsheets, were eliminated. Work changed from analysis and report preparation to information distribution. In fact, the department was able to provide Relationship managers with "sweet spots" of data. Furthermore, as a result of the simplification, some analysis tasks could be offloaded to other departments. Relationship managers were given the ability to navigate the data cubes and they strongly promoted multidimensional analysis within the bank so users would be able to create and view reports according to their individual preferences.

IMPACT OF PROJECTS

In the data warehouse project, the bank was able to reduce the operational costs involved in preparing the quarterly internal report, improve the accuracy of information available to the group credit department and leverage the investments in its existing CIM system. Bank processes became more effective, knowing the profitable and unprofitable market segments and having customer profiles. The bank also realized that, contrary to its thinking, corporate customers were profitable, trade financing was much more profitable than cash transactions, and customers' offices in the United Kingdom gave much lower margins compared to the offices in Asia-Pacific region.

In the data mining project, the use of five multidimensional cubes had a significant impact on the bank's operations; the regional controller, in fact, commented that they had "… cut analysis time from man-days to minutes." Key trends in the bank's operations were revealed and managers were able to compare important ratios against industry benchmarks. The ability to drill-down to the detailed data enabled users to discover the source of deviations and, hence, improve their forecasting and operational planning. The new tools also aligned the activities of the relationship managers with corporate goals. Previously, they concentrated on increasing market share rather than on profitability. Now, the data cubes gave managers the capability to measure the profitability of customers and of marketing campaigns and, thus, better adapt their strategies.

Key Lessons Learned

Management Support

One of the key lessons is how the level of management support affects the design of the technology solution. In the case of the data warehouse implementation, the project was mainly driven by the IT department, which was its champion. Despite rallying calls by senior IT management, business support was not very forthcoming, as most functional groups were too occupied with other projects. Since the warehouse was designed without any functional area in mind, it turned out to be "business-unit neutral." This apparent lack of design specificity turned out to be a blessing, as none of the business units felt threatened by it. As a result, they were all willing to share data, something they might not have done for the fear of their data being owned by the championing unit in case the project had been driven by a single business unit.

It is thus clear that in order to avoid conflicts and reduce business anxiety about proprietary data, a common, flexible, neutral platform is essential, even though it comes as the price of a generic design that requires further customization for use. Brick-and-mortar companies that have a significant online presence might have to adopt such solutions as they move towards integrating online and offline data with the goal of a single, unified view of the customer. On the other hand, Internet startups, by virtue of being nimble and having focused, inherent advantages that allow them to exploit disruptive innovations (Carr, 2005; Bower and Christensen, 1995) will likely deploy more tightly integrated solutions. Empirical research can look at this issue further.

User Involvement and Support

The data mining project had the clear support and backing of the users. It was keenly sponsored by the Finance team and built to its specifications. Therefore, there were no delays in deployment and the application met users' needs fully. Thus, both design and adoption were much easier because of user involvement and user ownership. In line with past results on IT adoption (Jiang, Chen, & Klein, 2002), our study shows that users should play a significant role in such projects right from the start.

Implementation: Formal Methodology

One of the striking commonalities in both cases was the adoption of formal guidelines. Both used formal methodologies (Barquin & Edelstein, 1997) and, as recommended, assessed users' needs, evaluated competing products, developed prototypes and deployed the projects as small scale whose scope was only enhanced once users were comfortable and also when success was evident to the organization. The small-to-scale approach was quite explicit for the data mining project that started with the Finance department and then expanded to other groups. For the data warehouse project, the formal planning took a long time, as its aim was to create a broad and encompassing platform. Such a design allowed a smooth integration of smaller data marts that were created later for functional areas. Thus, the adoption of formal guidelines, such as spending enough time on analysis and design, paid off in both cases. These considerations are important lessons for Internet companies, where time is critical due to the high-velocity environment in which they operate (Rajgopal, Venkatachalam, & Kotha, 2002). Still, they need to realize that architectural platforms, such as data warehouse projects, require a critical amount of time for an effective long-term solution.

CONCLUSION

Creating large, customer-focused platforms is a tough implementation challenge—as many as 60%-80% fail to achieve their objectives (Kale, 2004). The two cases described here outline how user and top management support can affect the design of data warehouse and data mining projects. They show trade-offs in design—generic, flexible solutions or a tightly focused design centered on the needs of a functional unit. The benefit of adopting a formal implementation methodology is also demonstrated. Internet companies can learn from some of these lessons as well as from past empirical studies, such as Hwang et al. (2004), as they now move into a new era of electronic commerce with customer-focused strategies and platforms.

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KEY TERMS

Data Cube: A data cube is a type of multidimensional matrix that lets users explore and analyze a collection of data from many different perspectives, usually considering three factors (dimensions) at a time.

Data Dictionary: A part of a database that holds definitions of data elements, such as tables, columns and views.

Database Schema: The physical model or blueprint for a database.

Drill Down: A method of exploring multidimensional data by moving from one level of detail to the next.

Logical Data Model: A logical data model is an abstract representation of a set of data entities and their relationship, usually including their key attributes.

Prototype: A preliminary type, form or instance of a system that serves as a model for later stages or for the final, complete version of the system.

Rapid Application Development (RAD): An iterative prototyping development approach, where requirements and analyses are continuously refined throughout the life cycle of a project.

Deception in Electronic Goods and Services

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INTRODUCTION

Deception is a frequent but under appreciated aspect of human society (Eckman, 2001). Deception in electronic goods and services is facilitated by the difficulty of verifying details in the limited information available in cyberspace (Mintz, 2002). Fear of being deceived (often unjustified) is in fact a major obstacle to wider use of e-commerce and e-government by the public. One survey reported consumers thought fraud on the Internet was 12 times more common than offline fraud, and 3 out of 5 people thought their credit card number could be stolen in most online transactions (Allen, 2001); both are overestimates. We assess here the nature of the deception threat, how deception can be detected, and what can be done about it.

BACKGROUND

Deception is common in many areas of human endeavor (Ford, 1996). Deception is in fact essential to the normal operation of business, law, government, and entertainment as a way to manipulate people (Nyberg, 1993). But there is a complex boundary between acceptable deception and unacceptable or illegal deception.

Deception can occur with either the purveyor (offeror) of goods or services or with the customer (buyer), and it strongly affects trust in a transaction (Friedman, Kahn, & Howe, 2000). Some examples in online activities include:

- A customer provides a fake credit card number for a transaction.
- A Web site takes a customer's money but never provides a promised good or service.
- A Web site solicits a customer's e-mail address for spamming them but claims it is for potential "problems with your order".
- A Web site incorrectly says they can legally sell you a drug without a doctor's prescription.
- A customer with a grudge posts false health reports about a product on a Web bulletin board.

Usually the motivation for deception in goods and services is financial gain, but other reasons include revenge and self-glorification.

Unfortunately, the rather anonymous nature of cyberspace encourages deception. One problem is that the communications bandwidth, or amount of information that can be transmitted between people, is considerably less than in face-to-face human interactions, even with videocameras. Studies indicate that people are more deceptive the smaller the bandwidth (Burgoon, Stoner, Bonito, & Dunbar, 2003); for instance, people are more deceptive on the telephone than in videoconferencing. The detection of deception in online interactions is made difficult by the absence of many useful visual and aural clues; careful studies of consumer behavior have confirmed this difficulty (Grazioli & Jarvenpaa, 2000). This raises problems for electronic commerce and government.

DECEPTION METHODS AND COUNTERMEASURES

Categories of Deception in Electronic Goods and Services

We can distinguish five major categories of deception in online transactions: Puffery or overstated claims, insincerity of promises or claims, trespassing, masquerading, and fraud (Grazioli & Jarvenpaa, 2003). Most instances happen with the World Wide Web, with some occurring in e-mail and other uses of the Internet.

Puffery includes mostly advertising since it rarely accurately summarizes the merits of a product or service. Deceptive advertising is encouraged by the nature of online interaction: It is hard for a customer to know with whom they are dealing. An impressive Web site is no guarantee of a reliable business, unlike an impressive real-world store or shop. Furthermore, the customer cannot hold and touch the merchandise, and the images, audio, or video provided of it are typically limited. So it is tempting for an online purveyor to make unsupportable claims. Puffery also includes indirect methods such as a Web site for a children's television show that is designed to sell a particular toy, or people who endorse products in online discussion groups without revealing they work for the purveyor ("shilling").

Insincerity has many forms online. Many Web search engines list pages they have been paid to display but that are not the best matches to the given keywords. A purveyor can promise "extras" to a sale they have no intention of delivering, or a customer can promise large future purchases. Emotions can also be faked, even love (Cornwell & Lundgren, 2001). False excuses like "being busy" are easy to make on the Internet. Negative puffery, where a customer or other business says bad things about a product or service (Floridi, 1996), as for revenge or to manipulate stock prices, are another form of insincerity. And "Remove me from the mailing list" links can actually be scams to get your name onto a mailing list.

Trespassing is breaking into computer systems to steal its time, memory, or other resources, and is usually by deception. It is commonly associated with "hackers", people breaking in for fun, but is increasingly practiced by spyware, and by criminals to obtain staging sites for attacks on other computers (Bosworth & Kabay, 2002; Chirillo, 2002).

Masquerarding or "identity deception" is pretending to be someone that one is not. There are many forms online:

- Customers can steal passwords or identification numbers, then use them to steal goods and services.
- Purveyors can also pretend to be a different entity than they really are. This is facilitated by the lack of regulation of Web sites and their claims, and by the ability to give false return addresses in e-mail and false link text on Web sites.
- A serious problem of this type is "phishing", inviting or threatening people to induce them to visit a decoy Web site where they are asked to supply personal data such as credit card numbers and bank-account numbers for subsequent theft. An example enticement is to claim to be the government tax office needing information about a tax return.
- Counterfeit Web sites try to mimic familiar Web sites to steal from customers. Classic tricks are names confusable with those of well-known sites, like "googl.com" instead of "google.com", or numbers in the address instead of letters to prevent recognition.
- Both deceptive Web sites and deceptive e-mail can steal professional-looking graphics and fonts from legitimate sites and e-mail to look more convincing.
- A site may even "hijack" business from another by using the same Internet (IP) address, but this will only work for a short time before it is discovered and stopped.
- Data, such as credit card numbers could possibly be stolen from packets traversing the Internet, but this is becoming very difficult as many commercial sites now encrypt such sensitive data.
- Fake online documents are hard to detect, since most clues to forgeries like handwriting style and provenance are not available, but style inconsistencies can still help (Kaza, Murthy, & Hu, 2003).

The most serious electronic deceptions in goods and services are crimes of fraud (Boni & Kovachich, 1999; Loader & Thomas, 2000). McEvoy, Albro, and McCracken (2001) and Fraudwatch (2005) survey specific popular techniques. Unscrupulous Web purveyors can collect money without providing a promised good or service since it is easy to appear and disappear on the Web; fake charities are a notorious example. Purveyors may not feel much consumer pressure because it is hard for customers to complain about long-distance transactions. The Internet is well suited to many classic scams, notably the many forms of the "Nigerian letter" asking for money in the promise of receiving much more money in the future. Electronic voting is a special concern for fraud (Kofler, Krimmer, & Prosser, 2003).

The Ethics and Legality of Deception

Online transactions benefit from the trust of the participants. Deception subverts trust and makes online businesses less efficient because of the subsequent need to check credentials and promises. Because of similar costs to society in general, ethical theories usually claim that most forms of deception are unethical (Bok, 1999), and laws in every society identify some forms of deception as fraud legally. American law uses the doctrine of "implied merchantability" to say that a contracted good or service must be provided adequately or the money must be refunded. Waivers of responsibility that consumers must approve before proceeding on a Web site do not have much weight in court because consumers rarely can be said to give informed consent. But there are many other issues; see the many Internet-related publications of the U.S. Federal Trade Commission (FTC, 2005).

Detecting Deception in Goods and Services

Studies have shown that most people are poor at detecting deception (Ford, 1996). Thus in cyberspace with its limited bandwidth, deception is even more of a problem. Most training of people (such as law-enforcement personnel) to recognize deception in human interactions focuses on clues that are absent in cyberspace such as the visual ones of increased pupil dilation, blinking, and self-grooming, and vocal clues such as higher voice pitch, more frequent speech errors, and hesitation. However, some traditional clues to deception do apply to cyberspace (Zhou & Zhang, 2004), including:

- Short responses, concealing lack of knowledge;
- Increased use of negatives, concealing lack of knowledge;
- Overgenerality, concealing lack of knowledge;
- Errors in spelling, punctuation, or grammar, indicating lack of knowledge or a deliberate attempt to get past spam filters;
- Obvious random selections, indicating program-generated text;
- Overly quick responses, indicating preplanned strategies;
- Overly slow responses, suggesting ongoing planning;
- Increased hyperbole or abusive language, inducing emotional responses as decoys; and
- Increased irrelevance, offering misdirection.

All these are common in deceptive advertising, as in "Never need a proscription [sic] again with Viocks, the secret of celebrities [sic] long health!!!!" Here is a real phishing e-mail with deliberate randomness and both deliberate and accidental spelling and punctuation errors (and invisible "normal" text as camouflage for spam filters):

From: Pasquale Pham [csjtirhqvmksdt@rr.com]
Sent: Tuesday, November 16, 2004 10:17 AM
To: mrsmorton@nps.edu
Subject: Why are you silent,
Hello,
You can . r e finance your mortga g e . with 4.15 % . ra t e and reduce your monthly payment at least twice. One minute can save you t h ousands. Your application is . approv e d.
uxqydujs
Thank you,
Pasquale Pham
OUI Group

Besides "low-level" clues which reflect the difficulty of the deceiver controlling all their channels of indirect communication, cognitive clues reflect the difficulty of constructing and maintaining deceptions (Heuer, 1982; Whaley & Busby, 2002). Logical inconsistencies are the most important of these. The above example shows inconsistency between the e-mail address of the sender, their name, and the company they claim to represent; inconsistency between the two parts of the sender's name; and inconsistency between the company, the clickable link text "uxqydujs", and the site the link actually takes you to, www.qolkamdnt.com. The Web registry, www.whois.sc, reports that this site was registered in Baku, Azerbaijan, for only 21 days, so it is unlikely to be a reputable lender for mortgages in the United States, the country to which it was sent. In addition, it is logically inconsistent to solicit a mortgage and also say "Your application is approved."

Lack of links from reputable Web sites is another clue that a site is suspicious, and that can be checked with a Web browser. The cliché that "If it's too good to be true, it probably is" is always helpful. Techniques derived from crime investigations are helpful for detecting dangerous deceptions (MacVittie, 2002) including computer forensics (Prosise & Mandia, 2001) and criminal profiling (Wang, Chen, & Akabashch, 2004).

Responding to Deception and Preventing It

Because deception can occur in such a range of online activities, a variety of countermeasures should be considered:

- **Ignoring It:** Deceptive businesses and sites should not be patronized, and this is helped if they are not indexed or linked to, based on critical review. Ignoring works well against lesser deceptions.
- **Education:** Both customers and purveyors can benefit from learning about possible deceptions. For instance, people should know not to give their passwords or identification numbers to anyone, no matter what emergency is alleged. Posting of statements of "netiquette", or etiquette for the Internet, also can educate customers as to acceptable behavior.
- **Passwords:** To reduce identity deception by users, passwords can be required in accessing a resource such as a Web site.
- **Encryption:** To maintain data privacy, sensitive data like credit card numbers should be encrypted in files and in transmission on the Internet (Schneier, 2000). Most Web vendors implement this for transactions.
- **Signatures:** To authenticate a message (prove who it came from), an unforgeable electronic signature can be attached to it. This encrypts a complicated function of the contents of the message, and can be decrypted by the receiver to prove that the message came unmodified from the sender.
- **Intrusion Detection:** Trespassing that breaks through first lines of defense can be recognized by software called intrusion-detection systems (Proctor, 2001).
- **Third-Party Escrow:** Utilities like PayPal can manage contracts between customers and purveyors as a neutral third-party broker.
- **Protocol Design:** Deception in electronic commerce can be reduced with good "protocols" (scripts and rules) for interactions. For instance, interruption of an online purchase at any time should not

allow other users to see private information, and this can be aided by "cookies" and time limits on responses.

- **Reputation Management Systems:** eBay and a number of Internet businesses have buyers and sellers rate one another. Observed deception affects these ratings which are visible to future buyers and sellers (Yu & Singh, 2003). While there are ways to deliberately manipulate ratings, they are difficult.
- **Automated Deception Detection:** Some automated tools assess text for deception (Qin, Burgoon, & Nunamaker, 2004). Some tools eliminate advertising in displaying Web pages (Rowe et al., 2002).
- **Manual Web Site Assessments:** Several organizations rate Web sites (e.g., the U.S. Better Business Bureau's "BBB Online Reliability Program"). Adequately-rated sites get a "seal of approval" which they can display on their sites, but such graphics are easy for a malicious site to copy. Pacifici (2002) offers suggestions for rating sites yourself.
- **Getting Background on a Web Site:** The sites www.whois.sc and www.betterwhois.com provide information about who registered a U.S. Web site and where, its description, certification, and "blacklist status". Similar information is available for most countries; see www.iana.org/cctld/cctld-whois.htm
- **Alerting Authorities:** Deceptive electronic commerce should be reported to government or consumer agencies.
- **Legal Recourse:** Particularly bad cases of deception should be handled by the courts. But jurisdictional conflicts can occur when the parties are in different countries or administrative areas.
- **Counterattacks and Revenge:** Not recommended because they are usually illegal, risk escalation, and may attack an innocent target because of the difficulty of confirming identity in cyberspace. Counterattacks have been tried in the form of deliberately garbled files posted to music-sharing utilities (Kushner, 2003).
- **Defensive Deception:** One can deceive a deceptive user to entrap or monitor them. For instance, one can post fake credit card numbers online and see if trespassers use them. "Honeypots" (The Honeynet Project, 2004) are fake Internet sites that entrap trespassers to collect data about them.

FUTURE TRENDS

The suitability of the Internet and the Web to particular kinds of deception means that this phenomenon will be with us for a long time. But a variety of new technology will increasingly provide help in combatting it. Rating and information services will be increasingly available for Web sites and other Internet business methods, and operating systems will offer increasingly effective built-in protection against hidden attacks. Laws eventually catch up with new technology, so we expect that legal recourses will steadily improve as precedents are gradually made for cyberspace. How quickly the customers and purveyors will overcome their fears of being deceived is another story, however. It may just take time, much in the way that automobiles were not trusted by the public for a long time simply because new powerful technology often looks dangerous.

CONCLUSION

Deception is always a danger in electronic transactions involving goods and services. Much of the public is reluctant to buy or contract online for this reason. But quite a variety of methods can detect deception and, better yet, prevent it. Wider use of these methods, and greater familiarity with them, can build public trust in online transactions. Trust is a key, but complex issue for societies (Sztompka, 1999).

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KEY TERMS

Deception: Conveying or implying false information to other people.

Fraud: Criminal deception leading to unjust enrichment of the deceiver.

Honeypot: A deceptive computer system that entraps trespassers into revealing their methods.

Identity Deception: Pretending to be someone or some category of person that one is not.

Intrusion-Detection System: Software for detecting when suspicious behavior occurs on a computer or network.

Netiquette: Informal policies for behavior in a virtual community, analogous to etiquette.

Phishing: Inducing people (often by e-mail) to visit a Web site that steals personal information about them.

Shilling: Making claims (pro or con) for something without revealing that you have a financial stake in it.

Signature, Electronic: A code someone supplies electronically that confirms their identity.

Social Engineering: Using social interactions to deceptively steal information like passwords from people.

Designing Service-Based Cooperative Systems

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INTRODUCTION

The connectivity generated by the Internet is opening opportunities for services composition. As a consequence, organizations are forming online alliances in order to deliver integrated value-added services. However, due to the lack of methodologies and tools, the development of such composite services across organizations is usually ad hoc and raises a number of issues, especially in the identification, composition, and orchestration of services. The objective of this article is to propose a goal-driven approach to understand the needs of different organizations for a new added-value composite service, and to model the cooperative process supporting this service provision in a declarative, goal-driven manner. The goal model called a map is then used for service elicitation, composition, and orchestration. The article presents the approach and illustrates it with a distance learning cooperative service.

BACKGROUND

Web standards and distributed technologies and platforms allow the development of new business paradigms such as *virtual organizations* and *virtual enterprises* (Georgakopoulos, 1999). Within such paradigms, different organizations pool together their services to offer more composite added-value services made easily accessible through network technologies and the Internet.

The support for such new paradigms is offered by cooperative applications. By using an approach based on interorganizational business-process coordination, the cooperation between organizations is obtained by sharing, composing, and orchestrating services across networks. Such services, usually referred to as *e-services* or *Web services* (Casati & Shan, 2001), are exported from the different organizations involved in the cooperative application. Such an e-service corresponds to a semantically well-defined functionality that allows users and applications to access and perform tasks offered by back-end business applications. Then, the cooperative application consists of a set of distributed applications that integrate the e-services offered by the participating organizations. Such integration raises some interesting points regarding service identification and composition.

A composition of e-services addresses the situation when a client request cannot be satisfied by available e-services but by a composite e-service, obtained by combining a set of available component e-services. Composition involves two different issues. The first issue is related to the elicitation of the composite service itself and the identification of e-services that will enter into this composition. Whereas this first issue is requirements driven, the second issue relates to the means to express the coordination between the various component e-services of the composite service. The former is referred to as composition whereas the latter is referred to as orchestration.

Several recent works address the second issue. In Casati, Georgakopoulos, and Shan (2001), an e-service that performs the coordination of e-services is considered a meta e-service, referred to as a composite e-service that can be invoked by clients. In Fauvet, Dumas, Benatallah, and Paik (2001), a composite e-service is modeled as an activity diagram, and its enactment is carried out through the coordination of different state coordinators in a decentralized way through peer-to-peer interactions. In Mecella, Presicce, and Pernici (2002), the orchestration of e-services is addressed by means of petri nets. In Bultan, Fu, Hull, and Su (2003), an e-service is modeled as a mealy machine processing a queue of input messages into output messages. Finally, in Shegalov, Gillmann, and Weikum (2001), the coordination of e-services is obtained by an enactment engine interpreting process schemas modeled as state charts.

The first issue still remains largely unexplored. However, Hull, Benedikt, Christophides, and Su (2003) propose to classify composition into three categories: (a) the peer-to-peer approach, in which the individual e-services are equal, (b) the mediated approach, based on a hub and spoke topology, in which one service is given the role of process mediator, and (c) the brokered approach, where process control is centralized but data can pass between e-services. In Aiello et al. (2002), a way of composing e-services is presented based on planning under uncertainty and constraint-satisfaction techniques, and a request language, to be used for specifying client goals, is proposed. In Fauvet et al. (2001), an approach to model service composition is introduced in which a composite service is defined as an aggregation of other composite and elementary services, whose dependencies are described through a state chart. Finally, in Yang and Papazoglou (2002), the issue of service composition is addressed in the context of Web components as a way for creating composite Web services by reusing, specializing, and extending existing ones.

Despite these attempts, an overall approach for eliciting, distributing, and orchestrating e-services into cooperative applications is still lacking. There is undoubtedly a need for a methodological approach toward service composition and cooperative application development.

Based on this observation of the current state of the art, our position is that the interorganizational composition of services should be tackled in a requirements-driven manner. In this article, we introduce a requirements-centric approach to understand the needs of different organizations that want to develop a cooperative information system implying service composition. We propose to use a goal-driven approach to (a) elicit functional requirements for a cooperative interorganizational process, (b) identify services that should be provided by each organization, and (c) design the coordination between those services to achieve the purpose of the cooperative process. The article presents the approach and illustrates it with an e-learning cooperative application.

MODELING THE COOPERATIVE PROCESS WITH MAPS

In this section, we introduce the map representation formalism (Rolland & Prakash, 2000) to model a process in goal and strategy terms, and illustrate the use of a map to model the cooperative process to provide distance learning in a virtual university. The map formalism has been practically validated in a number of large professional projects such as the FUSE project to model the business processes in the financial branch of Renault (Nurcan, Etien, Kaabi, Zoukar, & Rolland 2004), the ELEKTRA (Electrical Knowledge for Transforming Applications) project to conduct a change project (Nurcan & Rolland, 1999), and for the alignment of an Enterprise Resource Planning (ERP) functionality to the needs of Société Nationale des Chemins de Français (SNCF) (the French national railways company; Zoukar & Salinesi, 2004).

Introducing the Map

A map is a labeled, directed graph (Figure 1) with intentions as nodes, and strategies as edges between intentions. The directed nature of the graph shows which intentions can follow another. An edge enters a node if its strategy can be used to achieve the corresponding intention. Since there can be multiple edges entering a node, the map is capable of representing the many strategies that can be used for achieving an intention.

An intention is a goal to be achieved by the performance of the process. Each map has two special intentions, start and stop, to respectively start and end the process.

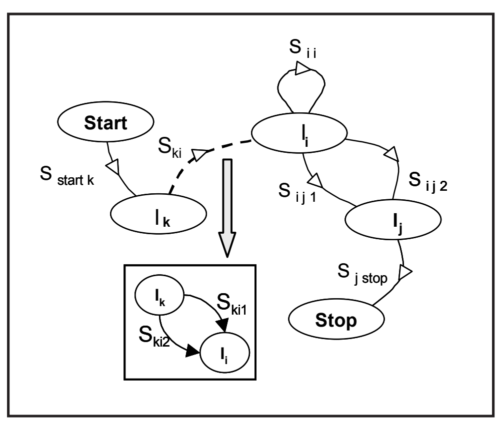
A strategy is an approach, a manner to achieve an intention.

A section is the key element of a map. It is a triplet $<I_i, I_j, S_{ij}>$ and represents a way to achieve the target intention I_j from the source intention I_i following the strategy S_{ij}. The strategy S_{ij} characterizes the flow from the source intention I_i to the target intention I_j, and the way I_j can be achieved once I_i has been achieved. Thus, each section of the map captures the condition to achieve an intention and the specific manner in which the process associated with the target intention can be performed.

It can be noticed that in general, a map comprises several paths from start to stop. This is due to the fact that (a) there might be several threads between a couple of intentions and (b) different combinations of sections can form different paths between two nonadjacent intentions.

Several strategies between a couple of intentions are usually related by an and/or relationship, with one or several of the set being applicable in a given situation. In cases of an exclusive *or* relationship, it is possible to bundle the set of alternative strategies as shown in Figure

Figure 1. A map



1 with the section $<I_k, I_i, S_{ki}>$ (the bold dashed line). This section is a bundle of $<I_k, I_i, S_{ki1}>$ and $<I_k, I_i, S_{ki2}>$, as shown in the figure.

The Example Case Map

We consider a European virtual university called e-U aiming to support the distance learning of students geographically distributed over Europe. E-U is a result of the alliance between universities in different European countries who want to cooperate to offer to European students a more competitive IT program than any of those that they currently, individually provide. E-U will take advantage of Web technology to develop an e-learning application as a composite service reusing local services such as university registration and diploma delivery.

In order to figure out what the requirements for the cooperative process were, an e-U committee composed of faculty, and administrative and pedagogical experts from the different partners' universities met together and modeled the e-learning map shown in Figure 2. They started by identifying the goal of the cooperative process and decided that it should be to provide a European IT program to students. Then, they brainstormed to identify the subgoals to be achieved to get the global goal achieved, and identified four of them, namely, to offer a course catalogue, manage course registration, teach courses, and validate courses, as shown in Figure 2. Thereafter, reasoning about the different manners to achieve these goals lead to the identification of a number of strategies, resulting in the map in Figure 2.

For example, since offering a course catalogue is an intention, the ways in which the course catalogue can be constructed become strategies for its achievement. This is shown in Figure 2 by the four strategies (a) from scratch or by reuse, (b) by adaptation, (c) by inspection, and (d) by evolution.

The first strategy is a bundle consisting of the from-scratch and reuse strategies; the former consists of building the catalogue from nothing, whereas the latter reuses some existing courses to define the new ones. These strategies are enacted by course authors.

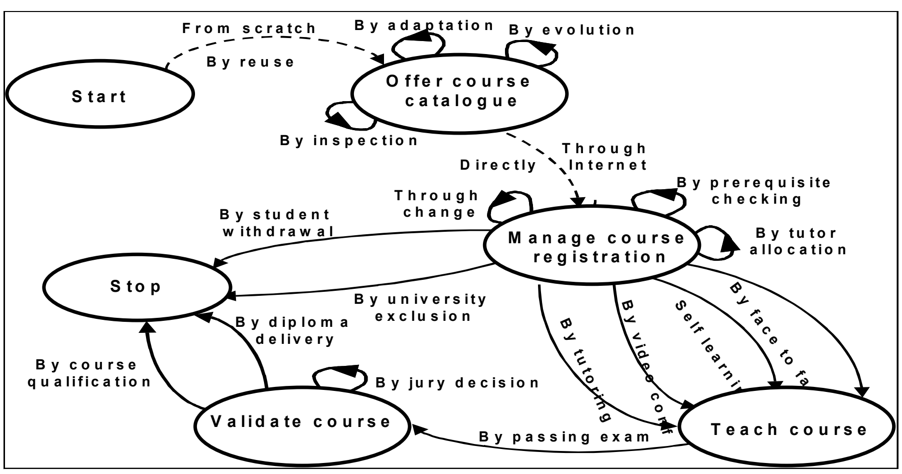
The inspection strategy reflects the decision of the e-U committee members to assure the quality of the courses offered to students, and to delegate this responsibility to a scientific committee.

The e-learning program can be modified or evolved according to the requirements of both course authors and the scientific committee. This is respectively modeled through the adaptation and evolution strategies. Any adaptation or evolution requires the validation of the scientific committee before the updated program is offered to the public.

At anytime, the curriculum can be removed by the scientific committee. This is shown in Figure 2 by the curriculum-withdrawal strategy that directly connects the intention to offer a course catalogue to the stop intention.

There is only one thread between the intentions to offer a course catalogue and to manage course registration that uses the Internet or direct strategy. This strategy is a bundle consisting of the Internet and direct strategies, which both allow students to register. The decision was to let students decide the university where they would register in and get their degree from. However, each of the e-U participating universities must provide the facilities for the student to register, access course material, attend examinations, and get the degree. Of course, the facilities provided to the student for distance teaching, which means the acquisition of knowl-

Figure 2. The e-learning map



edge and skills through mediated information and instruction, must respect the standards of distance learning set up by the scientific committee. For instance, tutoring shall be provided.

Managing course registration is the second key intention of the map. It can also be achieved using three other strategies: (a) through change, (b) by prerequisite checking, and (c) by tutor allocation.

The through-change strategy corresponds to the fact that students are allowed to change their selection of courses at least during a certain period. In order to ensure that students register for a course that they are able to follow, there is a check of the ad equation between the course requirements and the student profile. This is modeled by the prerequisite-checking strategy.

The university has the responsibility to affect tutors to e-learning modules and to remunerate them according to the number of students they tutored. This is shown in Figure 2 by the tutor-allocation strategy.

For sake of space, we leave the reader to interpret the remaining parts of the map. Also see Rolland and Prakash (2000).

It can be seen that the map allows us to represent the cooperative process in intentional terms: through intentions and strategies to achieve them. Therefore, the partners involved in the cooperation can reason on what they want to achieve and why without being bored with the details of how to do it. The directed form of the graph highlights the precedence relationships between intentions, therefore providing the process view of the expected cooperation in a declarative manner. Overall, e-U partners can discuss in their familiar terms and not be bothered by the technology that will be used to make the map work. Besides this, partners can easily change map intentions and strategies, add new strategies, and remove others during the design process itself and also during its evolution over time.

In the next section, we will discuss how the map serves as the basis for technical development using Web technology.

DESIGNING SERVICE COMPOSITION

The overall approach to develop the application by service composition and orchestration comprises four steps to (a) identify the services provided by the virtual organization, (b) specify these services, (c) identify legacy e-services, and (d) orchestrate their composition at run time. For sake of space, we present and illustrate briefly the three first steps. A detailed presentation of the approach including guidelines to perform the activities of the four steps can be found in Kaabi, Souveyet, and Rolland (2004).

Step 1: Identifying Services from the Map

The e-learning map was drawn in a business perspective. However the map-representation formalism has been designed to provide a means to combine in a single representation the business viewpoint and the system viewpoint. In other words, a map provides two faces: one for understanding the business viewpoint, and the other for the system viewpoint (Salinesi & Rolland, 2003). In order to establish a direct coupling between the business goals and the system functionality, we propose to associate each section of the map to a software service.

Applying this rule to the e-learning map leads us to identify 20 system services, each of them corresponding to a section of the map. Table 1 shows four of them related to sections S1 to S4 dealing with the achievement of the intention to offer a course catalogue.

Step 2: Defining Services

Once the services have been identified, their functionality shall be specified. We propose a scenario-driven approach inspired by the L'Ecritoire method and tool (Rolland, 2002; Rolland, Souveyet, & Ben Achour, 1998), which is part of the use-case theory. L'Ecritoire is based on a bidirectional coupling between goals and scenarios. In the forward direction, a scenario is seen as a concretization or realization of a goal, whereas in the backward direction, a scenario serves to discover subgoals of the initial goal. Scenarios are textual scenarios written in natural language. L'Ecritoire supports their conceptualization through linguistic analysis and interpretation, and provides two types of rules to (a) transform and complete a scenario (Rolland & Ben Achour, 1998) and (b) reason on the scenario contents for deriving subgoals, therefore helping to explore the functionality,

Table 1. Services underlying sections S1 to S4 of the e-learning map

Code	Service	Service description
S1	Course catalogue construction service	This service aims to help the different authors to construct the teaching support for the various e-learning modules.
S2	Adaptation service	This service consists of a set of facilities to support modifications and updates of the catalogue.
S3	Inspection service	This service consists of a set of check procedures carried out by the scientific committee in order to assure the right level of quality of the e-learning program.
S4	Evolution service	This service consists of a set of facilities to support the insertion and deletion of courses in the catalogue by authorized persons.

discover its variants, discover exception cases, and so forth. We illustrate the approach with the goal to manage course registration through the Internet of the e-learning map. The textual scenario of Table 2 is the initial scenario written by users as their vision of the normal way to achieve the goal through the enrollment of students in courses.

Using the L'Ecritoire software tool leads us to transform the above scenario into a conceptualized one showed in Table 3. As it can be seen, the tool helps first in explicating the conditions through which the course of actions is valid. This leads us, for example, to add the log-in condition (PIN [personal identification number] is valid), the prerequisites condition (if prerequisites are satisfied), the schedule-completeness condition (if the schedule is complete), as well as the scenario preconditions (student has a PIN; course registration is opened). Second, the conceptualization principle forces the writer to replace any anaphoric reference with an explicit noun; for example, "he has the necessary" has been replaced by "the student has the necessary." Third, the linguistic interpretation rules transform any initial sentence as an instance of the appropriate linguistic pattern; this leads us, for example, to transform the atomic action "the system verifies that he or she has the necessary prerequisites" into a communication action between the e-system and the university, where the student is registered in the phrase "the system asks the university to verify that the student has the necessary prerequisites." Fourth, the scenario-completeness rules help to complete the text with atomic actions performed by the system; the phrase "E-system checks the validity of the PIN" is one example of such an addition.

When the scenario has been conceptualized, L'Ecritoire analysis rules help in discovering new facets, variants, and exceptions related to the service functionality. For example, rules based on the analysis of scenario conditions will lead to the discovery of four alternative courses of actions that the service must be able to handle, namely, that the student PIN is invalid, the prerequisites for courses are not satisfied, course registration is not opened, and the schedule is not complete. Each of these cases corresponds to a subgoal to be handled, which yields a new scenario to be written and conceptualized, and so forth. In addition, rules based on the analysis of preconditions of the scenario help in discovering new functionality involved in the service, namely, the student log in, open course registration, and closed course registration.

A systematic application of L'Ecritoire rules guides toward a complete specification of the functionality em-

Table 2. Initial scenario

Course of actions: Students requests a new schedule. The system prepares a blank schedule form and pulls in a list of open and available courses from the Course Catalogue. Student selects primary and alternates courses from the available offerings. Fro each course, the system verifies that he has the necessary prerequisites and adds him to the course, making the student as 'enrolled' in that course. When the student indicates the schedule is complete, the system saves the schedule.

Table 3. Conceptualized scenario

Precondition: Student has a PIN; course registration is opened
Course of actions:
1. Student logs in the e-system and identifies herself or himself
2. E-system checks the validity of the PIN
3. If the PIN is correct, the system displays the menu
4. Student requests a new schedule
5. E-system prepares a blank schedule form and pulls in a list of open and available courses from the course catalogue of partners' universities
6. Student selects primary and alternate courses from the available offerings
7. For each course, the e-system asks the university to verify that the student has the necessary prerequisites
8. If the student satisfies the prerequisites, the e-system enrolls the student to the course
9. End $_{\text{for each}}$
10. The student pushes the validate button
11. If the schedule is complete,
12. E-system asks university to save the schedule
Post condition: Student has the PIN and is enrolled to courses; course registration is opened

bedded in the service. It also supports the discovery of the part of the service that can be reused from the legacy information systems. A detailed evaluation of L'Ecritoire can be found in Tawbi, Velez, Ben Achour, and Souveyet (2000).

Step 3: Identifying Legacy Services

In order to take advantage of the Web-services technology, this step aims to identify parts of existing legacy information systems (those of the entities involved in the virtual organization) that can be packaged as e-services and reused as such in the new cooperative application. Scenarios from the previous step are the basis for this identification. We developed a rule that searches for actions in the scenario that are communication between actors across the system. The rule determines who is asking what. The latter serves to elicit the candidate e-service, whereas the former leads to identifying the e-service call.

In the above scenario, there are three communication actions that involve a third actor in the interaction between the end user and the system, namely, Actions 5, 8, and 12. This leads us to identify three e-services that can be provided by the universities' legacy information systems, namely, to get available courses, check course prerequisites, and register student the schedule.

All other e-services of the entire e-learning map have been identified following the rule illustrated above.

FUTURE TRENDS

Starting from a technical viewpoint to solve issues of Service Oriented Architecture (SOA), namely, a service description language (Web Service Description Language [WSDL]), service repository (Universal Description Discovery Language [UDDI]), conversation (WSCL), choreography (Web Service Flow Language [WSFL]), and orchestration (XLANG), research as well as commercial tools are moving toward models to specify collaborations between business partners (Business Process Execution Language [BPEL], ebXML framework) and interorganizational work flows (Wise, CrossFlow, etc.). However, a holistic and integrated view is still lacking.

There are future research opportunities on the overall interorganization process specification and on methodological issues. Requirements engineering for interorganization composite services remains a key problem both from the functional point of view (in a similar way to the article's approach) as well as from the nonfunctional viewpoint, even though it exists in some initial works (Zeng, Banatallah, Dumas, Kalagnanam, & Sheng, 2003).

Identifying reusable and modifiable portions of legacy systems and combining them with new services for the construction of new business applications remains an open and critical issue. As noted by Heuvel, Hillegersberg, and Papazoglou (2002), tools, techniques, or guidelines on how to use legacy functionalities are not provided.

There are also specific architectural and enactment issues to support peer-to-peer distributed-service execution, the dynamic evolution and substitutability of services, and long-running transaction management. Peer-to-peer execution seems to be an appropriate architecture to support the distributed enactment of services (Fauvet et al., 2001). However, efforts remain to be made to improve performance, standardize tools, and improve rules for distribution.

Mecella, Pernici, and Craca (2001) introduced the interesting problem of the substitutability of services, which is critical to support the dynamic adaptation of a composite service to face the occurrence of threat and needs for change.

Long-term transaction enactment is evidently an issue related to composite services, which require monitoring over a long period of time (Christophides, Hull, Karvounarakis, Kumar, Tong, & Xiong, 2001).

CONCLUSION

Composition is a promising concept but is quite unexplored and difficult to use in practice. We believe that composition can offer a competitive advantage to organizations by giving the possibility to develop an added-value service just by assembling services they already possess. The contribution of this article's approach is in providing a methodological support to the development of such composite services across organizations that helps in (a) capturing the virtual organization's requirements and expressing its wishes and goals in terms that are familiar to the stakeholders so that they can understand and reason about them easily, and (b) easing the elicitation of e-services that permit the software-application development.

The method presented herein is still in an experimental stage. However, two case studies that we already conducted using the method seem to demonstrate its feasibility and practicability. In one of these projects, the implementation has been done with success and effectiveness using the .NET environment to program services, and Microsoft's BizTalk to orchestrate them.

Multiple industrial case studies are planned to experiment with and validate both the approach and the method foundation while considering both success stories and possible antipatterns. Our focus is also on the development of an enactment mechanism by which the composite-service execution at run time is driven by the goal model.

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KEY TERMS

E-Learning Application: An application that includes the development of teaching and learning materials, tools for managing the distant use of these materials by students, a platform for the delivery of courses, and standards and policies to be followed by users.

Interorganization Cooperative Process: An abstraction of a complex business process involving different organizations that cooperate with one another to offer complex services. The interorganization cooperative process is supported by an application that helps in the coordination of services.

Scenario: A use case is described by a set of scenarios, each of them being a sequence of interactions that yields a measurable result for the primary actor. The collection of use-case descriptions describes the system's complete functionality.

Service Composition: The ability of one business to provide value-added services through the composition of basic Web services, possibly offered by different companies.

Service Orchestration: Describes the interactions that two or more services have with each other to achieve a common goal, and the relation between these interactions.

Use-Case Model: Consists of actors, use cases, and the relations among them. Actors represent roles of agents who require services from the system (primary actor) or who contribute to the delivery of these services (supporting actor). A use case represents a service to be provided by the system in reaction to the primary-actor solicitation.

Virtual Enterprise: A temporary alliance of existing enterprises or organizations that share skills, competencies, and resources in order to better respond to some common business goals and whose cooperation is supported by computer networks.

Web Services: Software components that are self-containing, self-describing, modular applications that can be published to, located on, and invoked across the Web. They allow applications to interoperate in a loosely coupled environment, discovering and connecting dynamically to services without any previous agreements having been established between them.

Developing a Viable Product for an Emerging Market

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INTRODUCTION

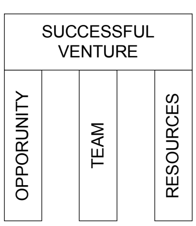
Launching an e-comm, dot-com, or Internet-based venture carries significant risk, and unfortunately failure is often the result. Yet, given the possibilities of large profits, entrepreneurial teams continue to come forward with new venture proposals, and venture capitalists continue to fund them. This case example illustrates the challenge and risk of developing a new product for a potentially emerging market. In this instance, the market did not evolve as expected and there were no profitable customers. An attempt to redefine the product/market focus was also unsuccessful. In the period of some two years, the company went from concept to start-up to closure.

This article starts with a brief review of venture creation and business model literature, considers an unsuccessful start-up, and concludes with lessons learned. References and a glossary follow.

NEW VENTURE FOUNDATIONS

Timmons and Spinelli (2004) identify three pillars upon which a new venture is built (Figure 1). All three are necessary; none are sufficient alone. First, an opportunity must exist. This opportunity must include a product/service for which a viable market exists (customers, distribution channel(s), sales and service support, etc.). With technology ventures, a 'whole product/service' is often required—a comprehensive package of products and services needed by customers to achieve the desired result, including such things as installation, training, and system integration support. High-tech ventures usually start with a concept that needs to be developed into an actual product/service. This requires significant time and effort, with a risk the market may reject the product/service, or a competitor may get there first. Second, a team is needed. This team must capably cover both technical and business sides of the venture, from conception to launch to successful market penetration. An ideal team has prior experience in developing and taking products to market. It is common for the initial team to be heavy on the technical side, with additional expertise added as the venture progresses. Third, sufficient resources are needed to carry the venture through the development phase and into active marketing, to at least the point of positive cashflow. These resources include financing, people, the business plan, and other assets. Venture capital sources exist to fund high-growth potential ventures through successive rounds of financing. So financial resources will follow, rather than lead, in venture creation.

Figure 1. New venture foundations



Every new venture needs to be built around a specific business model, supported by these three pillars, and articulated in a written business plan. There has been considerable confusion about the terms *business plan, business model, e-business model, Internet business model,* and *business strategy*. Sometimes the terms are used interchangeably. Other times they are used in a broad or narrow sense.

Chesbrough and Rosenbloom (2002) provide an excellent discussion of business models, identifying six functions (Table 1). A less detailed view of business models is articulated by Magretta (2002), who says, "A good business model begins with an insight into human motivations and ends in a rich stream of profits." To her, a business model contains a story (narrative) that explains how the enterprise will work. A financial model (pro forma P&L, etc.) supports this narrative and shows the numbers side. There are two tests to apply (Table 2).

Others have suggested alternatives. Clarke (2004) succinctly states a business model answers the question, "Who pays what, to whom, and why?" Hoppe and Breitner (2004) apply business models to e-learning, distinguishing three interdependent submodels (market, activity, asset) which comprise the holistic model. Mahadevan

Table 1. Functions of a business model (Chesbrough & Rosenbloom, 2002)

1. Articulates a customer value proposition
2. Identifies a market segment (*who* will use the technology for *what* purpose; specifies the revenue generation process)
3. Defines the venture's specific value chain structure
4. Estimates the cost structure and profit potential
5. Describes the venture's positioning within the value network linking suppliers and customers (includes identification of potential complementors and competitors)
6. Formulates the venture's competitive strategy

Table 2. Testing a business model (Magretta, 2002)

Narrative Test	Numbers Test
Does the business model tell a logical story, explaining who the customers are, what they value, and how the venture will successfully provide them with that value?	Does the pro forma P&L make sense? Are the assumptions reasonable?

(2000) sees three streams: the value stream (value propositions for various stakeholders), revenue stream (plan for assuring revenue generation), and logistical stream (addressing various issues related to supply chain design). Singh (2002) defines a business model as a method of doing business, and provides a taxonomy of current and emerging e-commerce models (emphasizing technology and participants). Weill and Vitale (2002) identify eight different 'atomic e-business models', each describing a different way of conducting business electronically and supported by various IT infrastructure capabilities.

On the strategy side, Porter (1996) provides several frameworks to guide firms in selecting their strategy and business model. His "5-forces" model, physical value chain network, and generic strategies are useful frameworks. Rayport and Sviokla's (1995) virtual value chain framework is particularly useful for firms using the Internet.

A complementary approach to viewing venture creation and growth is given by frameworks which segment evolution of the new firm. Kaulio (2003) identifies four perspectives: (1) milestones and time-pacing, (2) venture capital financing, (3) growth stages, and (4) market entry focus. Depending upon one's purpose, any (or all) of these frameworks can be useful. For purposes of this article, a growth stages model is considered: conception, start-up, growth, maturity; our emphasis here is on the first two stages, whereby the venture establishes itself and its business model.

Building upon this introduction, the following section tracks the history of an entrepreneurial team and its software venture. Initial failure during execution of the team's business plan led to refinement of the business model (a change in the product/market focus). This also proved unsuccessful.

BACKGROUND OF THE BUSINESS

The founders had backgrounds as independent application developers. While their university education was not in computer science or information systems, together they had well over a decade of experience in application development. Two of the team members had run a multimedia company for three years, developing advanced multimedia sales applications. The third founder had spent seven years running his own development firm, providing contract information systems design and marketing automation solutions for a diverse group of customers. In 1998 they joined forces and founded Ardesic. Their product was to be an eRM (electronic Relationship Management) package, aimed at the B2B e-comm market.

Developing this product would be expensive, and the founders did not have sufficient funds to even resource the development of a beta product. Timing was critical, and the market opportunity could be filled by competitors. The contribution of the venture team was the product concept and their preliminary work. This was sufficient to find financial backing, and in late 1999 a local venture capital firm agreed to provide seed financing (initial funding used to develop a business concept). Most of the funds were for product development, to get the code to beta stage. The remainder of funds were primarily for working capital, with a small amount for marketing and business development. If the market was responsive to the beta product, first-round financing would follow, with development of a fuller product and more intensive marketing.

A study by Forrester Research confirmed the venture team's foresight. Their report on "The Demise of CRM" (Forrester, 1999) concluded:

- A single view of each customer is cited (by the companies interviewed) as a critical or very important business need, but only 2% of firms have it today.
- Most firms feel that CRM vendors like Siebel and Vantive can help solve the problem, but Internet channel executives are not so sure.
- CRM will not work. Firms need eRM to synchronize cross-channel relationships.
- eRM applications will reshape the vendor landscape.

Ardesic's product, eMarketMinder, was aimed at this evolving eRM market.

DESCRIPTION OF THE BUSINESS

Ardesic started as a pre beta software company working on creating a solution for the emerging 'electronic Relationship Management' (eRM) space. The objective was to synchronize all customer-facing applications including, but not limited to, CRM and e-comm applications. Their business strategy aimed at partnering with incumbent vendors and extending the functionality of existing software products. Their product was to incorporate a messaging architecture that allowed a high degree of interoperability with existing enterprise applications. Because the software worked by passing messages between applications based on predetermined business rules, the software would allow customers to continue use of existing applications while realizing extended benefits. Table 3 provides a chronology for this venture.

At start-up time the CRM marketplace had large, well-financed vendors that one would not want as competitors. The perceived opportunity was to establish a strong first-mover presence in the eRM sector, become an attractive target for an established vendor, and be bought out. Since Forrester saw the introduction of eRM solutions to be 1-1½ years away, and expected eventual wide adoption, there appeared to be an excellent window of opportunity.

With seed financing, Ardesic developed a beta version of their eMarketMinder specifically designed for online B2B exchanges. Their burn rate (monthly rate of cash depletion) quickly consumed the seed funds. First-round financing followed in August 2000 and raised $10 million. Additional rounds of financing would likely be required, and would be conditional upon proving Ardesic's business model. However, as the months went by, the target market showed little interest. Target customers consisted mainly of start-up firms, which were either closing down or severely rationing their cash. The dot-com boom was turning into the dot-com bust. During the second quarter of 2001, the difficult decision was made to modify the product to support partner relationship management (PRM). The initial product would take six months to develop, and a further six months to add greater functionality. Later in the year it became evident that this new product could not gain customer traction and hence the business model was untenable. The decision was made to move into salvage mode.

Table 3. Chronology of events for Ardesic

Date	Event
'98	Firm founded by three partners with custom multimedia s/w background; B2B e-comm market focus
Q3, '99	Firm makes initial contact with local venture capitalist (VC)
Q4, '99	Seed round investment of $500K; employees hired; objective is to develop code to beta stage, while seeking first-round financing
Q2, '00	Product in beta testing, and two other initial prospects found; term sheet received from larger VC; CEO hired
Q3, '00	1st round financing of $10M by VC consortium
Q4, '00	VP Sales in place and sales force being hired; additional beta sites; market space moving rapidly; plan move to larger offices
Q1, '01	Sales force in place; difficulty gaining sales; Out-of-Cash (OOC) = 12 months
Q2, '01	Target customer base (e-markets) has evaporated; CEO replaced; staff & spending reduced; alternate options considered; OOC = 18 months
Q4, '01	Unable to gain customer traction; firm in salvage mode and shuts down; physical assets transferred to new firm; financial assets go to VCs; one of the founders starts a new venture

MANAGING THE BUSINESS

Three technically astute university graduates founded Ardesic. While not formally trained in computer science, they developed their skills as custom programmers for local businesses and organizations. While none had experience in developing a high-growth venture, they all had successful small business and IT project management experience. The lead entrepreneur drove the vision, found the funding, and became President.

Information technology projects are notorious for coming in late, over budget, and without the desired functionality (Standish Group, 2003). However, Ardesic did not flounder here. Development of the beta product proceeded fairly smoothly. As the beta product neared availability for customer consideration, the company emphasis shifted from product development to a mix of development plus marketing. With the President's strengths in technology, a CEO was hired in March 2000 to manage marketing of the product.

Experiencing increasing marketing difficulty, a new CEO came on board in April 2001. One of his first actions changed the culture and processes of Ardesic. Approximately one-third of the development and programming staff were replaced, and two of the original three founders left. Developing the new PRM product required a critical mass of experienced developers. Consequently, a group of mature computer science graduates, already experienced in developing enterprise software products, was hired to spearhead this effort. In contrast, the previous development group comprised many more college and anecdotally educated "heroic young programmers."

Ultimately, the VCs made the windup decision. Given the risk and cost of developing a comprehensive PRM product suite for an unresponsive and unproven market, it was safer to walk away from sunk costs and save remaining funds.

SUCCESS/FAILURE FACTORS

Ardesic placed a bad bet on a prospective market, but did so at a time when the bet seemed reasonable and funding was easily accessible. Their start-up timing was fortuitous, as venture funding more than quadrupled during 1999 (PricewaterhouseCoopers, 2004) from earlier years. Over a period of two years, from Ardesic's initial funding, it became evident the expected market did not exist. Concurrently, venture funding dropped back to pre dot-com boom levels.

The venture team, while strong on the technical side, was weak on the business side. This was recognized from the start, and resources (experienced business growth people) were added to the firm as it transitioned through the concept and start-up stages. While certain resources could have been brought in a little earlier, it would not have changed the final outcome.

VCs played an important role, providing much more than just financing. They supported the venture team through the initial product development stage, arranged first-round financing, and then brought in successive CEOs—the first to push marketing, and the second to make a final turnaround effort. Neither CEO succeeded. While Ardesic failed, losses were kept to an acceptable minimum.

LESSONS LEARNED

Several generalizable lessons are brought out by this case, relating to the risks of technology start-ups, development of viable business models, and the role of venture capitalists.

Ardesic started with two of the necessary three foundations (a team and a product concept), added the third (financing), and then worked on refining their business model. Using a "rifle" approach, the company developed a single product for a specific market. When it became evident this potential market did not exist, the firm shut down. The trade-off here is between focusing resources on a single high-risk goal vs. spreading resources around and pursuing several targets. Most new ventures do not have the luxury of taking the latter approach, and the result is a higher failure rate.

This case also illustrates venture stages and business model development. Ardesic started at the concept stage and did not get beyond start-up. A critical component of a viable business model is the ability to generate revenue, and Ardesic's eMarketMinder could not do this. Yet, it was only through development of the beta product that the market potential could be properly tested. Conceptually, their product looked attractive, and experts such as Forrester Research expected the marketplace to move to such products. Clearly, even experts can be wrong, and the marketplace changes over time.

Feedback received during product development and beta testing was invaluable in refining the business model—developing a fuller understanding of the market (whether or not it exists, and in what form; what it values, what additional products/services are needed to provide a "full product", and how much it will pay for the product/service), clarifying the value proposition for the potential customer, and ultimately proving the firm's competitive strategy. In Ardesic's case, this feedback disproved their business model.

Venture teams with good ideas can attract the necessary financing. Venture capitalists are willing to risk money, on the basis of anticipated returns. This willingness will continue through various rounds of financing, providing the venture is able to execute its business plan and refine its business model. Venture financing is usually obtained on an iterative basis of "rounds" (successive stages of funding) and "tranches" (a funding milestone, whereupon funds are advanced; it is rare for a deal amount to be paid as one lump sum). Proven success in moving forward with the business model leads to additional financing, which in turn allows further refinement. When progress is slow, the next financing round may value the venture less (a "down round"). When progress supports the business model, an 'up round' is more likely. Ardesic followed this usual model, first obtaining seed capital and then (on the basis of their beta product) first-round financing. This was an 'up round' for the backers. However, Ardesic did not get to second-round financing. By the time they determined a viable marketplace did not exist, the venture capital market had turned and backers chose not to support further development of an alternate product for a market that no longer was attractive.

Sometimes new ventures start without a written business plan (the "learn by doing" approach advocated by Gumpert (2003)). Kanter (2001) shows that dot-coms can be categorized in terms of style and substance. The former focuses on personality and style of the founder(s), and their ventures tend to follow an evolutionary path. In contrast, the latter focus on execution of a clear business model, with strong attention to the 'bottom line'. Ardesic was in this latter class. From a financing perspective, venture capitalists want this group. Firms of the first type must find other financing methods (such as bootstrapping or angels).

There are both benefits and costs in dealing with venture capitalists. Besides financing, they can add value-added services. Developing a successful high-tech venture is difficult, and firms need all the support available. Investors who can add significant value to the firm's development, beyond their financial investment, are one of the keys to success. Methods of adding value include identifying key management members to round out the team (especially as the firm grows), linking the firm with support organizations (lawyers, accountants) and potential suppliers and/or customers, and assisting with future rounds of financing (including government grants). VCs also extract a price, in terms of control and a significant share of any realized profits. With Ardesic, two of the three founding team members left during the start-up phase, as market problems became evident. There were no profits to share.

The dot-com boom was an exciting time to launch a venture. Financing was readily available, and the press reported on a seeming multitude of dot-com millionaires. Many in the industry felt that business rules had changed and a new era had started. The dot-com bust brought these people back to reality. As Rayport (1999) states, "In the end an e-business is just another business." Porter (2001), in response to the question of whether or not the Internet renders established rules of strategy obsolete (as some proposed), answers that it makes strategy more vital than ever. He concludes, "In our quest to see how the Internet is different, we have failed to see how the Internet is the same."

A final lesson is that venture failure is seldom fatal—future opportunities usually arise. The lead entrepreneur with Ardesic quickly found another opportunity and started a new venture.

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KEY TERMS

Angel Investor: An affluent person who provides start-up capital for a new venture in exchange for partial ownership; typically does not pool money as does a venture capital fund, but sometimes is part of a network or group which shares information and investments.

Burn Rate: Rate at which a new venture is using up its capital.

Out-of-Cash Time: Length of time a new venture will take to use up its current funding; usually stated in months.

Seed Financing: Initial financing for a start-up venture; used for proof-of-concept, market research, and/or initial product/service development.

Traction: Successfully putting a business model into operation, proving its viability

Venture Deal: Statement of what entrepreneurs are giving up and what the new venture is receiving in return; covers financing amount(s), method and timing of release(s), terms and conditions, equity given up, etc.; usually starts with a 'term sheet'.

Whole product/service: Direct product/service provided by a firm, augmented by everything else required by customers (installation, training, support, integration, etc.).

Development and Deployment of Web Services

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INTRODUCTION

A Web service is an interface that describes a collection of operations that are network accessible through standardized XML (extensible markup language) messaging specifications such as SOAP, WSDL (Web service description language), and UDDI to provide open, XML-based mechanisms for application interoperability, service description, and service discovery (Kim & Jain, 2005). They are self-contained, modular units of application logic that provide business functionality to other applications via an Internet connection (Srivastava & Koehler, 2003). Although Web services are a relatively new concept, they provide a solution to the set of serious problems that have plagued enterprise systems using a service-oriented architecture (SOA). Web services address a similar set of problems that middleware technologies such as CORBA, RPC, COM, and RMI address by providing a tightly coupled and vendor-driven proprietary environment for implementing SOA.

BACKGROUND

Web services are based on open standards and are designed to promote loosely coupled interactions between service providers and consumers to provide an interoperable environment (Gisolfi, 2001b). Loosely coupled Web services provide modularity and flexibility in complex, distributed IT environments (Kreger, 2003), emerging as a catalyst for SOA. A service is a unit of work such as a business function, a business transaction, or a system service (Channabasavaiah, Holley, & Tuggle, 2003) completed by a service provider to achieve desired end results for a service consumer. A well-designed SOA is therefore likely to be comprised of a relatively large number of modular, focused Web services that can be swapped in and out as needed to respond to changing needs.

Organizations can exploit Web services to enhance their ability to (a) respond quickly and reliably to special requests from customers and suppliers, (b) improve the agility of business processes to respond to various situations and changes in the marketplace, and (c) automate and integrate business processes across organizational boundaries (Seybold, 2002). As various standards related to Web services become mature, Web services are becoming basic building blocks of the service-oriented architecture from which new applications can be composed. For this vision to realize its full potential, several issues need to be addressed. The range of these issues includes quality of service (QoS; performance, availability, security, etc.), semantic matchmaking, and the development of services-based applications.

This article is organized as follows. In the next section, we discuss in depth these various issues. We categorize them in three groups: Web services matchmaking, Web services quality of service, and the development of services-based applications. In the final section, we present the implications of these issues for dynamic e-businesses and provide concluding remarks.

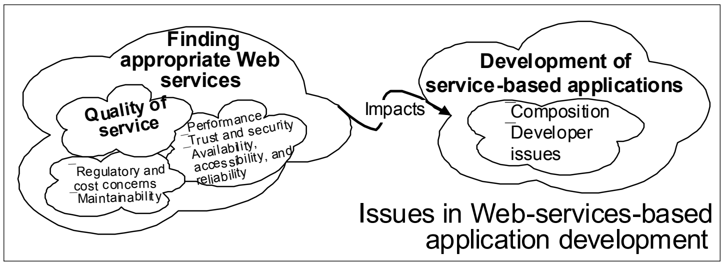
ISSUES IN THE DEVELOPMENT AND DEPLOYMENT OF WEB SERVICES

In this section, we present a discussion on a diverse set of technical, social, and regulatory issues faced by organizations that intend to deploy Web services. Figure 1 depicts these various issues in service-based application development efforts.

Matchmaking of Web Services Capabilities

The huge number of Web services already available on the Internet makes it almost impractical, if not impossible, for a human being to analyze and combine them efficiently (Matskin & Rao, 2002). One of the major tasks when using Web services for today's service-oriented business application development is their discovery and the degree of match between the tasks that a service can accomplish and the requirements of the consumer. This requires the capability to match Web service descriptions with the service requirements.

Figure 1. Issues in Web services-based application development for dynamic e-business



Matchmaking is a process by which parties that are interested in having an exchange of economic value are put in contact with potential counterparts. It is carried out by matching together the features required by one party with those provided by another. A common problem in this process is that different Web services may use the same name or term with different meanings. The challenge is then to mediate between these different contexts (Hansen, Madnick, & Siegel, 2002) and to select a Web service that provides accurate, complete, consistent, and correct functionality. Since Web services exist in an open environment, semantic matching is more natural (Matskin & Rao, 2002). By semantically enhancing the functional description of the Web service, more accuracy in service discovery can be achieved. This matchmaking process should ideally support the following: (a) functional matching, (b) input and output interface matching, and (c) matching the order of the subtasks' execution as it can potentially affect the QoS expectations such as compliance with requirements to follow a specific process.

Quality-of-Service Issues for Web Services

As businesses continue to assess the viability of Web services for enterprise-strength applications with their growing recognition and proliferation, a major issue is maintaining adequate levels of QoS. QoS, an important complement to the operational description of work flows supported by Web services, describes nonfunctional properties of a work flow (Cardoso, Sheth, & Miller, 2002). Delivering QoS on the Internet is a critical and significant challenge because it is dynamic and unpredictable in nature while applications with very different characteristics and requirements compete for scarce network resources. Changes in traffic patterns, denial-of-service attacks, infrastructure failures, low performance of Web protocols, and security issues over the Internet create a need for Internet QoS standards (Mani & Nagarajan, 2002) for Web services. The management of QoS directly impacts the success of organizations participating in e-commerce activities enabled by Web services. QoS issues should be assessed from the perspective of the providers as well the users of Web services. It is important to have some mechanisms for monitoring Web services and their deployment environment in real time to ensure their auditability (Seybold, 2002).

Performance

The performance of Web services is measured in terms of throughput and latency. Higher throughput and lower latency values represent good performance of a Web service (Mani & Nagarajan, 2002). One component affecting performance is the task time or the time taken to transform inputs into outputs. Other factors affecting performance include accessibility, availability, and reliability. When composing applications from Web services, care must be taken regarding the possibility that a Web service may time out (Myerson, 2002). In other words, the response time of a Web service will affect the performance of an application. This will involve making careful choices about when to use asynchronous vs. synchronous processing.

Maintainability

Sheth, Cardoso, Miller, and Kochut (2002) highlight the importance of taking into consideration the time taken to maintain a Web service when failures or changes take place (also known as the time taken to repair ;Mani & Nagarajan, 2002). A related concern is versioning (Myerson, 2002), that is, how new builds will affect the functionality of the existing Web services and applications that rely on them. Also, another issue is the ability to consistently serve the service consumers' requests despite variations in the volume of requests.

Trust and Security

Organizations that consume and provide Web services need to be in a relationship strong enough to warrant investing in understanding each others' processing systems (Seybold, 2002). Therefore, the first wave of Web services implementation is likely to occur between trusted trading partners. Providing confidentiality and nonrepudiation by authenticating the parties involved, encrypting messages, and providing access control (Clabby, 2002; Menascé, 2002; Myerson, 2002) will affect an organization's confidence in Web services for critical applications. A related concern is task fidelity, which reflects how well a product is being produced and how well a service is being rendered (Cardoso et al., 2002).

Availability, Accessibility, and Reliability

Availability represents whether or not a Web service is present and/or ready for immediate use. Accessibility represents the degree to which a Web service is capable of serving and is typically expressed as the probability of successful service instantiation at a point in time. Finally, reliability represents the ability to maintain the service and service quality (Mani & Nagarajan, 2002). It is possible that a Web service is available but not accessible at a given point in time. The accessibility of Web services can be improved by developing highly scalable systems.

Regulatory and Cost Concerns

Since Web services can be accessed from anywhere on the Web, they need not be located within the user organization. This raises the issues of the degree of compliance with rules, laws, and regulation, and the degree of compliance with standards and established service-level agreements (Mani & Nagarajan, 2002). Service providers and consumers need to provide mechanisms to enact and ensure compliance.

Another issue is the cost of services provided and consumed. Cardoso et al. (2002) break down the cost into two components: the enactment cost (EC) and the realization cost (RC). The enactment cost is associated with the management of the Web services and the monitoring of their execution. The realization cost is the cost associated with the run-time execution of the task, which is further broken down into direct labor cost, machine cost, direct material cost, and setup cost.

Development of Service-Oriented Applications

This section focuses on the issues related to the composition of Web services and the issues faced by the developers of service-oriented applications.

Composition of Web Services

While the functionality provided by Web services can be consumed as independent operations, Piccinelli and Mokrushin (2001) suggest that the realization of the full potential of Web services depends on the ability in two critical areas: composition and interaction orchestration. Composing Web services into complex service-oriented business applications will become increasingly crucial for organizations that use this technology to become more agile and responsive. The platform-neutral nature of Web services creates the opportunity for building composite Web services using existing elementary or complex services (Yang & Papazoglou, 2002). When composing applications, various constraints need to be addressed. First, it is necessary to ensure the interoperability of the Web services. The output of one Web service should be compatible with the input requirements of the Web service that consumes these outputs. In other words, one needs to ensure the compatibility of the service-oriented application and that there exists no conflict of interest (CIR; Hung, 2004) when Web services interact with and delegate tasks to other Web services. Delegation will be a common scenario, especially when activities are decomposed into many subactivities that are executed by multiple Web services.

There has been growing interest in how composition can be accomplished, leading to various standards such as WSDL, the business process execution language (BPEL) developed by IBM in conjunction with other industry giants, and DAML (DARPA agent markup language) Services (developed under the DAML program). While BPEL offers the definition of business protocols and supports fault handling and compensation, it does not address conformance and quality-of-service issues (Milanovic & Malek, 2004). Additionally, using BPEL alone, the properties of composition cannot be verified. Aral (2004) and McIlraith, Son, and Zeng (2001) suggest that for many of the automated reasoning tasks envisioned by semantic Web services, BPEL may not be sufficient. Although the ontology Web language for services (OWL-S) provides semantics allowing for reasoning about a service and takes an important step toward the ultimate goal of dynamic service discovery and usage, it is still not mature for use in describing Web services. Sabou, Richards, and Spluter (2003), based on their experiences in using DAML-S, suggest that DAML-S is difficult to learn and has an imprecise underlying conceptual model leading to multiple modeling possibilities and parametric polymorphism. Zeng, Benatallah, and Dumas (2003) suggest that the selection of component Web services during composition should be carried out during the execution of a composite service rather than at the design time. They consider multiple criteria such as price, duration, and reliability, and also take into account global constraints and preferences such as budget limitations. These above approaches assume the presence of predefined steps of various tasks and activities, and can work as long as the existing composition is unchanged. However, the existing composition may need to change for a variety of reasons. Kim and Jain (2005) present a task and business rules dependency-based approach to handling such composition efforts.

Since there may be various ways in which a given service-oriented application may be composed, one needs to select the composition that also exhibits a higher degree of QoS from its designers' perspective. In addition to various criteria mentioned earlier, it may also be necessary to identify a new set of QoS criteria to evaluate the goodness of such composed applications. For example, how flexible is the resulting composition and how easy is it to swap out one Web service with another one? It may also be interesting to keep a close eye on the total number of Web services as it may ultimately affect the performance and reliability of the service-oriented business application.

Developer Issues

The primary difficulty in creating Web services and applications with a service-oriented architecture is getting developers and architects to think about loose coupling and asynchrony (Seybold, 2002). The transactions that client-server developers are accustomed to building typically take place in tightly coupled and synchronous systems. Thus, developers will need to be well trained to use Web services to fully exploit the capabilities of a service-oriented architecture.

Based on the discussion presented in the preceding sections, Table 1 lists the various issues that an organization involved in creating and using Web services needs to address for their successful implementation. In the next section, we briefly discuss the implications of these issues for dynamic e-businesses and provide concluding remarks.

FUTURE TRENDS

The growing importance of Web services and a service-oriented architecture will change business application-

Table 1. List of issues in each of the three areas of Web services development

Area	Issue
Matchmaking	❑ Does the service provider support semantic matchmaking? ❑ Is a common vocabulary used in service descriptions? ❑ What should be the precision of matching?
Quality of Service	❑ Who will monitor and keep track of the quality-of-service parameters provided by various Web services? ❑ How should the cost of the overall composition be obtained? How will problems faced when the overall composition fails due to the noncompliance of one Web service be handled? ❑ Which QoS parameters should be taken into account, or how should they be combined to find appropriate Web services? ❑ Will there be one central repository? Will it be broadcast, or will it be part of the Web services description? ❑ How often will such QoS information on availability, reliability, and accessibility be updated and made available to the service requesters? ❑ If the overall QoS changes, how will it affect the application performance while the composition is executing? ❑ What are the implications when the service provider upgrades the version of the service that is currently being used by various applications? Will the service provider need to maintain different versions?
Development of Service-Based Applications	❑ What criteria should be used for composition? Should these criteria be context specific? ❑ How stable will the given Web services composition be in terms of the quality of service of the overall composition? ❑ How often does one need to change the composition, and when changes do occur, what are the things that one needs to keep record of? ❑ What support mechanisms and/or tools will the developers need to handle the dynamic composition of Web services? ❑ Will making available the knowledge embedded in past compositions make the development task any easier?

integration strategies affecting e-business dynamics. Gisolfi (2001a) defines dynamic e-business as the next generation of e-business focusing on the integration and infrastructure complexities of B2B (business-to-business) transactions by leveraging the benefits of Internet standards and a common infrastructure to produce optimal efficiencies for intra- and interenterprise computing. The benefits of adopting Web services over traditional business-to-business applications include faster time to production, the convergence of disparate business functionalities, a significant reduction in the total cost of development, and the ease with which business applications for trading and the supply chain can be created (Hung, 2004). This has the potential to improve the agility of various business processes within and across organizational boundaries by providing the ability to respond to a wide range of internal and external events.

CONCLUSION

Despite these potential opportunities presented by service-oriented technologies, organizations face a diverse set of issues as presented earlier. Without a carefully thought-out plan for development and deployment to address these issues, service-based applications may not attain their full potential. In summary, we identify various issues, listed in Table 1, that need to be addressed to practically realize the vision of dynamic e-business by any organization involved in the development and deployment of Web services.

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KEY TERMS

DAML (DARPA Agent Markup Language): DAML is an extension of XML and the resource description framework (RDF) providing constructs with which to create ontologies and to mark up information so that it is machine readable and understandable.

Dynamic E-Business: The next generation of e-business focusing on the integration and infrastructure complexities of B2B by leveraging the benefits of Internet standards and a common infrastructure to produce optimal efficiencies for intra- and interenterprise computing.

Matchmaking: Web service matchmaking is a process by which the parties that are interested in having an exchange of economic value are put in contact with potential counterparts by matching together the features required by one party and provided by another.

Quality of Service (QoS): QoS is a set of service requirements that the provider must meet in order to guarantee an adequate level of service provision.

Service-Oriented Architecture (SOA): A service-oriented architecture allows the designing of software systems that provide services to other applications through published and discoverable interfaces, and in which the services can be invoked over a network.

Web Services Composition: Web services provided by various organizations are interconnected so that they interact with each other in a way to realize some important business functionality.

WSDL (Web Services Description Language): WSDL provides a model and an XML format for describing Web services. It enables one to separate the description of the abstract functionality offered by a service from concrete details of the service description such as how and where that functionality is offered.

Digital Government Development

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INTRODUCTION

Effective implementation of digital government requires a well-articulated and sound strategy. Having a sound strategy is considered as the first and most important step in securing the success of information technology projects (Fletcher, 1999). Unfortunately, failures in the form of cost overruns, delays, and implementation problems are commonplace in digital government projects (Heeks, 1999). If executed properly, a strategic plan can help public organizations realize the full potential of an information technology investment. The framework proposed in this article attempts to identify the factors behind the successful design and development of a national digital government strategy, taking a normative perspective of policy and institutional design with emphasis on informing policymakers. A national strategy is the critical first step in building digital government. National digital government strategies, such as UK Online, e-Japan, and e-Korea, are commonplace.

Critical success factors have been identified in other research which examines individual IT projects at both state and local levels (Heeks, 1999; Dawes et al., 1997). Since national strategic plans provide the framework in which most digital government projects are prioritized, designed, and implemented, it is important to study these large-scale plans. However, there is a shortage of research-based frameworks for guiding the development of a national strategy. The comprehensive framework proposed in this article with a short illustration of application to a cross-country comparison offers policymakers a number of suggestions for developing sound national digital government strategies.[1]

BACKGROUND

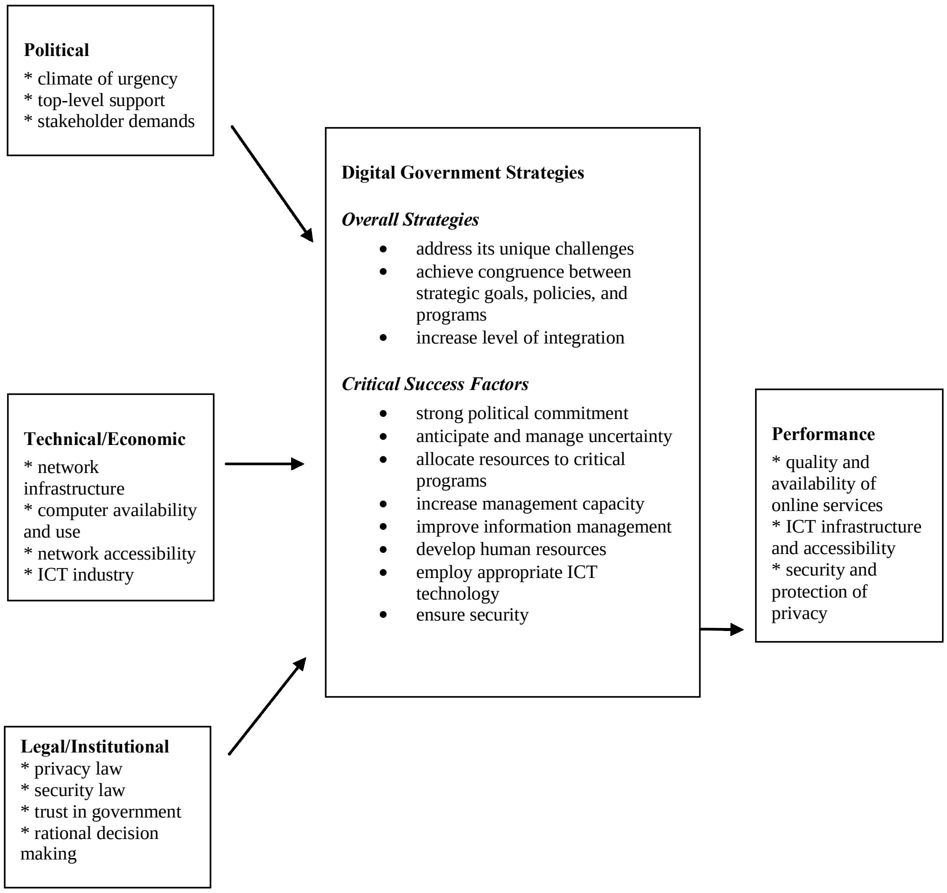
Digital government refers to the use of information and communication technology to improve the relations between government and its employees, citizens, businesses, nonprofit partners, and other agencies by enhancing access to and delivery of government information and services.[2] Digital government strategic plans are national plans designed to guide the development of a country's efforts to deliver information and services via digital means.

To gain a better understanding of the development of digital government strategies, it is important to look at the environmental conditions under which the strategy is developed and implemented. Political forces and institutional settings play a significant role in national digital government efforts. Digital government plans and projects need to be attentive to political considerations and governmental processes at all levels of government (Rocheleau, 2003). Moreover, legal and institutional incentives and constraints shape the design and use of information technology in the public sector (Fountain, 2001; Landsbergen & Wolken, 2001). Strong administrative and legal institutions support the creation of national digital government plans, guide their design and implementation, and provide mechanisms for measuring performance as well as addressing the physical environment (Ostrom, 1990; Farris & Tang, 1993). Institutions shape not only the selection of digital government projects, but also their design and implementation (Fountain, 2001). The link between institutions as an incentive structure and performance is another important insight (Ostrom, 1990; Ostrom, Schroeder, & Wynne, 1993). Institutional incentives are critical for soliciting cooperation from individual public employees and agencies as a whole to share information and resources.

Citizens and their participation also constitute an important environmental element of digital government (Marchionini, Samet, & Brandt, 2003; UN/ASPA, 2002; Schedler & Scharf, 2001). When an active civil society and a well-established information and communication infrastructure is in place, an e-government strategy that is more responsive to citizen needs is more likely to be implemented.

In addition to the environmental factors mentioned above, a national digital government plan needs to consider several unique characteristics of government. First, every government has multiple objectives, usually in competition with each other. Second, the planning horizon needs to correspond with election cycles, so the

Figure 1. A framework for the development of a national digital government strategy



planning horizon is shorter than the one used by the private sector (Guy, 2000). Lastly, stakeholders' involvement is regarded as critical for the successful implementation of an information system strategic plan.

A FRAMEWORK FOR DEVELOPING DIGITAL GOVERNMENT STRATEGIES

The framework described in Figure 1 is organized into digital government strategies (center) in response to environmental conditions (left) to generate performance results (right). Digital government strategies describe the contents of a given plan for national development. Environmental conditions are circumstances surrounding a plan for national development that have an impact on success or failure. Performance results describe the outcomes produced by the digital government development plan.

Four principles govern the development of the framework. First, a good strategic plan addresses the unique challenges posed by the environmental circumstances facing a national digital government effort. Second, there is a set of principles and success factors which will increase the likelihood of success. Third, the framework acknowledges the evolutionary nature of digital government efforts, in which strategies adapt to and affect the environment in which they are designed and executed. Lastly, performance measurement of digital government is necessary to trace the effect of strategies on outcomes.

Environmental Factors

Political Considerations

Three political drivers, as shown in the top left box of Figure 1, set the stage for the development of a national digital government strategy. External pressures, such as preconditions for membership in an international organization or for external assistance, may cause impetus for the drafting of a national plan. Another driver for a national digital government plan is the administration's policy agenda. Administrators may view digital government as a means to revitalize public services (Snellen, 2000) or increase competitiveness. A country's national legislature and executive branch might provide the support for a digital government plan, making the plan subject to the election cycle.

Stakeholder demand is another driver for digital government (Kamarck & Nye, 2002). Citizens, accustomed to the convenience and efficiency accompanied by e-commerce, demand the same efficiency and convenience of government. Businesses may speed up the adoption of digital government by offering better interoperability, and governments may feel internal pressure from staff and managers. Client demand also involves both electronic voting and civic participation in the government decision-making process, also known as electronic governance. This is an important area of development for a digital government plan to pay attention to (Marchionini et al., 2003). From a management perspective, electronic democracy should be integrated into the core mission of digital government. The extent to which civic participation may shape a national digital government plan in this way depends on the power of democratic institutions in shaping public policy.

Technical/Economic Conditions

Several technical/economic conditions, as shown in Figure 1, are relevant for the design and formulation of a national digital government strategy. National information and communication technology infrastructure is the first critical element for assessment. In particular, the UN/ASPA (2002) report has pointed out the importance of network availability, an important indicator of an infrastructure's maturity.

Second, computer availability and use determines whether the information and communication infrastructure is utilized. Accessibility to e-government services depends on the information and communication infrastructure of a country (UN/ASPA, 2002), which varies greatly around the world. For example, in the United States, more than half of the population has a computer, whereas in Brazil less than 5% of the population has one (UN/ASPA, 2002).

Third, the distribution of use and accessibility among various groups also shapes national digital government strategies. Digital divide is usually the term used to capture this issue. Lastly, the existence of a viable domestic IT industry is beneficial to the design and implementation of a national digital government strategy, providing a positive spillover effect on the affordability of computers, the establishment of an information and communication network, and the viability of building e-commerce applications for government use.

Legal and Institutional Issues

Two prominent legal and institutional issues pertaining to digital government are privacy and security (see Figure 1). These two issues have been identified as important by various levels of U.S. government (ICMA, 2000, 2002; GAO, 2001). The European Union (EU) has also developed Directive 2002/58/EC on Data Protection and Privacy (EU, 2002) to specify policies for the protection of individual data. Privacy laws govern the use and distribution of information by government and businesses. Security is a major concern when government information systems store vital information about individuals and government units. A national digital government strategy needs to address both privacy and security to win the trust and willingness of citizens and businesses to submit personal information and conduct transactions online, passing relevant laws and regulations where needed.

As a governmental effort, digital government also relies on the institutional capacity of government to be efficient and rational. If such capacity does not exist, a national digital government strategy needs to make this a high priority and incorporate it into its plan.

Digital Government Strategies

Digital government strategies have two components (see Figure 1). The first component is overall strategies that a country should follow to address its unique environmental challenges. Having a congruent strategic plan and striving for a high level of integration of electronic services are two additional indicators of a sound strategic plan. The second component includes critical factors for the success of a national digital government strategy. These factors include strong political support, management of uncertainties, allocation of resources, development of management capacity, the use and quality of managed information, the development of human resources, utilization of an appropriate level of technology, and the protection of privacy and security.

Overall Strategies

A successful digital government strategy needs to have the following three characteristics. First, the strategy needs to address its unique environmental conditions, focusing priorities on areas which are the foundation for further development, such as infrastructure. Second, strategic goals, policies, and programs should be congruent with one another. Internal consistency between goals, policies, and program as three integral components of a strategic plan are the preconditions for successful implementation. Congruence can be seen when policies and programs support the outlined strategic goals. Thirdly, the integration of government networks and infrastructure is the foundation for seamless e-government services, which usually involves a common platform for all government services and protocol for information and resource sharing. This is also a sign of maturity in the development of digital government (Layne & Kim, 2001).

Critical Success Factors

In order for a digital government plan to be successful, it requires firm political support. A good strategic plan addresses the constraints of political authority, mobilizing support for digital government, particularly high-level support. In addition, it reflects citizen demands and other political considerations. Another critical success factor of a national strategic plan is the anticipation and management of political and technological uncertainties.

A strategic plan needs to identify and anticipate political uncertainties caused by turnover of officials and rapid changes in policy. Another source of uncertainty is the rapid pace of technological development. Moreover, a strategic plan needs to allocate necessary resources to critical programs. A strategic plan also needs to address the recruiting and training of IT staff for critical programs. The building of human infrastructure for the use of information technology is as critical as building the physical one. The International City/County Management Association has conducted two e-government surveys of local government and each time has ranked the lack of IT personnel as the number two barrier to e-government (ICMA, 2000, 2002).

Quality and security of government information resources is at the center of any successful national digital government strategic plan. The management of government information resources has been discussed as a critical component for a national digital government plan (Fletcher, 2003). Government information is the underlying content base on which information and transaction services are created. The protection of privacy and security is critical for winning citizens' trust in government and for them to conduct transactions online (Edmiston, 2003).

Rational decision-making and implementation capacity are central to a national strategic plan, as various studies of e-government projects around the world have suggested (Heeks, 1999). This institutional capacity affects both the design and implementation of a digital government plan. With this capacity, a national government is able to identify what is lacking in its political, economic/technical, and institutional conditions, and develop a plan to address those gaps.

Performance

The performance of digital government has multiple dimensions (see Figure 1). The main indicators include the availability and quality of online services, the maturity of national information and communication infrastructure, online service accessibility to diverse groups of citizens and businesses, and finally security and protection of privacy. The availability of online services can be measured by the number of government information and services online, and the extent to which these online services are meeting citizens' needs. A developed national information and communication infrastructure will help improve efficiency and access of digital government services. Examples include establishing national communication infrastructure for all public agencies and providing free Internet access at public offices even at remote locations to serve disadvantageous groups. Moreover, a high-performing digital government also needs to win trust from citizens whose personal and confidential information is in the government's possession. Rigorous security measures and privacy policies are essential to accomplish that.

Application of the Framework

In order to demonstrate the utility of the framework for making determinations about national digital government plans, the authors made an in-depth comparison of the plans of Poland and Taiwan (Chen & Knepper, 2005), two countries with different levels of digital government development, making their experience applicable to a range of different situations. Taiwan was ranked as number one in a 2004 report comparing digital government performance in countries around the world, while Poland ranked 46th out of 198 (West, 2004). When the framework was applied to each government's e-government plan, although the difference between the two countries was clear, they also shared some common challenges.

In overall strategies, Poland was found to be slightly behind Taiwan in meeting external challenges. Taiwan's plan has benefited from a strong ICT infrastructure, and some goals have been met ahead of schedule. Poland's goals may be too high to reach in the short time allotted. Both the Taiwanese and Polish plans lack an ability to scan changes in the external environment for external changes. In the area of congruence between goals, policy, and programs, both countries score well. Moving on to integration issues, both countries scored similarly. Turning to the critical success factors laid out in the framework, Taiwan scored better than Poland in several areas, although both countries share some common problems. Poland and Taiwan both had weaknesses in uncertainty management, well-trained staff, and security. Poland was also victim to problems with funding, technology, and information management.

Judging from the areas examined in the framework, Taiwan appears to be in a much stronger position overall. The global e-government performance ranking by West (2004) confirms this. Although these countries appear far apart along the curve of digital government development, both have strengths in the area of information management, management capacity, security, and the use of technology. Both plans are faced with problems with risk management, training, and security. By identifying problem areas that are common to many digital government efforts, public managers can look for solutions that are applicable in a variety of cases.

FUTURE TRENDS

Privacy and security concerns will continue to be an important part of digital government plans for the foreseeable future. As a result, a successful national digital government strategy must address privacy and security on both wired and wireless networks. Another security measure is the implementation of a "quality seal" by which users verify official information and services. A comprehensive digital government strategy should also deal with the legal and institutional issues that surround security and privacy directives required by governing bodies.

Client-oriented design, in which citizens and businesses have information and services tailored to their needs, will become more prevalent. Client-oriented design should guide the development of digital government strategies. To be more client-centric, a successful digital government strategy can follow guidelines in the proposed framework, such as increasing the level of service integration. Multilingual populations, at various levels of ability and computer literacy, require "design-for-all" (Aichholzer, 2004). The increasing variety of platforms by which citizens interact with government will require multichannel delivery, so that citizens can make use of services via computer, in person, by telephone, cell phone, and PDA. Digital government strategies must decide on a particular mix of services which best fits their citizens' needs and the available resources.

Electronic governance is becoming more integral to a comprehensive digital government strategy. One of the first main issues for electronic governance to address is digital divide. This requires a national strategy that focuses on building ICT infrastructure issues and developing human resources. Electronic governance in the form of e-voting, e-rulemaking, and e-consultation opens up ways for government to engage citizens in making public policy decisions (Macintosh & Coleman, 2003). This holds the potential for government to be truly citizen-centric in setting policy priorities and providing needed information and services.

CONCLUSION

The framework for digital government strategy outlined in this article serves as a tool to guide the development and evaluation of national strategic digital government plans. The framework describes environmental concerns which affect every digital government plan. The critical factors listed in the framework provide guidance for drafters and implementers of digital government plans. If these factors are not addressed, the results of the process may not be satisfactory. A number of conditions must be right for a strategy to be implemented successfully. A strategy must scan its situation and address areas that are particularly needed. Finally, the individual components of a digital government strategy should be complementary.

As a tool for making judgments about national strategic digital government plans, the framework can be used as a means for either comparing two different plans or finding gaps in a plan that might weaken its prospects for achieving all of its goals. The framework may be useful in pointing out missing areas not covered by a plan. As the future trends mentioned above take place, the framework's focus on underlying elements and uncertainty management allows plan drafters to create plans that are responsive and flexible in the face of technological change. The framework's emphasis on privacy and security, as well as issues of access, focus on areas that will become increasingly important, allowing the framework to remain relevant despite a rapid rate of change.

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KEY TERMS

Client-Centered Transaction Environment: A service portal with available services that cross agency boundaries organized by their relevance to a client's situation. For citizens, these may be organized by "life events" such as marrying, employment, or health care.

"Design-for-All" Principle: Design principle in which services are able to be used by all members of society. This includes multilingual and services for the disabled.

Digital Government: The use of information and communications technology to improve the relations between government and its employees, citizens, businesses, non-profit partners, and other agencies by enhancing access to and delivery of government information and services.

Electronic Governance: The use of information and communication technologies to make public policy decisions. Examples include electronic voting to elect public officials (e-voting), electronic commenting on regulatory rules (e-rulemaking), and deliberating on public policy issues (deliberative e-democracy).

Multi-Channel Delivery: Provision of the same or similar services on different platforms, such as computer, PDA, mobile phone, and in person.

National Digital Government Strategy: A plan for digital government development at the national level, which may include infrastructure, training, security and privacy, digital divide, service provision, access, and publication initiatives. Examples include UK Online, e-Japan, and e-Korea.

Quality Seal: A virtual seal placed on a government Web site or form which allows citizens to know that the item in question is legitimate and not a "phishing" site designed to gather information for use in identity theft.

ENDNOTE

[1] Due to space limitations, the framework is described here in brief. A more complete illustration of the framework, including the full findings of the cross-country comparison, can be found in Chen and Knepper (2005).

[2] This definition is adopted from the General Accounting Office's (2001) report on e-government.

Category: Concepts, Trends and Challenges

Digital Rights Management for E-Content and E-Technologies

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INTRODUCTION

Digital rights management (DRM) provides digital content creators and owners with a range of controls over how their information resources may be used. It is a fairly young discipline yet is becoming increasingly important as digital content can be copied and distributed so easily that the piracy of them is growing critical. In addition, with the rapid adoption of the Internet as an e-content delivery channel, complex DRM systems are required to protect the digital content besides the distribution channel. Risking their intellectual property (IP) rights, many major e-content providers are relying on DRM to not only protect the packaged digital products, but also to promote the e-content market over the Internet.

As a multidisciplinary technology, DRM has advanced innovative research and development in various fields such as biometrics, watermarking, security protocols, smart-card technology, forgery detection, and secure collaboration and data sharing. Commercially, DRM provides the e-content market with a significant impetus to grow, where secure e-content distribution is essential. Despite its short history, many DRM tools have already been developed by IBM, Sony, Real Networks, Intertrust, and Thomson. These products need be compatible with existing standards for contents, consumer electronics, and often times, different DRM systems. Standardization efforts in industry are ongoing to ensure the interoperability of DRM products and services.

Another important impetus is the legal and regulatory framework. Technical measures provide an effective hurdle for limiting abuse, but legal actions against violators can prevent organized piracy from infringing. With a properly integrated legal, technological, and commercial framework, we expect that the DRM products and services will greatly foster the growth of the e-content market that is eagerly awaited by content providers and consumers. Without proper DRM technologies and laws, the creative industries that create digital products such as DVDs, business software, music recordings, theatrical films, and digital TV programs will suffer from piracy and would be reluctant to support Web-based commerce. The socio-economic impact of DRM is huge.

In this article, DRM techniques using cryptography, data hiding, and biometrics are discussed. Also covered are the standardization issues, emerging trends, and challenges in DRM-related technologies, commerce, and legislative regulations.

BACKGROUND

The beginning of DRM systems was in 1996 when the launch of the DVD raised copy protection concerns from the motion picture industry. The Copy Protection Technical Working Group (CPTWG) was created to address the copyright issues. CPTWG generated a series of commercial solutions, including the following.

- The content scrambling system (CSS) for DVDs in 1996
- Digital transmission content protection (DTCP) for securing compressed content across the IEEE 1394 interface in 1998
- High-bandwidth digital content protection (HDCP) for securing uncompressed content across the DVI (DVI, 1998) in 1999

Nowadays, e-technology providers, including IT and consumer electronics (CE) industries, produce DRM systems with respect to various e-business models. The interest in DRM comes from not only the copy protection of mass-distributed digital content like CDs and broadcast, but also from the promise of using the Internet as a content distribution infrastructure. Because DRM offers a means of setting up a contract between consumers and content providers, it can achieve much more restrictive and fine-grained usage rights than fair use defined by the U.S. Digital Millennium Copyright Act (DMCA, 2000).

Integrating Technological, Commercial, and Legal Measures

Technologically, encryption and watermarking are the pillars of most DRM systems. But they alone cannot prevent the systems from being attacked or circumvented. A serious vulnerability lies in key management. This may be addressed using biometrics for personal key generation or an additional layer of security in accessing the content.

We believe effective DRM systems should be based on a combination of technical means, legal agreements between the different parties, and the consumers' ability to access the digital data only on DRM-compliant devices. The concept of the compliance of devices refers to a common set of rules or policies agreed on by device manufactures, content producers, and consumers. This necessitates, among others, not only the regulation of the commercial activities of device manufacturers and e-content providers, but also the establishment of industrial standards governing the interoperability and behaviors of products and services.

Effective DRM systems should integrate technological measures, commercial products and services, business models, and legislative regulations. The interleaving of them shall enable the organic growth of DRM and thus the e-content market.

Legislative Aspects

The recognition and protection of IP rights is an international concern and effort. The World Intellectual Property Organization (WIPO), with 179 member states, enforces and protects IP around the world. Two WIPO treaties (1994, 1995) and other international treaties and conventions set up a complex framework invoking copyrights, neighboring rights, and exceptions. Correspondingly, most national laws recognize similar types of exceptions via restrictive lists or through general provisions. The DMCA (2000) lays the very legal foundation for DRM applications in United States. It defines an exception through fair use. Exceptions exempt certain uses of IP from authorization, but they are not rights. Thus, fair use needs to be enforced under the legal provisions as well as the agreement between content provider and consumers. The proper enforcement calls for technological protection means, and thus came DRM. Not only do legislative regulations lay the legal foundation for DRM techniques, but they also forbid tampering with the DRM technical barrier and severely punish violators (DMCA).

Despite the legislative efforts to protect copyrights, there are some challenges in the context of DRM systems to apply copyright laws. The foremost is due to underdeveloped policy languages and missing attributes. The copyrights are subject to a number of exceptions, which depend on a variety of factors including the user's role, intent, purpose of use, and so forth. A primary defense to a claim of infringement of fair use is fuzzy by nature. The risks of DRM systems must be examined due to automatic enforcement. There are some transactions between copyright holders and users that may benefit from the technical mechanisms; however, many legitimate, noninfringing uses of copyrighted works by individuals may be prevented. DRM systems often include authorization authorities from which the users are required to seek permission for the desired use. Virtually all DRM mechanisms utilize encryption for transport security, ensuring that the content is managed by a trusted agent. This may require users to divulge personal information prior to using a legally acquired copyrighted work at home, which is at odds with current consumer expectations.

Cryptographic Algorithms and Key Management for DRM

DRM technological tools usually consist of cryptographic algorithms, key management, watermarking, and personal authentication using biometrics. General security and privacy policies are often enforced with strong cryptographic algorithms, protocols, and key management. The cryptographic algorithms are used in DRM systems so that the consumers can only process the digital content on a trusted device. That is, the cryptographic algorithms in DRM prevent the consumers from accessing the digital data directly. A famous example is the CSS used for DVD encryption and key management. CSS provides a weak technical hurdle in its own right, with the effective encryption key length only in the order of 8 to 16 bits. Its protection primarily comes from the legal enforcement of DMCA. Also, the cryptographic algorithms provide a means to establish trust between consumers and device manufacturers. The management of trust needs to be handled be over time and across a huge number of devices. A famous example is the xCP technologies of IBM (Lotspiech, Nusser, & Pestoni, 2002), a peer-to-peer content-protection protocol utilizing Fiat and Naor's (1994) broadcast-encryption scheme. The xCP can implement a compliant, authorized domain, which is a trusted collection or a home network of devices. It provides mechanisms for enforcing compliance without device identification or authentication. Anonymous authorization and exception mechanisms are also supported.

Watermarking-Based Techniques for DRM

For multimedia content, cryptographic measures are not enough to protect IP due to the existence of the analog hole: Because the digital content has to be rendered or presented to the end users in an analog form, it is always possible to capture and redigitize the analog signals for illegal redistribution. Thus, digital watermarking or data-hiding techniques need to be applied. By inserting imperceptible watermarks into the digital content, the usage of each digital copy can be individualized, traced, and controlled. The main players of a digital watermarking system consist of an encoder, an attacker that attempts to disrupt the watermark, and a decoder. The encoder inserts watermarks into the digital content, and the watermarks usually encode a certain amount of information with a cryptographic key. At the decoder, a key is also used to decode or detect the watermark information. If the decoding key is the same as that of the encoding, the watermarking system is symmetric; otherwise, it is asymmetric (Cheng, Wang, & Huang, 2004). Asymmetric watermarking systems potentially have higher security levels than their symmetric counterparts.

The applications of digital watermarking include fingerprinting, covert communications, copy control or protection, broadcast monitoring, and so forth. There are a number of digital watermarking techniques for different applications, such as robust watermarking, fragile watermarking, steganography, and others. From the point of view of transmitting much watermark information in applications like covert communications, the original digital content may be regarded as side information, usually available only to the encoder. Correspondingly, watermarking can be modeled as a variant of communications with side information at the encoder (Costa, 1983). This model benefits the data rate of covert communications. The spread spectrum communications model has also been applied to watermarking systems, resulting in high resilience to noise and manipulations (Cheng & Huang, 2003).

Important properties of watermarking systems usually include robustness, security, imperceptibility, reliability, capacity, and complexity. These properties may contradict mutually; for example, robustness and imperceptibility, imperceptibility and capacity, or robustness and capacity cannot be improved simultaneously. Proper balances need to be struck depending on the application. Critical are good imperceptibility and high reliability in most, if not all, applications. In copy protection and control applications, robustness is one of the key requirements. Imperceptibility needs to be traded for robustness in this case, while capacity becomes relatively less important. The reliable detection of watermarks proves to be extremely important considering the commercial or legal consequences caused by detection errors. The required error rate may be lower than 1 out of 1 million, or even 1 out of 1 billion. It poses great difficulty in experimentally verifying or guaranteeing such low error rates. Theoretical as well as practical studies have provided important guidance in predicting and estimating the error rates and achieving high reliability (Cheng & Huang, 2001; Cheng et al., 2004). Also, attackers attempt to intercept or impersonate the watermark information. Thus, the watermark security must be sufficiently high.

Biometrics-Based DRM Approaches

In a DRM system, biometrics may find an important place for personal authentication and key management. Classical user authentication systems are usually based on what the user owns or knows such as keys, identification cards, smart cards, passwords, and others. In contrast, biometrics provides a means of personal authentication based on what the user is or produces. Included are both physiological and behavioral modalities such as a fingerprint, iris, face, palm print, voice, handwriting, signature, and so on. Most biometric systems in commercial applications operate under the verification mode (Jain, Bolle, & Pankanti, 1999), which gives a binary detection decision. The verification performance can be improved by multimodal biometrics that combines several verification strategies and modalities. Common commercial biometric technologies encompass fingerprint readers, multimodal speaker verification, online signature recognizers, and so forth.

There may exist many parties in a DRM system, including end users (individuals, groups, or companies) and intermediaries (dealers, distributors, or system administrators). The consumers need different keys for encryption, decryption, and watermarking (with public and/or private watermarking keys). In practice, pass codes are usually used instead of cryptographically strong keys, but pass codes lack a direct connection with the users. Biometrics can be applied for the personal authentication of these consumers as well as key management, for example, with the creation and retrieval of electronic signatures. However, the disadvantage of a biometric pattern is that it can no longer be used once compromised. This presents a main difficulty in integrating biometrics into DRM systems. To handle this compromising problem, statistical features have been used instead of direct biometric patterns, or biometric patterns combined with secret keys are used. Alternatively exploited is dynamic biometrics such as voice and online writing (Vielhauer et al., 2002), with the advantage of the tested biometrics being different each time to void the compromise problem.

DRM SYSTEMS AND STANDARDS

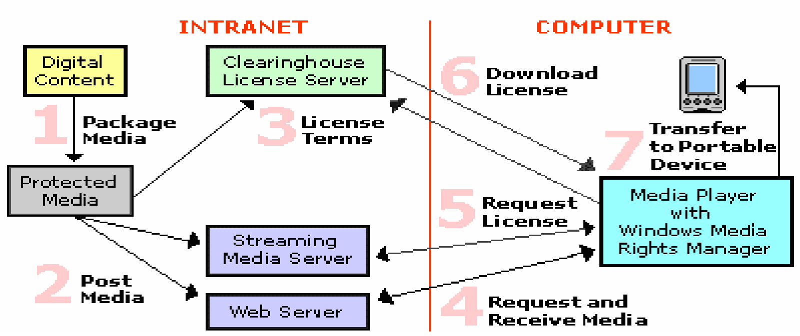
Technological measures can raise the barrier for casual violation, but they alone are not sufficient for managing and protecting digital IP rights. Concerted effort from relevant industries and legislative actions is completely necessary to enable DRM at a large or even global scale.

Despite DRM's short history, many commercial DRM tools have been developed. Real Networks developed their Media Commerce Suite for media servers that includes content encryption and run-time license generation. Macrovision has produced anticopy technologies for analog consumer videos and music CDs. Its more recent Rip Guard can prevent the ripping of video from DVDs. IBM xCP, Sony Open Magic Gate, Apple iTunes, and ContentGuard (2002) are well-known DRM tools. Currently, the most visible DRM for media protection is Microsoft's Windows Media Rights Manager, whose flow process is shown in Figure 1 (Microsoft, 2004). In the first stage, it packages the media file by encrypting and locking it with a cryptographic key. The key is stored in a license that is encrypted and distributed separately from the content file. The second stage involves the distribution of the media file through the streaming media server, CD, Web server, and so forth. In the next stage, the content provider chooses a license clearinghouse to authenticate the consumer's request for a license. At the user's side, the consumer needs to acquire the license key to unlock the content file. Windows DRM either sends the consumer's request to the media server, or downloads a license from the clearinghouse. Also, the consumer's player must support the Widows DRM to play the content file. The licenses have such rights as the allowable operation, duration, and starting time. The content can only be played according to the rules in the license, and can only be played by the person who has obtained a license.

The multiplicity of DRM systems and products has raised controversial issues of DRM interoperability and standardization. These tools often require the compliance of devices to DRM policies or contracts. Regulations are needed to govern the commercial behaviors of the device manufacturers and content providers. Industrial efforts started to incorporate various cryptographic, data-hiding, and biometrics techniques into industry standards for commercial products. Included are the following:

- The Open Platform Initiative for Multimedia Access (OPIMA), which developed hooks to allow for interoperability
- The Organization for the Advancement of Structured Information Standards (OASIS), which developed the extensible commerce markup language (XCML)
- The Open Mobile Alliance (OMA) with its rights expression language (REL)
- The Open eBook Forum with its rights grammar
- The MPEG-4 (Moving Pictures Experts Group), which developed DRM hooks, a mechanism for associating an IP identification data set (IPIDS) with audiovisual objects, the rights data dictionary (RDD), REL, and so forth
- The MPEG-21, which provides a multimedia framework

Figure 1. Flow process of Microsoft's Windows Media Rights Manager (Microsoft, 2004).



Some of these open standards are still en route to becoming international standards. Though the development of MPEG-21 is still ongoing, being a comprehensive next-generation framework for multimedia, its impact on the e-content market is prominent. MPEG-21 pays extensive attention to intellectual property management and protection (IPMP), with 4 out of 14 parts currently directly dealing with it. Kill and Bormans (2002) pointed out that the aim of the open framework is to "provide content creators, producers, distributors, and service providers with equal opportunities in the MPEG-21-enabled open market." They also noted this will benefit content consumers by "providing them access to a large variety of content in an interoperable manner." The fundamental unit in MPEG-21 is the digital item (DI) where the content is packaged and traded. The DI's declaration part is an XML (extensible markup language; Bray, Paoli, Sperberg-McQueen, & Maler, 2000) file providing identification, description, and references. The REL of MPEG-21 is based on the DRM-oriented language XrML (extensible right markup language; ContentGuard, Inc., 2002) that expresses relations between the essential entities. These entities compose a policy that is governed by IPMP. Rights within XrML are defined through XML schemas and shared among applications. Policies are mapped to grants that include actions to deny, permit, or indeterminate.

CHALLENGES

Despite the huge interest, extensive development and research, developed DRM tools, active standardization initiatives, and legislative acts, there are many challenges yet to be met. The legislative challenge has been discussed previously. A few technical and commercial challenges are the following.

Many attacks to watermarking systems have been developed, such as copy attacks and sensitivity attacks. To counterattack these attacks, watermark security poses a requirement that the attacker should have little chance to succeed. However, it turns out to be a highly demanding requirement in a very hostile environment. For example, there are many DRM frauds and attacks that DRM efforts have suffered, including the following.

- A DeCSS attack to a CSS by Johansen in 1999
- The Scientific attack to the Secure Digital Music Initiative's (SDMI) watermark technology by Felten et al. in 2001
- The PlayFair attack to Apple's iTunes Music Store's DRM in 2004

Asymmetric watermarking is a very promising technique in enhancing watermark security. In addition, new business models are proposed so that there is no incentive to impersonate watermarks. At this moment, it remains unclear what security level can eventually be achieved for DRM applications. Also, an important drawback of watermarking is that the content needs to be changed. The already released content is thus left unprotected. Even though fingerprinting has been introduced to fill this vacuum, it is still unclear to what extent it can be applied in practice.

Also unclear is how to achieve the best practice in offering interoperability in the standardization of DRM. Fully standardizing DRM systems may not be desirable; for example, CSS has been rendered ineffective, and SDMI has failed to produce any useful specifications. Standardizing components and parts of underlying infrastructures is an alternative, but the question remains whether the general principles can actually work toward DRM interoperability.

Comparatively simple, conditional access control systems are insufficient for Internet-distribution applications. To this end, MPEG has specified a set of hooks and extensions for DRM applications. The architecture is mature for MPEG-4 but unclear for MPEG-21. Without a universal architecture in current MPEG-21 specifications, also unclear is how different parts of MPEG-21 should be put together to work. Because MPEG-21 defines "a normative open framework for multimedia delivery and consumption for use by all the players in the delivery and consumption chain" (Kill & Bormans, 2002), it includes the whole life circle of digital content. Particularly included is digital-item adaptation, which allows for both resource and item adaptations. Thus, individual resources can be physically changed and/or different resources selected. A very challenging issue is how content adaptation should be properly handled by a DRM system.

A more important and bigger challenge is whether content users accept the new DRM technology that restricts the copying of contents. From the content consumer's point of view, content from any source will play on players from any manufacturer, and content users have become used to freely copying DVDs for viewing at their own home or for sharing with their friends. Many DRM restrictions will be considered a downside for consumers. For example, it may irritate consumers if the promised in-home distribution of many DRM tools is not easy to use. The DRM tools would be accepted if consumers could move the videos or music around a home network and among different machines without difficulties. Otherwise, individual consumers might try to attack DRM tools, and it may become more challenging to block the wholesale pirating of digital content.

D

FUTURE TRENDS

The evolution of DRM technology has included an increasing adoption of accepted security practice and the application of standardized protocols based on XML. Examples include XrML, ODRL (Iannella, 2001), and others. An emerging standard is the security assertion markup language (SAML; OASIS, 2002). This is an open framework and there is no commercial DRM mechanism that has been built on it. Because particular implementations of this model would incorporate various infrastructures for identification, authentication, cryptography, and metadata, we believe that a DRM system compliant to this framework will provide proper interoperability and become an indispensable part of future e-business.

DRM in home networks has mainly focused on physical links and storage protection. An emerging interest is in middleware or application layers, for example, DRM support for universal plug and play and authorized domains in digital video broadcasting. Currently, DRM is mostly concentrated in the broadband domain. In the broadcasting domain, simple, conditional access systems are often used. With the wide use of digital TV, an apparent trend is the widespread use of DRM systems in the broadcasting domain. The broadcast flag has already been adopted, but this is only the very beginning. With the growing bandwidth of mobile systems, DRM will also expand in this domain.

CONCLUSION

In the digital age, DRM is critical in the e-content distribution chain. We discuss the related concepts, trends, and challenges in this article. We conclude by emphasizing our belief: Only with an integrated legal, technological, and commercial framework can the goal of DRM be fully achieved.

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KEY TERMS

Content Scrambling System (CSS): A well-known technological protection measure for the access control and copy prevention of DVDs. It is based on encryption but was broken by the Norwegian teenager Jon Johansen (and two other individuals) in 1999. The decryption program, DeCSS, allows for the copying and playback of digital content on noncompliant machines.

Digital Rights Management (DRM): It refers to the protection and management of the intellectual property rights of digital content. It offers a means of setting up a contract between content consumers and providers. Specifically, it provides content creators or owners with a range of controls over their products or services. It also offers interoperability to consumers, including end users and any intermediaries such as dealers, distributors, and system administrators.

Digital Watermarking: Sometimes also known as digital data hiding, it is a technique for inserting secret information into digital content in a seemingly innocuous and standards-compliant manner for applications of content authentication, covert communications, copyright control or protection, and so forth. In the case of covert communications, it is also called steganography.

DRM Hooks: Also known as IPMP hooks, they were developed in 1999 and standardized by MPEG-4 in 2000. They allow proprietary DRM systems to be used within an MPEG-4-compliant terminal by associating the IPIDS of an IPMP system with each audiovisual object. The IPIDS is unique for any IPMP system and is assigned by a registration authority.

MPEG (Moving Pictures Experts Group): It is an international standardization organization (ISO) for digital multimedia, especially audiovisual objects. It developed a series of international standards, including MPEG-1, MPEG-2, MPEG-4, MPEG-7, and MPEG-21.

XML (Extensible Markup Language): It is a metalanguage defining the syntax for presenting and exchanging data in Web environments. It overcomes the limit of fixed tags in HTML (hypertext markup language) and allows users to define their document structures. W3C (World Wide Web Consortium) has designated XML as the standard for Web data.

XrML (Extensible Right Markup Language): It was submitted to MPEG responding to a call for a proposal in 2001, and is the basis for the REL syntax developed by MPEG.

Distributed Workflow Management Based on UML and Web Services

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INTRODUCTION

The definition and the management of business processes are considered a relevant issue to support organizations in their activities. Indeed, in the last few years many organizations have been changing their business processes to keep competitive in the global market. Workflow management is an emerging technology enabling process performance improvement in a cooperative working environment. In particular, a workflow management system (WfMS) enables processes automation through the integration, the coordination, and communication of both human and automatic task of business processes. WfMSs provide a process definition language (PDL) for modeling business processes. A PDL sentence is named process model and is enacted by a component of the WfMS, namely the process engine. The main task of this component is executing the enactment rules and the activities specified in the Process Model.

A huge number of PDLs based on several formalisms have been proposed in literature. Recently, some authors suggest exploiting the unified modeling language (UML) proposed by the Object Management Group (OMG, 2002) to model business processes (Aversano, Canfora, De Lucia, & Gallucci, 2002; Di Nitto, Lavazza, Schiavoni, Tracanella, & Trombetta, 2002; Eriksson & Penker, 2000, Jager, Schleicher, & Westfechtel, 1999; Marshall, 2000). UML is a natural choice for representing business processes, as it is a well known notation that can be easily understood and used by any kind of users.

In this article, we propose a Web services-based WfMS that lets users manage and enact business processes. The proposed system offers a visual environment based on an extension of UML activity diagrams that allows to graphically design a process model and to visually monitor its enactment. Since UML does not have a well defined operational semantics and is not executable, we had to make the process model executable by appropriately enriching the syntax and semantics of UML activity diagrams. The architecture of the proposed WfMS is based on Web services to manage and enact distributed business processes.

BACKGROUND

In the last decades workflow management systems (WfMSs) (Workflow Management Coalition, 1999) have been developed by researchers to provide support to the modeling, improvement, and automation of business and industrial engineering processes (Cugola, Di Nitto, & Fuggetta, 2001; Eder & Panagos, 1999; Winograd & Flores, 1986), including software processes (Bandinelli, Di Nitto, & Fuggetta, 1996; Heimann, Joeris, Krapp, & Westfechtel, 1996; Kaiser, Dossick, Jiang, Yang, & Xi Ye, 1998).

Most of the WfMSs of the last decade are client-server systems, with centralized enactment facilities, although they do not exploit the web as basic infrastructure to ease the accessibility by remote users. Recent research on workflow management is focusing on the use of web technologies and/or specialized middleware to support distributed processes across organizations (Aversano et al., 2004; Cugola et al., 2001; Eder & Panagos, 1999; Kaiser et al., 1998; Kammer, Bolcer, Taylor, & Hitomi, 1998; Maurer et al., 2000). The new frontier for the management of distributed e-business processes is provided by Web services (ebXML, 2001; Leymann, 2001). In particular, Pautasso and Alonso (2003) propose a visual approach to compose the various services as task of a process. A process is modeled by using two different diagrams, one for data flow and another for control flow. This requires two different process views.

In general, a number of process definition languages have been proposed in the literature, based on several formalisms such as event-condition-action mechanisms (Aversano et al., 2004, Loops & Allweyer, 1998), graph rewriting mechanism (Heimann et al., 1996), Petri Nets (Bandinelli et al., 1996), etc.

Several authors have recently proposed to adopt UML (OMG, 2002) for representing business processes (Di Nitto et al., 2002; Eriksson & Penker, 2000; Jager et al., 1999; Marshall, 2000). UML is a well known notation that can be easily understood and used by a project manager. It is important to point out that UML has been conceived for the communication among people. As a consequence, it does not have a well defined operational semantics and is not executable. Indeed, most approaches proposed in the literature use UML to model business processes at a very high level (Loops & Allweyer, 1998; Eriksson & Penker, 2000; Marshall, 2000) and in some cases manually translate the UML model into the PDL of a specific workflow management system (Loops & Allweyer, 1998; Aversano et al., 2002).

In the last years some research efforts are being made to add a well defined operational semantics to UML notations to automatically derive executable process models (Di Nitto et al., 2002; Jager et al., 1999). In (Jager et al., 1999) UML class diagrams and state diagrams are used to model the structure and the behavior of a process. Semantics is attached to UML process models by mapping them to programmed graph rewriting systems (Heimann et al., 1996). In (Di Nitto et al., 2002) a process is modeled by using a subset of UML diagrams, including UML activity diagrams with object flow to model the control and data flow, class diagrams to model structural properties of the process, and state diagrams to model the behavior of activities. The XMI standard representation of these models produced using a UML CASE tool can then be translated into an executable process description for the OPSS Workflow Management System (Cugola et al., 2001). De Lucia, Francese, and Tortora (2003) have presented a case study of mapping UML activity diagrams with object flow on the process definition language of the GENESIS environment (Aversano et al., 2004). The authors showed that UML activity diagrams do not support all the control flow and data flow rules of the GENESIS process definition language. As a consequence, the syntax and semantics of this type of UML diagrams often need to be extended to make them suitable for modeling business processes in workflow management systems.

AN UML BASED DISTRIBUTED WORKFLOW MANAGEMENT SYSTEM

In this section we present a distributed WfMS that uses UML activity diagrams as process definition language (PD) and Web services for the execution of distributed automatic activities.

The Process Definition Language

UML activity diagrams provide an intuitive and easy to learn PDL. In particular, we use an extension of the activity diagrams with object-flow (OMG, 2002). UML activity diagrams are a particular variation of UML state diagrams where states represents actions (or activities) and are modeled by rounded rectangles and transitions between states depicted as solid arrows model the control flow between two activities. Activity diagrams have been enriched with object flow to depict the data flow between activities.

Although structural properties and relations between process elements, such as artifacts, activities, and roles, could be specified using other UML diagrams (Di Nitto et al., 2002), we did not include them in the proposed PDL, to avoid the use of too many diagrams. Indeed, a process modeling tool can provide other features to model these aspects, such as forms or simpler graphical notations (e.g., organizational charts for the roles). Some approaches (Di Nitto et al., 2002; Jager et al., 1999) use state diagrams for modeling the internal behavior of activities. In our approach activities may be interactive or automatic depending on if they are performed by humans or by a tool, respectively. For interactive activities, unlike other WfMSs, we do not provide a visual notation to model them. Rather, their user interface is automatically generated from the definition of the input and output objects of the interactive activity. Automatic activities are associated to Web services using Web service description language (WSDL) specification and executed on remote machines.

We needed to suitably enrich the syntax and semantics of UML activity diagrams to enable the specification and execution of particular aspects of a distributed business process. In particular, distributed processes are organized in a hierarchical way and modeled as subprocesses in UML activity diagrams (see Figure 1 for an example). A compound activity is depicted as an activity with the addition of an icon in the right lower corner denoting a nested activity diagram, see activity *A2* in Figure 1(a). In particular, Figure 1(a) shows a partial

Figure 1. Process and sub-process modeling

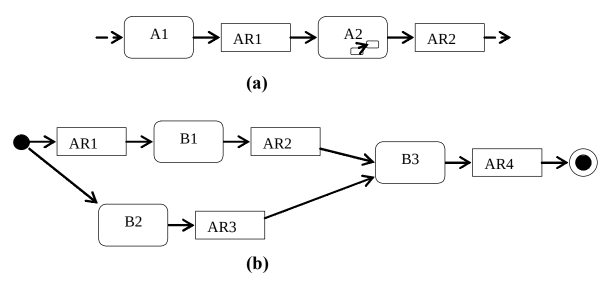


Figure 2. Activity multiplicity

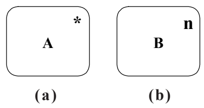


Figure 3. The pair synchronization type

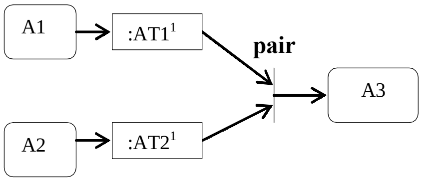


Figure 4. The traceability synchronization type

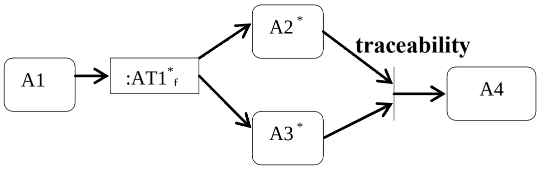
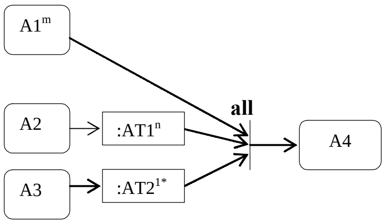


Figure 5. The all synchronization type



process and Figure 1(b) the subprocess associated to the composed activity *A2*. The input artifacts are transferred to the subprocess as if they were produced by the start activity. Similarly, all the output artifacts are transferred to the higher level process by assigning them to the end activity.

We also extended UML activity diagrams for modeling several aspects concerning the synchronization between groups of artifacts and activities. To this end we need to provide some basic concepts.

In UML activity diagrams it is possible to specify whether concurrent instances of the same activity can be executed and in this case their multiplicity. We can use the *(*)* symbol (*multiplicity marker*) in the right-higher corner of the activity symbol, as shown in Figure 2(a) to denote that multiple instances of the activity can be executed. This symbol indicates that the number of instances is unknown during the process modeling and will be determined at run-time. Differently, whether the exact number of instance is known the multiplicity can be specified as in Figure 2(b).

In UML activity diagrams, a specific object with a name is exchanged between two activities. On the other hand, we need to provide more flexibility, in that an undefined number of artifacts of a given type can be produced by the source activity and consumed by the target activity. Therefore, we can use for artifact names the typical UML object notation *artifact-name: artifact-type* in case the multiplicity of the artifact is one. Whenever the multiplicity of the artifact type is undefined (many), we can use the notation *: artifact-type*, without specifying the name of the artifact.

To model the synchronization between two or more transitions UML synchronization bars can be used. We associate to the join construct a different operational semantics depending on the synchronization type. We have identified four different synchronization types: *pair*, *traceability*, *all*, and *once*. The synchronization type can be depicted as a label on the top of the UML synchronization bar. Whether the synchronization type is unspecified the default value is *all*. The first synchronization type, *pair*, is allowed only if the artifacts or the activities to be synchronized have multiplicity one, as shown in Figure 3. In this case the control is transferred to the target activity only when each artifact instance is produced.

Other synchronization policies have to be considered when we need to synchronize artifacts and/or activities with undefined multiplicity. The *traceability* synchronization type is used when activities or artifacts with multiplicity greater than one instantiate several artifacts (or activities) of the same type that have to be synchronized with other artifacts or activities. We need a way to distinguish the activities and the artifacts belonging to the same group. To this aim, we identify a point of the process, the *traceability fire*, where a new traceability identifier is generated. A traceability fire is depicted by adding *f* as subscript to the name of the node, as in the artifact type *AT1* in Figure 4. Here *A1* produces several artifacts of type *AT1* having a traceability fire assigned to them. Whenever a new instance of the artifact is produced, a new traceability identifier is associated to it, and the two instances of *A2* and *A3* having the same traceability identifier are activated. The edge having the traceability join as source is started when the join node receives as input two control flows deriving from two instances of *A2* and *A3* with the same traceability identifier.

The *all* synchronization type consists of waiting the availability of all the instances of each object type or activity. As shown in Figure 5, the control is transferred to *A4* only when the *m* instances of the activity *A1* are terminated, the *n* instances of the artifact type *AT2* and all the instances of the type *AT3* (whose number is known during enactment) are available. Finally, the *once* synchronization type consists of waiting that at least one artifact of each type is produced and letting all the artifacts flowing without any further synchronization.

The WfMS Architecture

The architecture of the system follows the model proposed by the Workflow Management Coalition (1999). Figure 6 shows the architecture.

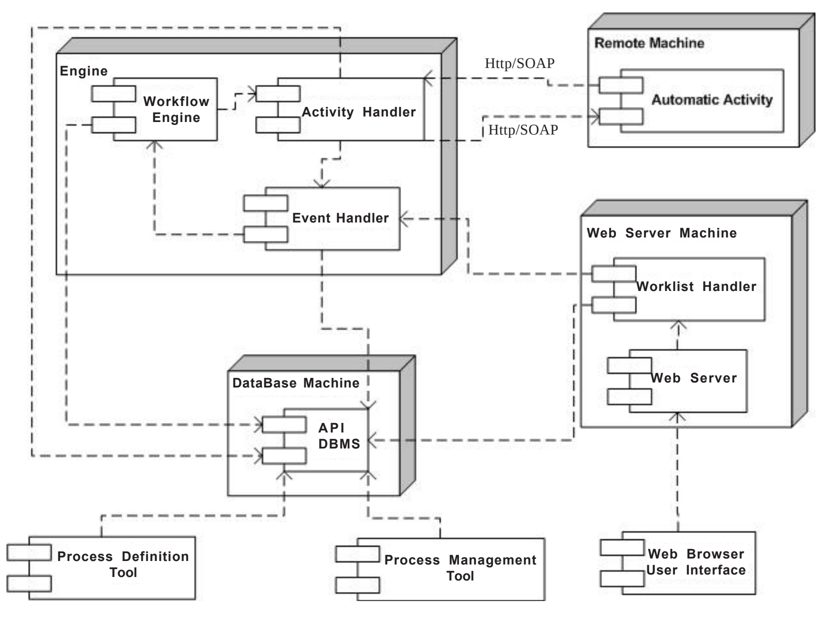
The *process definition tool* enables the definition of the process according to the UML based PDL described above. This is stored in the database in terms of the process components (activities, artifacts, transitions, etc.).

The *workflow engine* is a component whose main task is to manage the execution of process instances through the enactment rules specified in the process model. The workflow engine is in charge of instantiating both types of activities, automatic and interactive. Besides instantiating an automatic activity, the workflow engine needs to identify the corresponding Web service. To this aim the *activity handler* component is used. This is a component that is in charge to identify and select the Web service corresponding to the definition of the automatic activity. Once this has been identified and registered in the UDDI registry, the activity handler creates the instance of the automatic activity in the database and associates the URL of the corresponding Web service. The activity handler is in charge of monitoring the evolution of the activity, storing the data returned by the corresponding Web service and notifying the event handler (a component of the workflow engine) of events concerning the activity, such as its termination or the production of an object. These events are stored in the database and later processed by the workflow engine according to the workflow enactment rules.

Compound activities corresponding to subprocesses are handled as automatic activities. Whenever a compound activity has to be instantiated, the activity handler identifies the workflow management system that is in charge of executing the subprocess. The latter maintains the model of the subprocess and the data concerning the instance execution in the local database and only events concerning the change of state of the process instance or the production of output objects are monitored by the activity handler and notified to the event handler of the higher level process.

Interactive activities are simply created in the database by the workflow engine and are managed by the *worklist handler*, a component developed using Web technologies, which optimizes the assignment of human resources by considering the effort needed to accomplish each activity. The graphical interface of an interactive activity is generated through the worklist handler, and is presented through Web browser on the client machine. The worklist handler provides information on the activities that can be executed, the corresponding state (such as running, suspended, or terminated), and its input and

Figure 6. WfMS architecture



output objects. The Worklist Handler stores the objects produced by the interactive activities into the database and notifies events concerning interactive activities to the Event Handler.

Finally, the *process management tool* is the component which handles the process execution. It allows starting a process, monitoring its state during enactment and managing deviations from the process model in case of unforeseen situations (Casati & Cugola, 2001).

FUTURE TRENDS

Generally, WfMSs do not support the knowledge improvement of human resources by learning on the job and learning on demand. Thus, the human resources can only trust on their knowledge to accomplish activities belonging to business processes or use external enterprise e-learning systems, if available. This would require integrating WfMSs with e-learning systems.

Costagliola, Ferrucci, Polese, and Scanniello (2005) suggested a hierarchy of visual languages to model learning process regarding e-learning activities and their relationships. We are currently integrating the presented WfMS with this e-learning system. The process definition tool of the WfMS will associate activities of the business process with e-learning processes defined with the visual editor of the e-learning system. A key for this integration is the common UML based notation for both business processes and e-learning processes. This system also will allow business process participants to adaptively access the contents of the e-learning courses associated with their activities.

CONCLUSION

A briefly description of the main characteristics of a distributed WfMS based on an extension of the UML activity diagrams with object flow has been proposed. Future trends of our research have also been highlighted in this article.

Differently from the other approaches, we have not used many UML notations to model different aspects of a process. Making UML activity diagrams executable required some minor extensions of the UML syntax and semantics, some of them achieved using stereotypes. However, these modifications are quite simple to understand. We distinguished between automatic and interactive activities. Automatic activities are managed as Web services, whilst the interfaces of interactive activities are automatically generated starting from the specification of the input and output artifacts.

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KEY TERMS

Artifact: Any object produced or consumed by an activity of a business process.

Business Process: One or more linked procedures or coordinated activities, which collectively realize a business objective or policy goal.

E-Learning: The delivery of knowledge using electronic devices.

Process Definition: The process definition consists of a network of activities and their relationships, criteria to indicate the start and termination of the process, and information about the individual activities.

Web Services: A modular self-describing software service universally accessible in a standardized and platform independent way.

Workflow: The automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules.

Workflow Management System: A system that defines, creates, and manages workflows by the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of applications.

Dot Net and J2EE for Web Services

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INTRODUCTION

The capabilities of Internet technologies continue to evolve as businesses learn and implement more sophisticated e-business applications in order to adapt to dynamic environments. Web services are an industry-wide response to the need for a more flexible and efficient business collaboration environment. Supported by major institutions and industry leaders, Web services have become the promising method for making e-business information and applications programmatically available via the Internet. Web services are self-contained, modular business applications that have open, Internet-oriented, and standards-based interfaces. Chen, Chen, and Shao (2003) provide a good review of the implications and impacts of Web services to electronic-commerce research and practices.

In order for the Web-services idea to become a working reality, there must be a common agreement on how they will work. Web services rely on a set of standards to support interoperability among applications developed in different languages and running on different platforms or operating systems. Core Web-services standards include SOAP (simple object access protocol), WSDL (Web services description language), and UDDI (universal description, discovery, and integration). The basic idea of Web services is the use of the SOAP messaging protocol to invoke software methods in remote systems. A WSDL file contains service definitions for distributed systems to support the automatic creation of client-side links and the binding to the Web services. UDDI is a registry standard for Web-services providers to publish their Web services. It then can be used by a Web-services consumer to discover (search) Web services developed by Web-services providers.

The grand vision of Web-services-oriented architecture is that Web services can be composed and invoked dynamically to support business processes within and across enterprises. A number of new standards have been introduced to address this Web-services composition issue, including BPEL4WS (business process execution language for Web services), WSCI (Web services choreography interface), and BPML (business process modeling language; Arkin, 2002; Arkin et al., 2002).

Semantic matching and Semantic Web are other developments that enable greater access to services on the Web (Berners-Lee, Hendler, & Lassila, 2001; McIlraith, Son, & Zeng, 2001). The purposes for the development of an ontology of services, DAML-S (DAML Services Coalition, 2003) under the DARPA agent markup language (DAML) program, are closely related to various Web-services standards. There are very limited interactions between Web-services standards and semantic-Web research. Adding ontology support to UDDI to facilitate Web-services search is a promising direction for future research.

BACKGROUND

Organizations have been motivated to start Web-services initiatives in order to compete in the future business environment. Two major companies, Microsoft and Sun Microsystems, have developed platforms (Microsoft .NET and Java 2 Enterprise Edition [J2EE], respectively) to support Web services. In general, Microsoft .NET is a product suite that enables organizations to build enterprise-class Web-services applications. On the other hand, J2EE is a standard that facilitates building Web services with other products (e.g., used with IBM's WebSphere, HP's Web Services Platform, and Sun's Sun ONE).

Microsoft .NET

Microsoft focuses on three goals as its vision for Web services. First, everything in the system must be a Web service. Second, once these services are created, one must be able to integrate and aggregate these services in simple and easy ways. Third, one needs to have a simple and compelling consumer or end-user experience (Microsoft Corporation, 2001b). According to the Microsoft Corporation, "The Microsoft .NET platform includes a comprehensive family of products…that provide for each aspect of developing, managing, using and experiencing XML Web Services." One unique idea that the .Net framework proposes is its multilanguage support. This idea is to allow developers to program Web services in any language they feel comfortable with (e.g., COBOL, C, Java, VB, etc.). For Web applications, active server page (ASP) technology has been updated to ASP.NET, which provides advanced server-side Web controls and easy-to-create user controls. At the same time, Windows

XP is introduced as the innovative operating system that is aimed at helping consumers interact more directly with Web services. An important part of the XP system is the integration of common tasks with services available on the Internet. With these fundamental innovations, Microsoft has made substantial efforts to advocate Web-services development and implementation.

J2EE

J2EE was designed to simplify complex problems with the development, deployment, and management of multitier enterprise solutions (Vawter & Roman, 2001). The goal of J2EE is to give the user free choice in the use of other products and tools, and to encourage best-of-breed products to emerge through competition. This is the idea of the market and community that J2EE envisions.

J2EE was not originally created for Web services per se; however, J2EE supports the server-side deployment of goods and services with the J2EE application server. Typically, a J2EE application server deploys, manages, and executes three types of standard components, namely, the Web component, Web service, and EJB (Enterprise JavaBean) component. Briefly described, a Web component (e.g., a servlet component, a Java server page [JSP] component) interacts with a Web-based client by connecting with Web-services components for functionalities, and with EJB components for business logic and live business data.

COMPARISON OF .NET AND J2EE

While both .NET and J2EE help business build Web-services applications, many similarities and differences exist between them. There are many studies that compare .NET and J2EE from different perspectives such as Web services in general (Lurie & Belanger, 2002; McGarvey, 2004; Vawter & Roman, 2001), benchmark performance (Microsoft Corporation, 2004; Middleware Company, 2002), architecture (Farley, 2000), and enterprise Web application (Sheil & Monteiro, 2002). While these studies provide many insightful and interesting comparisons, in this section, these platforms will be compared on the basis of factors that can be reasonably measured or ascertained. Furthermore, we also summarize findings of benchmark-performance comparisons between .NET and J2EE at the end of this section.

Portability

Vawter and Roman (2001) state that a key difference between J2EE and .NET is that J2EE is platform agnostic, running on a variety of hardware and operating systems, such as Win32, UNIX, and Mainframe systems. This portability is real today because the Java run-time environment (JRE), on which J2EE is based, is available on any platform. On the other hand, Microsoft claims that .NET offers portability as well. Even most experts believe that J2EE possesses superior portability, but Microsoft has positioned .NET for portability by offering a two-step compilation process that allows .NET to provide run-time environments for different platforms.

Another aspect of portability is how .NET or J2EE can support a variety of implementations. Companies will likely choose between .NET and J2EE with considerations of implementations on not only intrafirm applications, but also interfirm-application integrations. As suggested by Vawter and Roman (2001), this aspect makes the future of J2EE very bright and is one of the critical differentiators between J2EE and .NET.

Platform Maturity

Platform maturity assesses the potential risk of system failure. Java has been developed and refined since the mid-'90s. The release of J2EE furthered the strength of Java by providing a stable and mature standard for Web applications. On the other hand, not until 2000 did Microsoft start to introduce its .NET strategy and subsequently offer the .NET platform. Further, many developers from different companies and technology communities have used and supported Java-oriented applications. This phenomenon results in better maturity for J2EE compared to .NET, which is young and supported by only one player: Microsoft. As suggested by Vawter and Roman (2001), J2EE is the more mature platform. They suggested that the very underlying fabric of .NET is an overhauled rewrite, and this represents enormous risk compared to the new J2EE features.

Language Support

Extended from Java, naturally all J2EE applications have to be written in Java. This single-language nature of J2EE contrasts fundamentally with .NET, which supports many different languages. While J2EE supporters can argue that a single language provides a more elegant solution, .NET offers an advantage to organizations that would like to leverage its knowledge workers' IT expertise (Lurie & Belanger, 2002). In its design, .NET's multilanguage-support concept is more appealing to a wider range of developers because it can encompass a wider variety of programmers, each knowing different programming languages. However, while a complicated application is written with multiple languages, it is very likely to cause a great deal of difficulties to maintain and modify the application.

Developer Tools and Rapid Application Development Features

Microsoft has traditionally set a strategy to provide users and developers with more comprehensive and easy-to-use tools. The success of promoting Visual Studio with multiproject debugging and ease of use has extended to Microsoft's Visual Studio.NET. This aspect for .NET-application developments has promised many features including a more powerful IDE (integrated development environment), life-cycle development tools, and VB.NET Web forms. These features can help novice developers make the transition to becoming proficient at developing Web applications for Web services. Arguably, Microsoft has held the edge in developer tools, and Visual Studio.NET holds the promise for continuing this trend of facilitating the rapid development of enterprise applications.

Sun has recently become a more viable source for development tools with its new Forte for Java. Sun has recently announced the release of Forte for the Java IDE for simplifying the development of applications for the J2EE/Sun ONE architecture. An important part of the Forte tool kit is that "a new Web service module provides automatic binding of Java technology and XML [extensible markup language] through intuitive wizards…and supports Web-based publishing to a services registry" (Sun Microsystems, 2001). Other tools such as Eclipse Platform and Eclipse SDK (Software Developer Kit) also provide an open, extensible IDE and a feature-rich development environment for building J2EE applications (Eclipse Foundation, 2004).

In summary, Table 1 provides a conclusive comparison on the factors discussed in this section.

Comparison Test

Since the emergence of .NET and the idea of Web services, empirical comparisons of .NET to J2EE also have begun. Since it is too early to tell which platform will win out in the long term, direct-comparison tests have been run to help distinguish between the two. VeriTest (2002) found that the .NET version in some instances performed as much as 10 times faster on page loads than the Java version of the online Pet Store. The Java-based application required approximately 4 times as much code as the .NET version. However, many Java developers as well as Sun, IBM, and Oracle have maintained that the comparisons to date have not been valid because the Java-based Pet Store application was not properly optimized for performance and not meant to be benchmarked. Middleware Company used an extensive new series of benchmarks based on a new implementation of the Java Pet Store, which has been extensively optimized for performance and scalability (Middleware Company, 2002). Its results still showed that the .NET version performed better than the J2EE version on, for example, peak throughput and maximum user load (supported users).

Another direct comparison was made in the testing of the Nile E-Commerce Application Server Benchmark implemented in .NET using C# and in the latest version of a leading J2EE-based application-server product. The results showed the .NET version outperformed the J2EE version by over 340% (Microsoft Corporation, 2001a). Microsoft also published comparison results for Web-services performance between the J2EE platform and .NET framework (Microsoft Corporation, 2004). Again, the report concluded that .NET performed better than J2EE on throughput and response time.

FUTURE TRENDS

Web services promise to revolutionize not only the way we develop systems, but also, more importantly, how we do business. Lurie and Belanger (2002) suggest that businesses should not be totally preoccupied with choosing a platform over the other, but should build Web services with a homogenous view of a heterogeneous environment. Both the technology and business fields look forward to more advanced cooperation and bridging between .NET and J2EE. For example, MONO is a compre-

Table 1. Comparison summary of .Net and J2EE

Feature	***.NET***	***J2EE***
Portability		X
Platform Maturity		X
Language Support	X	
Developer Tools and Rapid Application Development Features	X	

Note: X *indicates that a specific platform has better edge over the other one. For the factors that have an* X *on both platforms, it indicates that both platforms are equally good on these features.*

hensive open-source development platform based on the .NET framework that allows developers to build Unix and cross-platform applications with unprecedented productivity (Novell, Inc., 2004). On the other hand, IBM is offering an interoperability tool for Eclipse and .NET WinForms to help developers move to the Eclipse platform while making use of investments in .NET WinForms controls (IBM, 2004).

CONCLUSION

In summary, J2EE fares better in portability and platform maturity, but .NET is a favorable choice for better language support, developer tools, and rapid application development features. In general, many benchmark-performance comparison tests showed .NET-based applications perform better than J2EE-based applications.

J2EE is a standard supported by many IT players; that is, it is supported by a community and there are more choices of vendors for companies' Web-services applications. .NET is a product that is promoted and developed by one company, Microsoft, and support from others is slender. However, the implementation of .NET applications can be straightforward. On the other hand, a J2EE implementation typically involves buying tools from multiple vendors and patching them together, and can be complicated and time consuming (McGarvey, 2004).

Most businesses can benefit from .NET or J2EE in different ways. However, the choice of Web-services implementations should depend on the company's current systems and worker skills that can be compatible with either Microsoft or J2EE. Lurie and Belanger (2002) suggest that many people concede to the following rule of thumb: If you are committed to a homogenous Microsoft platform now, then choose .NET; otherwise, choose J2EE.

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KEY TERMS

Electronic Commerce: E-commerce or e-business generally refers to the conduct of business transactional or managerial activities using Internet technologies via the Web.

J2EE: The Java 2 Enterprise Edition is designed to simplify complex problems with the development, deployment, and management of a multitier enterprise solution. J2EE is an industry standard that helps build Web services (e.g., used with IBM's WebSphere, HP's Web Services Platform, and Sun's Sun ONE).

.NET: Microsoft .NET is a product suite that enables companies to build smart, enterprise-class Web services. Microsoft .NET is a product strategy that serves as a platform for developing Web services.

SOAP: The simple object access protocol is the messaging protocol that facilitates Web services to invoke software methods in remote systems.

UDDI: Universal description, discovery, and integration is a registry standard for Web-services providers to publish their Web services. It may be used by a Web-services consumer to discover (search) Web services developed by Web-services providers.

Web Services: Web services are self-contained, self-describing, modular applications that have open, Internet-oriented, standards-based interfaces and can be published, located, and invoked across the Web.

WSDL: The Web services description language defines Web services for distributed systems to support the automatic creation of client-side stubs or proxies, and the binding to the Web services. It describes the interfaces to a Web-services implementation in terms of the format of the messages, binding of the abstract messages to a concrete protocol, and address of the endpoint.

Category: Dot-Com Experiences

Dot-Com Conversion at Egghead

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INTRODUCTION

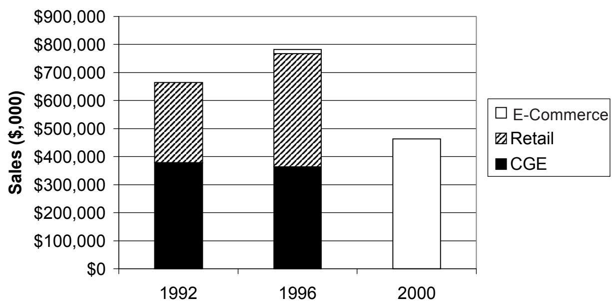
Egghead Software, Inc.'s evolution from a multichannel, traditional retailer of computer software and hardware into an e-commerce-only channel parallels the rise and fall of many e-commerce ventures. At one time, Egghead had a well-defined multichannel strategy, with a direct-sales unit focused on corporate, government, and education customers (CGE); a retail-store unit focused on early adopters of computer software and hardware; and a catalog and call-center unit that targeted consumers and small businesses. Struggling to survive in the face of increased competition and declining margins, Egghead made a series of decisions to sell its CGE unit and abandon its retail stores and catalog operations, shifting all of its resources into an e-commerce strategy. This shift was cited by many journalists and analysts as a sign that e-commerce was here to stay and highlighted Egghead.com as an example that traditional retailers should follow or risk becoming obsolete (Wilde, 1999). This article reviews the history of Egghead, focusing on the decisions and events that led to its demise.

BACKGROUND OF EGGHEAD SOFTWARE, INC.

Victor Alhadeff, a Washington-state entrepreneur, founded Egghead Software, Inc. in the early 1980s initially focusing on providing customers with knowledgeable support, competitive prices, free trials, and a liberal return policy. As one author noted, he aimed to be the high-quality service provider of software sales (Bond, 1996). In the late 1980s, Egghead added a call-center division that targeted customers not able to shop at its retail stores, and a direct-sales division that focused on selling software to corporate, government, and education customers. Its value to many suppliers was in its multichannel strategy (Figure 1), which aligned well with its customer base. It was able to surround customers with numerous points of contact that allowed the customer to buy in the manner they chose. Suppliers could deal with one channel, Egghead, and know they would reach many targeted customers in a variety of different ways.

After a disagreement with the board over the direction of the company, Alhadeff left in 1990. Egghead then went through two CEOs (chief executive officers) with little experience in high technology until Ronald Erickson took over in 1992 (Santucci, Bond, & Golding, 1999). With Erickson in charge, Egghead missed its projected sales and profit forecast. The management team attributed the results to an increase in competition, a slowdown in sales to the aerospace and military markets, and fewer new-product introductions. Egghead's gross margins also declined, causing management to apply more pressure on its retail-store managers with new performance measurements that focused on reducing the cost of returned software. At the same time, the company ran an advertising campaign that highlighted its no-questions-asked return policy (Speck, 1998). As one former store manager noted, the net result was to drive customers away by making the return of software an unpleasant experience (Speck).

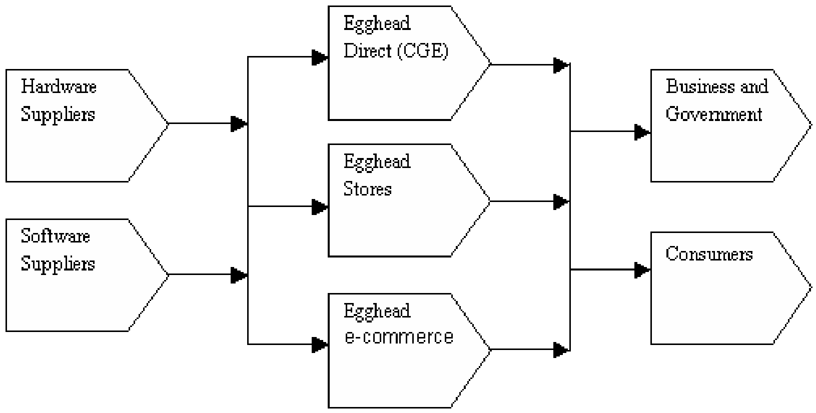
Figure 1. Revenue based on shifting channels (Compiled from Egghead annual reports)



Although margins continued to decline in 1994, Egghead implemented an electronic data-interchange (EDI) system, and signed an agreement with AT&T and Lotus to put its catalog online as part of a test for a new service (AT&T, 1994).

The following year, as sales reached $860 million, Terence Strom, a former vice president of marketing at Best Buy, Inc. was brought in as CEO to help revitalize Egghead's retail-store sales (Browder, 1996). Strom began to develop a new store concept that would average close to 5,000 square feet (twice the size of Egghead's current stores) with more hardware and software (Browder). These new "mini superstores" were designed to leverage Egghead's reputation for excellent customer support while

Figure 2. Egghead's position in the value chain as an intermediary (1983-1997)



also allowing the company to compete with other computer retailers like CompUSA and Best Buy (Browder). In 1995, Egghead had expanded its e-commerce efforts by establishing Elekom, which was charged with developing a new e-commerce system for Egghead (Browder). Egghead's position in the value chain (Figure 2) seemed secure: It would continue to leverage its existing retail locations, updating them to reflect the changing competitive environment, while extending its reach through e-commerce.

Within a year of taking over, Strom then decided that Egghead needed to focus more of its resources on the retail trade. This led to Egghead selling its CGE division to Software Spectrum, Inc. in 1996. The dismantling of Egghead's position in the market had begun.

Around the time that Strom decided to sell the CGE division, George Orban, a minority shareholder and member of the board, began to get more involved in the operations of Egghead. Believing e-commerce was the way to go, Strom, Orban, and their team started shifting efforts into this area. With cash from the sale of the CGE unit, they purchased Surplus Software, one of the early e-commerce developers and owner of the surplusdirect.com and surplusauction.com Web sites. Mixed results from Egghead's mini superstores, coupled with further declines in profitability in the traditional stores, led to the closing of 77 retail locations in 1997. While Egghead still had a strong brand name, a database full of customer information, and good relationships with many suppliers, Orban felt Egghead had to make a move or consider liquidation. Declining revenues and margins in the retail format, triple-digit growth in Egghead's e-commerce channels, and staggering growth projections for e-commerce in general by research firms such as the Yankee Group led Orban to decide the time had come to act. In late 1997, Strom left Egghead and Orban assumed the position of president and CEO.

FUTURE TRENDS: CATCHING THE DOT-COM WAVE

In January of 1998, Egghead announced that it was going to close its last remaining retail stores and focus exclusively on e-commerce through its three Web sites: Egghead.com, surplusauction.com, and surplusdirect.com. "The decision to close our brick-and-mortar retail network was made to enable the company's management and resources to focus on Internet sales and market share," said Orban (McNally, 1998). Many analysts and journalists praised Egghead for transforming its business model, holding it in the same regard as Dell and Gateway. As Erica Regulies of Giga Information Group noted, "This is the beginning of a trend. This is the first time we've really been able to say, 'Electronic commerce is here'" (Miles, 1998). Analysts called Egghead's move bold while recommending the stock as a buy. Orban said that while he also considered closing shop as an option, there were too many strengths and opportunities that led Egghead to the transition. "Egghead had a very strong brand name, great vendor relationships, and a retail culture that would help us take advantage of the Internet opportunity," Orban said. "We had the financial resources to fund the transition, and we put together a management group that was up to the challenge of exiting the traditional business and entering the new business" (Wilde, p. 92).

E-commerce competitors, like Insight.com, thought Egghead had made the right move (Miles, 1998). John Dixon, director of electronic media at Insight at that time, noted, "Retail is going to die. It's on its way out" (Miles). Some analysts were less optimistic. As Katrina Roche, general manager of supply chain solutions at Baan, noted, "it's not acceptable to have only one channel. Consumers expect to be able to buy products through a channel that meets their service needs, some that are oriented toward a higher-priced, high-service level, and some oriented toward getting product out at the lowest possible cost" (Murphy, 1999).

Positive signs continued to reinforce Orban's decision, however. Web-site traffic to the three sites Egghead operated had grown to 21 million site visits per quarter by September 1998 (Battey, 1998). Egghead.com reported that its auction service located at surplusauction.com had 242,000 registered bidders, up from 29,000 a year earlier (Battey). MediaMetrix, an online Web-site tracking service, reported that Egghead.com's Web sites were the seventh most heavily visited sites in July of 1998 (Ditlea, 1998). Revenues reached $35.1 million in the second quarter of 1998 (Battey), while the stock price hit a high of $40.25 in late 1998. One financial journalist picked Egghead.com as his "stock of the decade" (Robbins, 1998). As Egghead.com rolled into 1999, the positive press continued. In April of that year, the Sloan School of Management at the Massachusetts Institute of Technology awarded Egghead.com its Web Transformation Award (see http://mitsloan.mit.edu).

Meanwhile, in the California bay area, Jerry Kaplan, founder and CEO of Onsale, Inc., was reporting a profit of $361,000 on revenue of $14.3 million for 1996. Onsale was one of many emerging competitors that caught the attention of George Orban and his new team in late 1997.

As Egghead.com and Onsale continued to evolve and grow, both firms began to lose money and deplete their cash reserves in an effort to boost their sales. This led to Onsale acquiring Egghead.com. Just one day before the announced merger, Amazon.com issued a press release indicating that it was moving into the sales of electronics at its Web site. A new phase in e-commerce seemed about to begin.

FUTURE TRENDS PART II: FROM DOT-COM TO NOT-COM

With its strong brand name, excellent reputation for customer service, and leadership as an e-commerce business, it seemed natural that Amazon.com would begin to offer more and more products beyond books and music (Wolverton, 1999). Along with eBay, Yahoo, and AOL, Amazon.com was one of the most widely heralded e-commerce-only companies—one that many analysts and journalists believed would survive the impending shakeout.

When Onsale acquired Egghead.com, it decided to keep Egghead.com as the corporate name as the Egghead brand name was still well known. In 1999, overall sales increased to $530 million and biz-rate.com (an online rating service) gave Egghead.com a four-star rating. Sales declined, however, from 1999 to 2000 due to increased competition, a downturn in the economy, and Egghead.com's efforts to cut losses by eliminating low-margin customers. Egghead.com was able to reduce its losses from $155 million in 1999 to $62 million in 2000. Despite the decline in sales, all other trend lines were positive. Problems began to plague Egghead.com, however, as it began to receive negative reviews from customers. The University of Michigan Business School's American Customer Satisfaction Index showed that Egghead.com was significantly below off-line retailers (C. King, 2000).

In December 2000, Egghead.com received unwelcome publicity when hackers were able to access its servers and possibly obtain customer information (Enos, 2000). The security violation that resulted in the possible theft of credit-card information cost millions of dollars in direct costs according to some security experts (Lemos, 2001). It further upset Egghead.com's customers. "Any company that's going to do something as stupid as maintain credit card information online on a vulnerable server that long after the transaction, I have no reason to trust them at all," said John Groseclose of Scottsdale, Arizona. "That goes against every industry best practice that's out there" (Wolverton, 2001).

Within weeks of the security violation, Egghead's Web site ran into another problem when it was unable to handle the traffic in the week before Christmas, causing more than $1 million in lost sales according to Markus Allen, president of WatchDog247.com. Egghead's 90 minutes of downtime per day was more than twice as much as any other retail site, and over 10 times the reported downtime of Amazon.com (http://www.itsecurity.com/tecsnews/dec2000/dec410.htm). By 2001, savvy online consumers continued to spend, but did not necessarily remain loyal to one vendor. Claes Fornell, a noted professor at the University of Michigan and the principal author of the American Consumer Satisfaction Index, noted that "customer loyalty is not high" and customer defections were increasing (Morphy, 2001).

The technical and customer-service miscues, coupled with the downturn in the economy and the lack of consumer loyalty, proved too much for Egghead.com. On August 15, 2001, Egghead.com announced that it was almost out of cash and that it was filing for bankruptcy protection. In December of 2001, Amazon.com purchased Egghead.com's Web site and customer database at auction for $6.1 million.

CONCLUSION

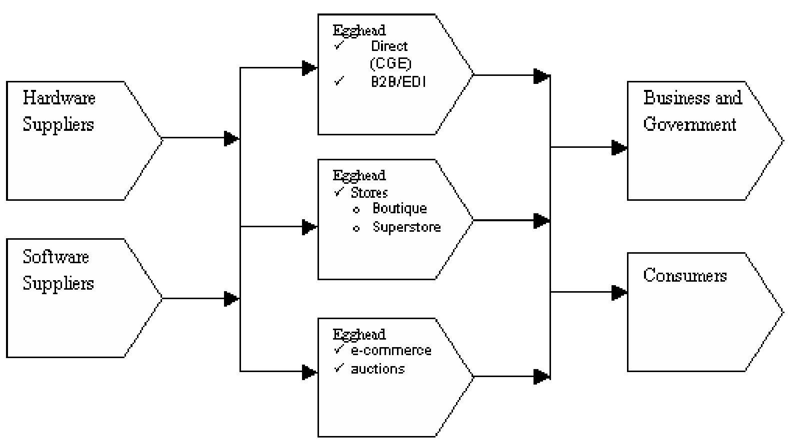
When Victor Alhadeff founded Egghead, he focused heavily on taking care of his customers, and offering fair prices and a liberal return policy. Many of the customers were early adopters and looked to Egghead to help them make the right purchases. The salespeople were considered friendly, knowledgeable, and helpful, and customers had a strong, trusting relationship with the company. Alhadeff led Egghead into new channels through a catalog-sales and call-center unit, and into the high-volume corporate, government, and education market. This increased Egghead's power with suppliers and allowed it to leverage its resources.

Within 7 years, Alhadeff and some of his key executives were forced out. The board began to assert itself, forcing more controls and greater bureaucracy on the company. The changes in the return policy upset loyal customers. This, coupled with the change in sales managers' compensation related to the return policy and the use of less knowledgeable, more sales-focused salespeople, negatively affected the image Alhadeff had worked hard to create. Direct involvement by senior management with customers as well as a fundamental understanding of Egghead's key competitive positioning might have helped Egghead's executives map out a strategy that would allow them to migrate from their supply-chain-focused EDI into a more comprehensive, e-commerce-focused enterprise progressively, limit risk, and integrate such a move with the other existing channels. It would also have positioned Egghead as an early leader with both CGE customers and consumers, and would have helped them maintain some power over their suppliers, many of whom were seeking alternative channels for software distribution.

The decision to sell the most profitable division, CGE, provided Egghead with a short-term boost in cash. Management intended to use the funds to revise the retail-store format and, possibly, to expand into e-commerce. The decision eliminated Egghead's biggest and most profitable channel, however, which affected its relationships with its suppliers. It no longer had the purchasing power or presence in large accounts to put it in a favorable position with suppliers. When it finally closed its remaining stores, Egghead ultimately became an intermediary in the highest risk, most competitive channel. Any competitive advantage it might have had based on its past multichannel approach and strong brand name was gone. Suppliers and buyers both had many other options for purchasing products. By the time Egghead went bankrupt, it was competing head-on with Amazon.com, Walmart.com, and hundreds of other online channels selling everything from computer software to coffeepots. It was one of many rather than a relatively unique, well-respected channel that meant good value, expert advice, and excellent customer service. Had management decided to maintain their multichannel approach (Figure 3), they may have been able to preserve shareholder equity while also maintaining an advantageous position with their suppliers. The brand name alone had significant value that all but dissipated due to the decision to go dot-com only.

Board members and executive management teams who find themselves in similar situations should first understand why their company is successful in the eyes of its customers. They should solicit input from employees and customers alike to make sure their decisions are in alignment with their customers' expectations. Today's consumers want to determine whom they buy from and in what format transactions takes place. Egghead's strengths lay in the off-line retail world. It was well positioned to leverage its brand name and market presence online. It had strong relationships with many customers, close to 200 locations throughout the United States, a profitable and sizeable corporate division, and a growing online presence. It also had inside information about the shift to e-

Figure 3. Egghead's potential role in the value chain (1996 and beyond)



commerce that it may not have been aware of: As Bellman, Lohse, and Johnson noted (1999), catalog buyers were more likely to share the traits of e-commerce buyers. R. King, Sen, and Xia (2004, p. 3) indicated that the "prototypical Internet shopper is time-starved and looks for convenience in buying." Perhaps if Egghead's executives had focused on the type of customers they had and how to best leverage their strengths, they would not have reacted so swiftly. Rather than leverage its multichannel approach to the market and the relationships it had with its customers, Egghead made the ultimately fatal decision to focus exclusively on an unproven channel. In their study of five companies, Rohm and Milne (2003) found that the Internet offered companies with strong brand equity expanded market alternatives and more market control. This does not suggest that a company should weaken its overall position in the market and shift entirely to an online strategy. In fact, the company should understand the source of its brand equity and make sure that what it does adds value rather than alters the value. Other retailers and wholesalers could learn from this catastrophic error by using their online presence to strengthen their off-line presence. They could provide customers with a range of channels that enable them to determine how they want to purchase products. In turn, the companies can focus on aligning their organizations so that each channel and each point of contact with the consumers maximizes the value to the customers and the profitability of the transactions.

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KEY TERMS

B2B: "Short for business-to-business, the exchange of services, information and/or products from one business to another, as opposed to between a business and a consumer" (B2B, n.d.).

Channel: "In sales and marketing, the way in which a vendor communicates with and sells products to consumers" (Channel, n.d.).

Disintermediation: "Removing the middleman" (Disintermediation, n.d.).

E-Commerce: "The buying and selling of goods and services over the Internet" (Ecommerce, n.d.).

Intermediary: "Acting as a mediator or an agent between persons or things" (Intermediary, n.d.).

Multichannel: "[O]ffering customers more than one way to buy something—for example, from a Web site as well as in retail stores" (Multichannel Marketing, n.d.).

Reach: "Be in or establish communication with" (Reach, n.d.).

Category: Concepts, Trends, and Challenges

DWDM Technology and E-Government Initiatives

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INTRODUCTION

The pervasive use of the Internet and unprecedented demand for dependable access to bandwidth-intensive multimedia applications motivate utilization of Dense Wavelength Division Multiplexing (DWDM) as a technological enabler of electronic government (e-government) operations by public agencies. In the public-sector, DWDM increasingly serves as a reliable technology for enhancing citizen access to inter-agency and intra-agency e-government programs, regulations, and policies and providing high-speed connectivity to e-government resources via optical fiber, a medium that transports voice, video, and data signals as light pulses. In addition to provisioning connections to feature-rich applications, DWDM also supports network backbone operations and accommodates bandwidth requirements for e-government interactions that take the form of government-to-government (G2G), government-to-employee (G2E), government-to-citizen (G2C), and government-to-business (G2B) exchanges (Carter & Belanger, 2004).

This chapter delineates the distinctive attributes of DWDM technology and the capabilities of DWDM in providing the capacity necessary for supporting e-government services that are responsive to citizen requirements. Metropolitan area and wider area e-government initiatives that utilize DWDM technology are described. Finally, considerations leading to effective utilization of this technology in supporting public-sector services are explored.

BACKGROUND

DWDM Technical Fundamentals

DWDM optimizes the capacity of a single optical fiber strand by dividing the optical spectrum into numerous non-overlapping lambdas or wavelengths of light to facilitate reliable high-speed transmission of vast numbers of optical signals concurrently with minimal or zero latencies. DWDM enables voice, video, and data transport at the Optical Layer, a sublayer of the Physical Layer or Layer 1 of the seven-layer OSI (Open Systems Interconnection) Reference Model in MAN (metropolitan area network) and WAN (wide area network) environments. In the public-sector, DWDM seamlessly interworks with Asynchronous Transfer Mode (ATM), Synchronous Optical Network/Synchronous Digital Hierarchy (SONET/SDH), Internet Protocol (IP), Gigabit Ethernet, and 10 Gigabit Ethernet broadband technologies.

DWDM Advantages and Limitations

With DWDM, the total amount of information transported is determined by multiplying the capacity of each lambda or wavelength of light by the total number of lambdas available (Littman, 2002). For example, in an 80 lambda DWDM network, 80 times the capacity of each 10 Gbps (gigabits per second) lambda enables transmissions at rates of 800 Gbps via a single optical fiber strand. This rate is doubled to 1.6 Tbps (terabits per second) in an 80 lambda DWDM solution featuring a pair of optical fiber strands.

It is important to note that a DWDM implementation is also subject to operational constraints. Physical barriers to DWDM optical transmission include chromatic dispersion that requires periodic signal regeneration through the use of electrical-to-optical-to-electrical conversion. Moreover, DWDM transmissions are adversely affected by unexpected temperature changes in optical equipment, the optical signal-to-noise ratio (OSNR), and manufacturing flaws in the optical fiber plant. Optical signal attenuation and crosstalk negatively impact high-volume optical throughput as well (Littman, 2002). To counter these constraints, network management systems designed for DWDM implementations monitor network performance, support fault identification and isolation, and enable system restoration resulting from optical fiber cuts and breakdowns in optical devices.

DWDM long-haul backbone networks support terabit transmission rates (Davis, Smolyaninov, & Milner, 2003). However, technical advances in the access network or that portion of the infrastructure between the home or business location and the telecommunications company central office (CO) or the first-mile do not keep pace with DWDM backbone network developments. As a consequence, transmission rates from the DWDM backbone network via the CO to the customer premise reflect the speed of the first-mile connection.

First-mile technologies including digital subscriber line (DSL) variants such as ADSL2 (asymmetric DSL2) and ADSL2+ employ sophisticated modulation techniques to optimize the transmission capacity of twisted copper pair typically found in the public switched telephone network. ADSL2 supports downstream rates at 18 Mbps (megabits per second) and ADSL2+ enables downstream rates at 24 Mbps over distances that extend to 4 km (kilometers). Increasingly popular, Ethernet in the first-mile over optical fiber broadband passive optical network (BPON) solutions foster downstream rates of 100 Mbps in fiber-to-the home (FTTH) and 1 Gbps in fiber-to-the-business (FTTB) configurations over distances that extend to 10 km (Littman, 2002).

DWDM and CWDM (Coarse WDM)

As with DWDM, CWDM is based on WDM technology and works either independently or in conjunction with DWDM. CWDM utilizes uncooled lasers that require less precise wavelength control and less costly optical components than DWDM. CWDM supports up to 16 lambdas on a single optical fiber strand whereas DWDM enables as many as 80 and potentially more lambdas to achieve terabit and petabit transmission rates.

CWDM technology is primarily used to extend the reach of optical fiber networks in local area BPONs. As with Ethernet BPONs, CWDM BPONs are immune to lightning and other transient forms of electromagnetic interference and feature greater bandwidth and fewer points of failure than first-mile broadband access network technologies such as ADSL2 and ADSL2+. Government agencies providing services in MANs and WANs also employ CWDM/DWDM configurations with an option to implement DWDM upgrades in response to traffic demand (Littman, 2002).

DWDM Standards

The ITU-T (International Telecommunications Union-Telecommunications Sector) approved Recommendations in 2001 for standardization of next-generation DWDM optical transport networks (OTNs) that provision on-demand bandwidth service. Endorsed in 2003, the ITU-T G.959.1 Recommendation describes capabilities of DWDM networks in enabling dependable high-speed transmissions at distances of 40 km and 80 km without signal amplification. In addition to the ITU-T, organizations that promote development of standards for interoperable high-capacity next-generation DWDM configurations include the European Telecommunications Standards Institute and the Internet Engineering Task Force.

DWDM E-GOVERNMENT INITIATIVES

E-government refers to the use of technology for enabling citizens to conduct online transactions and access government applications and services (Ke & Wei, 2004). In response to citizen demands for a more responsive government, public-sector entities increasingly employ DWDM to support cross-agency network consolidation, integration of fragmented and distributed processes, improvements in the quality of citizen services, and high-speed access to e-government resources and e-collaborative tools via a single interface (Bakry, Al-Bassam, & Alheraish, 2004).

The increase in multimedia traffic resulting from Internet popularity and requirements to ensure network reliability and availability contribute to the use of DWDM technology in e-government initiatives (Stoll, Leisching, Bock, & Richter, 2001). Capabilities of DWDM in enabling e-government services in metropolitan DWDM (MDWDM) networks in municipalities in Canada, Japan, and the U.S. are initially examined in this section. The role of DWDM in facilitating regional and wider area network operations in Canada, the European Union, South Korea, and the U.S. is then explored.

MDWDM Networks

Canada

Multiple factors including the pervasiveness of Web applications and demand for seamless high-speed access to interactive e-government services contribute to the use of MDWDM technology in Canada as a platform for supporting municipal e-government initiatives (Grobe, Wiegand, & McCall, 2002). For example, the City of Ottawa (2003) in the Province of Ontario administers Telecom Ottawa, a municipal public utility that provides MDWDM operations to support civic projects that include the City of Ottawa's Smart Central initiative. Sponsored by the Ottawa Center for Research and Innovation, this MDWDM-based e-government initiative interlinks public-sector agencies, research laboratories, local hospitals, businesses, schools, and post-secondary institutions and provides fast and dependable access to e-healthcare, e-learning, and e-business applications and national, regional, and municipal services. The City of Ottawa also participates in the Ottawa Rural Communities Network

(ORCnet) in extending Optical Regional Advanced Network (ORAN) broadband services to rural and remote communities (ITU, 2003).

Japan

In Tokyo, Japan, MDWDM technology provides connectivity to e-government applications with quality of service (QoS) assurances (Wang, Bretschneider, & Gant, 2005). This MWDM initiative facilitates online citizen participation in civic affairs; access to government policies; and delivery of video broadcasts, e-training sessions, e-learning applications, and security monitoring services. Similarly, the e-government MDWDM initiative in Kyotango City, Japan supports e-voting, disaster recovery and prevention services, and e-medicine consultations.

U.S.

In the U.S., municipalities that utilize MDWDM technology enlist the support of public and private entities that include K-12 schools, school districts, post-secondary institutions, housing and transit authorities, financial organizations, museums, businesses, and hospitals. For example, the MWDM e-government solution developed by the U.S. City of Santa Monica, California in conjunction with the Santa Monica-Malibu School District and Santa Monica College enables e-learning and public safety applications and access to e-services provided by utility companies and public-sector agencies.

DWDM WANs

Canada

A Government of Canada initiative, CA*net 4 (Canadian Network for the Advancement of Research, Industry, and Education, Phase 4) utilizes a DWDM infrastructure that supports connections to international peer-level DWDM networks such as GÉANT2, the second phase of the pan-European backbone WAN, and high-performance DWDM regional networks implemented by provincial governments. The CA*net 4 DWDM infrastructure facilitates deployment of e-government services including an e-voter outreach program to encourage citizen participation in elections, access to legal information through the MyLegalAnswers Web portal, and connectivity to the Flintbox initiative to assist organizations with copyright compliance (CANARIE, 2004). The CA*net 4 DWDM platform also provides links to the Electronic Courthouse to help arbitrators and adjudicators resolve contract disputes virtually, simulations for training Canadian transit workers, e-learning sessions for educators sponsored by the Canadian School Boards Association, and the Grid Canada initiative. This government-sponsored grid supports access to shared computational, simulation, storage, and visualization resources to support cross-institutional research in fields that include education and healthcare (Foster, Kesselman, & Tuecke, 2001; Littman, 2005).

European Union

A European Commission initiative, GÉANT2 enables advanced information communications and technology (ICT) initiatives in sectors that include e-government, e-medicine, e-business, and e-learning and interconnects NRENs (next-generation research and education networks) in member states and affiliates in more than 30 countries (Littman, 2002). Moreover, GÉANT2 contributes to the realization of e-Europe objectives that include development of a consolidated pan-European e-government interoperability framework to provide uniform access to secure e-government services in accordance with the e-Europe 2005 Action Plan. GÉANT2 NREN participants with DWDM implementations that provide a foundation for supporting broadband connectivity to interactive public-sector initiatives include the Czech Republic (CESNET2), the Netherlands (Surfnet6), Poland (PIONIER), Switzerland (SWITCH), and Greece (GRNET2).

South Korea

In South Korea, the DWDM e-government initiative enables citizens to readily access information on national security, defense, legislation, schools, and businesses; review public policies; and obtain personal records on birth, marriage, and death via an e-government portal that is accessible via KORNET, the nationwide DWDM Internet backbone network. When this DWDM e-government initiative is fully operational, citizens will be able to make payments online for national and local taxes, traffic tickets, health insurance, and utility services. Participating agencies include the Ministry of Government, Administration and Home Affairs; the Ministry of Construction and Transportation; the Supreme Court; and the National Tax Service.

U.S.

Despite budget cutbacks, state agencies in the U.S. continue to invest in DWDM to provide high-quality e-government services and citizen access to relevant public-sector information (Carter & Belanger, 2004). For example, the state-sponsored Iowa Communications Network utilizes DWDM technology to interlink government agencies, K-12 schools, post-secondary institutions, and medical facilities in an area that extends to 4,800 kilometers. Operated by the Oklahoma State Regents for Higher Education, Oklahoma OneNet employs DWDM technology to provide integrated access to e-government services and digital records including state legislation and judicial decisions, e-learning and e-medicine projects, virtual training sessions, and Internet2 (I2) via the Abilene DWDM backbone network. Established by universities and research centers in cooperation with industry and government, I2 facilitates development of new networking initiatives and applications in fields such as biomedicine and grid computing (Littman, 2002).

The state-sponsored Illinois Century Network (ICN) uses a DWDM infrastructure to provide equitable access to e-government applications and information resources maintained by state agencies such as the Illinois Board of Education, the State Library, and the State Department of Central Management Services. The ICN also supports DWDM links to e-learning and e-training services for health professionals, farmers, merchants, and educators and advanced optical projects such as I-WIRE (Illinois Wired/Wireless Infrastructure for Research and Education) and StarLight, a DWDM peer-level international exchange facility in Chicago that features connections to next-generation networks and serves as a testbed for assessing DWDM performance (Littman, 2005).

Multiple organizations form strategic partnerships to defray the costs of building a DWDM infrastructure. For instance, the MAX (Mid-Atlantic Crossroads) DWDM backbone network initiative is supported by a multi-state consortium. Participants in the MAX consortium include academic institutions, research centers, and federal agencies such as the U.S. Department of Agriculture, the U.S. Food and Drug Administration, the U.S. Department of Health and Human Services, and the National Institute of Standards and Technology. In addition to enabling bandwidth-intensive operations and high-speed connections to support the work of consortium participants in Washington, DC, Virginia, and Maryland, MAX serves as a traffic aggregation point for the National LambdaRail, a DWDM research and production backbone WAN that extends across the U.S. and facilitates connectivity to Abilene, the I2 backbone network.

Subsequent to the endorsement of the U.S. E-Government Act of 2002 that supports development of a federal e-government portal and elimination of redundant systems and services, U.S. government agencies that typically operated a multiplicity of separate networks involving public health, emergency management, disaster recovery, and military operations increasingly use DWDM to support cross-agency network integration to make service provisioning more efficient. Sponsored by the U.S. Department of Defense Information Systems Agency (DISA), for example, the Global Information Grid-Bandwidth Expansion initiative launched in 2004 features a long-haul mission-critical DWDM backbone network that facilitates real-time command and control information exchange and reliable access to bandwidth-intensive military applications, e-training sessions, and critical operations at intelligence and DISA facilities at more than 100 locations.

FUTURE TRENDS

Demand for robust, reliable, and scalable networks to provide multimedia services and accommodate the increase in Internet traffic flow contributes to DWDM implementation in the public-sector to improve the effectiveness of traditional government operations and provision dependable connectivity to e-government programs to meet stakeholders' expectations and priorities (Elmagarmid & McIver, 2001; Scherlis & Eisenberg, 2001). However, utilization of DWDM technology as a platform for e-government operations can also result in unanticipated and undesired outcomes such as cost overruns, security problems, inter-agency conflicts, and stalled e-government processes (United Nations, 2004).

A phased and flexible planning strategy based on a detailed analysis of workflow and a systematic inventory of core processes to identify candidate government applications that are likely to succeed in an electronic format can aid in reducing disruptive changes during the transition from conventional government services to DWDM-based e-government operations (Scholl, 2002). Stakeholders including senior management, civic leaders, professionals, government employees, and communities of interest that actively participate in e-government strategic planning sessions can play a critical role in either encouraging or rejecting adoption of DWDM-enabled e-government initiatives.

MDWDM and wider area DWDM networks support implementation of sophisticated e-government initiatives that enable citizens regardless of geographic location to interactively develop solutions to public-sector problems in the same virtual space (Foster et al., 2001). Since DWDM networks sponsored by public-sector agencies carry economically valuable data and sensitive information, policies for network security, non-repudiation of services, data protection, identification, authentication, acceptable use, and privacy must be in-place prior to full-scale e-government implementation (Joshi, Ghafoor, Aref, & Spafford, 2001). Mechanisms for monitoring network operations to ensure network availability while providing convenient access to e-government resources and support of disaster recovery services in the event of cyber-terrorism and natural and artificial disasters must also be firmly established.

CONCLUSION

Government agencies turn to DWDM technology to provide on-demand bandwidth and dependable high-speed access to citizen-centric services and public-sector applications (Medjahed, Rezgui, Bouguettaya, & Ouzzani, 2003). Public-sector agencies that build a successful DWDM infrastructure must establish attainable goals and objectives with specific milestones, a realistic timeframe for full-scale implementation, and a set of standards and guidelines to facilitate dependable G2G, G2E, G2C, and G2B interactions that conform to agreed-upon security and privacy policies. Implementation of an effective e-government solution based on DWDM technology requires a holistic view of e-government processes, a strong commitment of government funding, effective leadership, and a phased implementation of public-sector applications that are responsive to citizen requirements and equally accessible. To overcome resistance to change, gain grassroots support, and encourage widespread participation in DWDM-based e-government initiatives, public-sector agencies should also sponsor e-training sessions on how the e-government DWDM platform works, provide around-the-clock technical assistance, and assure citizens through demonstrations of practical applications that e-government transactions are conducted in a safe and trusted environment.

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KEY TERMS

Attenuation: Loss of signal strength and power as a signal passes through the optical fiber medium.

Backbone Network: Long-haul networks such as CA*net 4 and GÉANT 2, Long-haul that interconnect network segments in WAN configurations to facilitate resource sharing and e-collaborative information exchange.

Broadband Passive Optical Network (BPON): Features point-to-multipoint architecture for provisioning access to high-speed broadband applications such as video-on-demand over the first-mile.

Chromatic Dispersion: Spreading of light pulses as they transit an optical fiber. Results from variations in the density of the optic fiber medium and culminates in signal distortion.

DSL: Supports consolidation of data, video, and voice traffic to facilitate broadband transmission via ordinary twisted-copper-wire pair telephone lines over the first-mile between the telephone company CO and the subscriber premise.

Ethernet: A popular local area network (LAN) technology that supports transmission rates at 10 Mbps and serves as the basis for the IEEE (Institute of Electrical and Electronics Engineers) 802.3 standard and its extensions. Newer and faster versions of Ethernet include Fast Ethernet (100 Mbps), Gigabit Ethernet (1 Gbps), and 10 Gigabit Ethernet (10 Gbps).

Open Systems Interconnection (OSI) Reference Model: Seven-layer architectural model developed by the International Standards Organization (ISO) to describe standardized network operations.

Web Portal: A Web site that serves as a gateway to distributed network resources, applications, and other Web sites.

Dynamic Planning Models for E-Business Strategy

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INTRODUCTION

Much has been written about e-business and how this concept will transform industries into virtual networks of customers and suppliers working together to create value-added processes (Fahey, Srivastava, Sharon, & Smith, 2001). Typically, successful organisations will have embraced enterprise resource planning (ERP) systems to integrate e-business processes within the organisation and to underpin the creation of integrated interorganisational systems. This frequently results in new business processes, organisational structures, human resource skill requirements, management roles, and knowledge management systems (Robey et al., 2002). To be successful in this new climate, however, organisations have to learn new approaches to strategy and planning for collaborative systems and to manage e-business enabled cycles of innovation (Wheeler, 2002; Zahra & George, 2002). Few studies have explored the dynamics of e-business strategic planning and little information is available on how to implement new paradigms successfully and how to ensure more effective e-business performance as a result (Damanpour, 2001; Kallio, Saarinen, & Tannila, 2002).

This article reports on the findings from multiple case studies of e-business projects in ERP-enabled organisations. Each organisation was investigated in a three stage study over 4 years, using three theoretical models of e-business implementations to assess success. The key findings from each case study were captured into a staged model for e-business transformation and related to a dynamic planning model that can be applied across all stages of growth of the extended enterprise.

BACKGROUND

Planning for E-Business

Fahey et al. (2001) stated that:

E-business embodies the most pervasive, disruptive, and disconcerting form of change: it leaves no aspect of managing organisations untouched, it challenges long-accepted business models, and organisation leaders have little to draw on from their past experience to manage its effects. In particular, its capacity to transform business processes is no longer in dispute. Senior executives—thus confront a central challenge: How should they endeavour to capture, analyse, and project the transformational impact of e-business on their organisation's most critical or core processes? (p. 890)

Strategic planning for such systems has to encompass capabilities for managing, measuring and evaluating organisational abilities to create value across the network of alliances and hence requires evolutionary approaches which can be tailored to organisational needs at different stages of e-business growth (Ash & Burn, 2003; Wheeler, 2002). This whole process is sometimes described as IT governance, including strategic planning processes, change management processes and accountability and return on investment (Kallio et al., 2002; Patel, 2002). Planning cannot take place in isolation and must encompass all aspects of the emergent learning organisation in virtual networks of value alliances.

In order to study this environment in detail the authors embarked on a longitudinal study of organisations implementing large-scale e-business applications over a 4 year period. The 11 organisations were visited three times during this period, and a minimum of three interviewees participated on each visit. The structured interviews were focused on three separate models of business change to investigate different aspects of e-business governance, and the results from these investigations brought together into a dynamic planning model for e-business transformation. The use of three research models was specifically intended to give breadth to the study and allow the incorporation of a variety of strategic views that informed the planning process.

Theoretical Framework

E-business implementations were investigated from the perspective of three strategic theories: Virtual Organising, e-Business Change, and Benefits of B2B, where:

1. Virtual organising is measured along a continuum applied to each of the three dimensions of customer interaction, asset configuration, and organisational knowledge (Venkatraman & Henderson, 1998).
2. E-business change processes are measured across eleven interrelated components within three broad categories of organisational change, strategic management innovation, and information systems evaluation (Guha, Grover, & Kettinger, 1997).
3. Benefits of B2B are related directly to a comprehensive set of B2B models: B2B: $B2B^C$ and $B2B^S$, B2C, B2E.

Each model reflects a different business focus: organisational strategy, change management, and e-business work practices. The resulting conceptual frameworks are described in terms of an e-business strategy model and a dynamic planning model for e-business implementation. The dynamic planning approach is a strategic collaborative process between alliances where there is a continual review of alignment of the e-business transformation against business objectives. This is quite distinct from the 'one size fits all' approach of centralised planning and allows strategy to evolve with changing market conditions. This approach provides the means to explicitly define and manage relationships between supply network partners and to monitor trends and trigger a revisiting of strategic decisions across the network (Oliver, Chung, & Samanich, 2003).

Methodology

Data were gathered from three sources: primary, secondary, and tertiary:

1. **Primary Data:** From semistructured interviews conducted November 1999, June 2000, and June 2001. Three separate interviewees were identified within each organisation and revisited across the study.
2. **Secondary Data:** From company documents collected or sent via e-mails.
3. **Tertiary Data:** From case research papers written by third-party specialists.

The case material collected was used to verify all the strategic characteristics of e-business transformation and to develop the dynamic planning model.

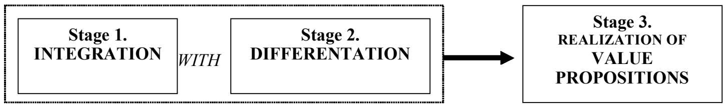
E-BUSINESS STRATEGY MODEL

The model in Figure 1 shows the focus for strategic planning shifting through three stages of development with outcomes and performance gains realised through greater progression towards extended enterprise resource planning:

Table 1. Participating organisations

Case Organistion	Industry	B2E Interaction	e-Business Project Title	No. of Users
1. Halliburton **2. UBS**	Engineering Banking	Intranet access to ERP	"Employee Tracking Intranet" "Employee Networking"	~1,100 staff ~40,000 emps
		B2C Interaction		
3. Wine Society	Retailing	Internet access to ERP	Online Ordering by Members	~60 staff
4. UNICEF Aust.	National Charity	Internet access to ERP by ASP	1st Australian Charity Web site	~35 employees +30 volunteers
		B2B Interaction	($B2B^S$ and $B2B^C$)	
5. Biotech **6. Novartis** **7. Bertelsmann** **8. Statoil** **9. Employee-Nat**	Biotechnology Chemical Media Oil and Gas Employment	ERP to supplier catalogues and Intranet access to ERP data	Staff research procurement Sales Order and Rapid Delivery Simple Ordering e-catalogue Staff travel procurement Simple Ordering e-catalogue	~240 staff ~22,000 ~28,000 ~18,000 ~14,000
10. FSC - Fujitsu Siemens computer	Computer	ERP to corporate customers	Order Request System extended to an e-Mall of 3 companies	~11,000
11. Dell corp with **LSI Logic corp**	Computer ------------------ Electronics	non-ERP with ERP	Customised online sales Integrated with customers MRO procurement	~27,000 ~14,000

Figure 1. Three stages of strategic model



- **Stage 1:** Integration of technologies is critical for cost reductions and operating efficiencies along the supply chain;
- **Stage 2:** Differentiation of products and services is critical for e-business market positioning through effective resourcing across multiple supply chains;
- **Stage 3:** Demonstration of value propositions within an inter-organisational network to design and leverage multiple interdependent communities to create superior economic value across the virtual supply chain (Singh & Thomson, 2002; Venkatraman & Henderson, 1998).

Table 2 represents a map of the issues distilled from the findings of this longitudinal three-stage study. The results of the analysis can be mapped along the e-business stages of growth as: integration of e-business technologies for e-malls and B2B commerce, differentiation of products and services for e-business positioning, and the realisation of value propositions of the e-partnerships.

In Table 2, the three shaded cells in the eBS model (3×3) indicate the "critical" elements that require a cultural shift for a real organisational transformation and so represent distinct shifts in the federated planning approach. The other elements contribute to the organisation's competitive advantage.

Stage 1: Integration

Technologies: E-ERP

The findings show that back-end to front-end enterprise application integration is essential to achieve savings and cost reduction. Integration of the system architecture is made possible through a variety of back-end, sell-side and buy-side systems; all 11 cases demonstrated this, but specifically Statoil and Siemens with their standardised ERP platform and e-business applications.

Products and Services: E-Malls

In a study of Australian e-Malls, Singh and Thompson (2002, p. 308) concluded, "it is apparent that for effective B2B exchange in Australia, standards for interoperability between business partners, and technology integration for information exchange on goods and services is essential"; for example, Fujitsu Siemens Computers (FSC)

Table 2. Stages of e-business strategy (The diagonal cells (shaded) represent the critical stages of eBP and the arrows represent real organisational transformation with e-business)

	Stages of e-Business Strategy (1999 -)	(2000 -)	(2001 -)
Business Dimensions	**Stage 1: Integration**	**Stage 2: Differentiation**	**Stage 3: Realisation of Value Propositions**
Technology (virtual infrastructure)	* ICT ERP with e-Sales & e-Procurement applns	Differential Resourcing ASP vs. cost of ownership on the outsourcing spectrum	Innovative Technologies ERP and non-ERP networks for e-marketplaces
Products & Services (virtual experience)	E-Malls E-Mall integration and information exchange	* E-Branding Customisation vs. standardisation, Brand identity & integrity	E-Communities Foster customer, supplier, and employee expertise. Emerging collaborative online communities
Business Models (virtual B2B interactions)	E-Commerce Integration B2B Integration of E-Sales & E-Procurement systems $B2B^C + B2B^S$	E-Positioning B2B positioning within a range open to private e-marketplaces	* E-Enterprise One2Many vs. One2One Distinct focus of One2One partnerships
Examples	Remote experience of e-catalogues. More tasks, "group ware" skills for online communication.	Assemble and coordinate assets through effective use of online services	Business network to design and leverage interdependent e-communities. Dependent on relationships

achieved integration of three groups' online sales systems.

Business Models: E-Commerce B2B Integration

The integration of e-business models, $B2B^C$ with $B2B^S$ is essential to maximise efficiency gains from supporting technology infrastructure, so that people can get the job done efficiently. Two cases of B2B e-business integration with a global computer supplier (Dell) and its largest corporate customer (FSC) demonstrate a more complex model. These exemplar cases demonstrate the integration of ERP with non-ERP systems using Web-based technologies to provide the infrastructure required to optimise the overall B2B value chain. Also, the study emphasizes the synergistic benefit stream from B2B integration and the interaction of interorganisation e-business solutions.

Stage 2: Differentiation

Technologies: Differential Outsourcing

Segev and Gebauer (2001, p. 249) argue "the mid points of the outsourcing continuum are the most challenging." From case observations they describe the continuum as a wide range from "do it yourself" to complete outsourcing, with an increasing number of possibilities. The one case study where the complete management of an e-ERP project was outsourced to an ASP, demonstrates the challenge for UNICEF to balance the loss of control against the cost of ownership whereas FSC partially outsourced their online sales systems to Siemens Business Systems quite successfully.

Products and Services: E-Branding

The e-business tactics for positioning in the virtual space were to:

- differentiate between corporate customers and end consumers (e.g., UNICEF and Dell);
- deliver customised products and services using standard components (e.g., Dell and FSC); and
- differentiate between brand identity and brand integrity, where e-branding becomes a critical issue (e.g., Bertlesmann, UNICEF, Wine Society, Dell, and FSC).

Business Models: E-Positioning

Biotech and Novartis repositioned to align with their largest corporate suppliers. FSC repositioned itself into the computer industry through e-sales. The tendency of these pioneers was to start with development of public relationship building and then shift to private relationship building between suppliers and buyers. This is observed to be more than a passing phase.

Stage 3: Demonstration of Value Propositions

Technologies: Innovative Technologies

Halliburton's HR Intranet ERP system demonstrated a B2E value proposition. Their technology innovation was bottom-up driven and from both sides of B2E and B2G of the value chain. This bottom-up approach provided a model for the company's global e-ERP infrastructure. Employee-Nat demonstrated the integration of ERP and non-ERP systems with Web technologies (Fan, Stallaert, & Whinston, 2000). The Wine Society found problems with a lack of internal expertise to implement Web-based innovations within their ERP system.

Products and Services: E-Communities

Statoil and UBS used Intranet employee self-service applications to develop a practice of industry-based e-communities. Dell has competence centres where customers can validate system design and configuration without disrupting their live computing network. These facilities act as collaborative online network to provide customers with systems design and application tuning support, allowing them to test various hardware and software configurations before making a purchase decision (e.g., Dell and FSC).

Business Models: E-Enterprise Model

A pilot approach demonstrating a value proposition is shown in the One2One relationship formed by Dell and LSI. Also, the case emphasizes the synergistic benefit stream from B2B integration and the interaction of inter-organisation e-business solutions. In the short term, it may be better to adopt e-commerce implementations (e-sales and e-procurement) with new customers and suppliers. This has the capability of persuading existing customers and suppliers that are more resistant to e-business change of the win-win value propositions (e.g., FSC with SAP, Dell and LSI). In these twin case studies, the focus was on building a One2One relationship. The creation of a win-win value proposition was observed to be a model for other B2B partnering.

Table 3. Stages of dynamic planning model

	Stage 1	Stage 2	Stage 3
Strategic focus	Self-service	Empowerment	Relationship building
Planning focus	Top-down Training Internal	Bottom-up Self-learning External	Collaborative Value enhancement Community
Outcomes and Performance Gains	Improved operating efficiency (ROI)	Effective resourcing (QWL)	Virtual and economic value added (EVA)

Key: Return on investment (ROI), Quality of working life (QWL), Economic value added (EVA)

DYNAMIC PLANNING MODEL

The changing strategic focus across the stages of the dynamic planning model are classified in Table 3, and viewed as interdependent and supportive of each other. This is especially so in the area of *outcomes and performances objectives* where *efficiency* through employee self-service and *effectiveness* through empowerment in customer care is used to support *value adding* activities for sustained competitive advantage. Value includes complementary benefits realised for all network partners across the virtual supply chain. The interplay between strategy, e-business, change management and evaluation is crucial to the creation of dynamic capabilities and will enable organisations to gain sustainable competitive advantage (Zahra & George, 2002).

At stage one of the extended enterprise, the focus is very much internal with top-down planning and an emphasis on training employees to become proficient in self-service to improve operating efficiencies and increase returns on investment. For example, UNICEF had to expend considerable energies on retraining staff to improve the efficiency of its operations and then experienced difficulties moving into the second stage. The first shift comes when the enterprise extends its relationships across the full supply chain for products or services. At this stage, the focus is on empowerment and self-learning through bottom-up planning within the organisation. There is also a realignment of business objectives to include external alliances across the supply chain. Halliburton found that much of their HR process could be shifted into the operational face of the organisation as hand held computers logged work hours against contracted hours and government legislation for foreign employees. This often necessitates changes in personnel since higher skill levels may be required. Finally, the focus will be directed towards reengineering the supply chain though collaborative planning to gain value enhancement throughout the networked community. This occurs with a shift of business model towards the e-enterprise.

FUTURE TRENDS

By taking a more holistic approach, executives can turn the stages of a company's transformation into the drivers of e-business excellence. So the central task for senior managers lies in understanding what drives operational excellence in the e-business realm, and then committing the necessary resources (structures, training, planning responsibilities) to the development of the drivers. To this end managers should assess the company's operations by looking at both the traditional and e-business measures. The complete model for e-business strategy can act as a comprehensive tool, for assisting managers in diagnosing the key facilitators and inhibitors of successful stages of e-business development. It is not seen as a prognostic tool. The case analyses confirmed that the more successful projects were found to have facilitators in all components of the e-business strategic framework. Barua, Konana, Whinstone, and Yin (2001) specifically refer to the success of a company's e-business initiatives coming from the readiness of customers and suppliers to engage in electronic interactions. To overcome resistance to change, each component must be aligned, along with the enabling technology, to the strategic initiatives.

Vering and Matthias (2002, p. 159) argued that in the learning organisation there is:

- a new generation of system users,
- a constant or continuous nature of change, and
- a demand for both top-down and bottom-up change.

However, change still requires that resources be matched to the business objects and tasks and, further, that planning systems are appropriate to drive organisational change through workplace implementation (van Hooft & Stegwee, 2001; Coltman, Devinney, Latukefu, & Migley, 2001). In the new business environment organisational business models are more complex, supply chain networks more flexible and agile, training is shifting to self-directed learning, and collaborative planning approaches are needed to achieve greater added value to the community network (Fahey et al., 2001). The challenge for future research will be to identify whether alignment occurs within a staged growth model of change or through a dynamic intervention from internal or external sources.

CONCLUSION

This study of e-business strategy was based around a triangulation of three independent research models: virtual organising, e-business change with critical success factors and facilitators, and complementary benefits from B2B interaction. Each model exhibits attributes that have varying influences at different stages of e-business planning and implementation. The proposed model of e-business strategy and planning can be used as a detailed criterion to direct and evaluate the progress in the virtual space for traditional organisations or new entrants. The model offers a foundational perspective of strategies, planning tactics and performance objectives for e-business implementations. These together form the basis for a dynamic planning system.

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KEY TERMS

Dynamic Planning System: A three staged model identifying different approaches to planning at different stages of e-business growth.

E-Business Strategy: Comprehensive set of planning approaches that reflect the stage of e-business growth within the organisation.

ERP-Enabled Organisations: Organisations with fully implemented enterprise resource planning systems extending into B2B and/or B2C applications.

EVA: Economic Value Added, this is an attempt to measure value over and above return of costs and includes many of the intangibles. A typical approach would combine some form of ROI and QWL.

Extended Organisation: Knowledge based-organisation with links to customers and suppliers across an electronic supply chain.

QWL: Quality of Work Life, this is a measure of employee satisfaction with their working environment and can include fairly subjective measures such as self-empowerment, enjoyment, self-satisficing indices.

ROI: Return on Investment; typically, a simple calculation based on costs of systems development and implementation measured against returns on investment. Problems with this include a measure relate to the difficulties of quantifying intangible costs and benefits.

Virtual Organising: An integrated approach to becoming an extended organisation by focusing on customer assets, supplier alliances and employee empowerment through ICT enabled knowledge management.

Dynamic Pricing for E-Commerce

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INTRODUCTION

Over the last decade, e-commerce has significantly changed the traditional forms of interaction among humans in conducting business by automating business processes over the Internet. Early seller Web sites consisted of passive text-based catalogs of products that could be manually browsed by potential customers. Online passive catalogs were soon replaced by dynamically updated catalogs containing detailed product descriptions using combinations of text and images that could be searched in various formats and according to different search criteria. E-commerce techniques used by sellers for operations such as price setting, negotiation, and payment have matured from manual off-line processing of sales data to automated algorithms that dynamically determine prices and profits for sellers. Modern e-commerce processes for trading goods between buyers and sellers can be divided into five stages: search, valuation, negotiation, payment, and delivery. Depending on the type of market in which the goods are traded, some of the above stages are more important than others.

There are three principal market models that are used for online trading. The most common market model used by online sellers for trading goods over the Internet is the posted-price market model. The other two market models, the auction model (Sandholm, Suri, Gilpin, & Levine, 2002) and the marketplace model (Chavez & Maes, 1996), are used for markets in which niche or specialty items with sporadic or uncertain demand are traded.

In the posted-price market model, a seller announces the price of a product on its Web site. Buyers visiting the seller's Web site request a quote from the seller. The seller responds with a quote in response to the buyers' requests, and the buyers examine the seller's quote to make a purchase decision. Unlike auctions and marketplaces, products traded in posted-price markets are no-niche items and exhibit continuous demand over time. The Web site of online book merchant Amazon (http://www.amazon.com) is an example of a posted-price market. A buyer interested in a particular book enters the necessary information through a form on Amazon's Web site to request the price of the book and receives the price in response.

Modern seller Web sites employ automated techniques for the different stages of e-commerce. Intermediaries called *intelligent agents* are used to automate trading processes by implementing different algorithms for selling products. For example, Web sites such as MySimon (http://www.mysimon.com) and PriceGrabber (http://www.pricegrabber.com) automate the search stage by employing the services of intelligent agents called *shopbots*. Shopbots enable buyers to make an informed purchase decision by comparing the prices and other attributes of products from thousands of online sellers. Automated price comparison by buyers has resulted in increased competition among sellers. Sellers have responded to this challenge by using intelligent agents called *pricebots* that dynamically determine the price of a product in response to varying market conditions and buyers' preferences. Intelligent agents are also used to enable other e-commerce processes, such as supply-chain management and automated negotiation.

In this article, we focus on the different algorithms that sellers' pricebots can use for the dynamic pricing of goods in posted-price markets.

BACKGROUND

Over the past few years, online dynamic pricing has stimulated considerable interest in both the commercial and research communities. Increased profits and rapidly clearing inventories resulting from efficient pricing have encouraged the development of software pricing tools including Azerity (http://www.azerity.com) and Live Exchange (http://www.moai.com). Automated dynamic pricing for posted-price markets has been implemented and analyzed using simulated market models (Brooks, Gazzale, MacKie-Mason, & Durfee, 2003; Dasgupta & Melliar-

Smith, 2003; Kephart, Hanson, & Greenwald, 2000). Most of these models consider the price of a product as the only attribute affecting a buyer's purchase decision. Surveys of consumers who purchase products online, reported in Brown and Goolsbee (2000) and by ResellerRatings (http://www.resellerratings.com), reveal that online buyers are frequently willing to pay an elevated price for particular product attributes such as delivery time, seller reputation, and service. Moreover, the preferences of buyers vary over time depending on exogenous factors such as sales promotions, aggressive advertising, and the time of year. Therefore, it is important for an online seller to differentiate a product using multiple attributes and to determine the purchase preferences of a potential buyer over those attributes so that the seller can tailor its offer to the buyer's requirements and improve its profits.

In online markets, a seller must determine the prices that its competitors charge for a product so that it can place its price at a competitive advantage. The rapid fluctuation of market prices can leave a seller with outdated competitor price information that can cause the seller's dynamic-pricing algorithm to function incorrectly. However, it is difficult for sellers to obtain prior information about buyers' parameters. Therefore, it is desirable if online sellers do not assume prior knowledge about market parameters, but rather use a learning algorithm (Brooks et al., 2003; Dasgupta & Hashimoto, 2004) to determine changing market parameters dynamically.

DYNAMIC PRICING USING INTELLIGENT AGENTS

In an automated posted-price market, a seller employs the services of a pricebot that dynamically calculates a profit-maximizing price of a product in response to fluctuations in market parameters, such as the prices and profits of competing sellers and the reservation prices of buyers. The seller posts the updated product price at regular intervals to attract buyers while maintaining a competitive edge.

The market model we consider is based on the shopbot economy model of Kephart, Hanson, and Greenwald (2000), which makes simplifying assumptions about the online economy that facilitate analysis while retaining the essential features of the market. It consists of S sellers who compete with each other for B buyers ($B \gg S$). Only one type of commodity is traded in the market. A seller behaves as a profit maximizer and has a sufficient supply of the commodity for the lifetimes of the buyers. Buyers return to the market repeatedly to purchase the commodity. Examples of such markets include telephone and Internet services.

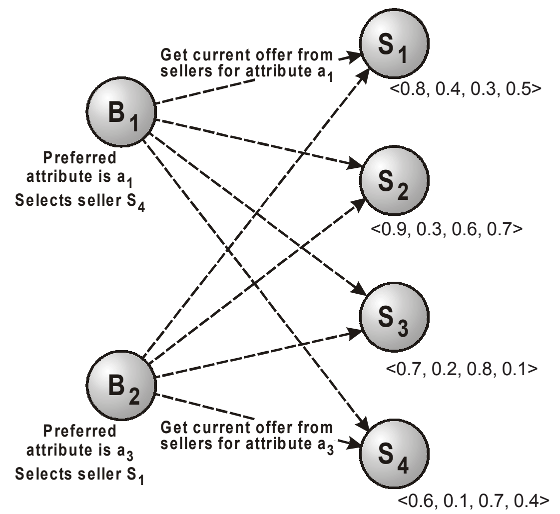
A product is characterized by multiple attributes. A seller offers a slightly different price for the product along each of its attributes. As shown in Figure 1, a buyer first requests a quote from the sellers for the price based on his or her preferred product attribute, and then selects the seller that makes the best offer. The buyer's preferred attribute is not revealed to a seller when the buyer makes a quote request. Therefore, a profit-maximizing seller must determine a buyer's preferred attribute in response to the buyer's quote request. The seller then calculates a competitive price for the product along the buyer's preferred attribute and makes an offer to the buyer.

Dynamic-Pricing Algorithms

Because online sellers are profit maximizers, the objective of a seller is to determine a price for each attribute of the product that maximizes the seller's profit. However, the pricing function of a seller cannot be stationary as there are other competing sellers who revise their prices to improve their offers and attract buyers away from each other. Therefore, the seller updates the prices it charges on different product attributes at intervals in response to competitors' pricing strategies and changes in the buyers' preferred attributes.

We describe in the following sections some pricing algorithms used by an online seller's pricebot to determine the price of a product. We omit the subscript for

Figure 1. A hypothetical market showing two buyers, B_1 and B_2, with preferred attributes a_1 and a_3, respectively, making a quote request to four sellers, S_1, S_2, S_3, and S_4, and then selecting the seller that offers the best price for the product on their respective attributes. The four-tuple below each seller denotes the normalized price on the different product attributes offered by that seller.



attribute a_i in the price and profit notation for the sake of clarity. We illustrate the algorithms for a single seller assuming that it is competing with other sellers in the market. We use p_t to denote the price charged by the seller during interval t.

Derivative-Following Algorithm

In the derivative-following (DF) algorithm, a seller uses its profit information since the last price update to adjust its price in the next interval. If the profit in the last interval has increased from its previous value, the price for the next interval continues to move in the same direction as in the last interval. On the other hand, if the profit in the last interval has decreased from its previous value, the direction of the price movement is the reverse of the direction in the last interval. The equation for updating the price during interval t+1 using the DF technique is given by:

$$p_{t+1} = p_t + \delta_t \operatorname{sign}(\pi_t - \pi_{t-1}) \operatorname{sign}(p_t - p_{t-1})$$

Here, π_t represents the profit made by the seller during interval t, and δ_t represents the amplitude of the price change and is drawn randomly from the uniform distribution $U[l, u]$, where $l > 0$ and $u > 0$.

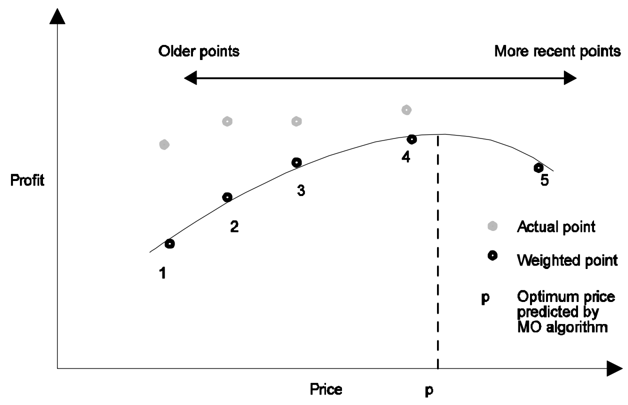
In the DF algorithm, the price of the product is updated based on the profit information from only the last interval. Therefore, the DF strategy is not very efficient in dynamically tracking the price of a product in a rapidly fluctuating market. A more efficient technique, the model-optimizer (MO) algorithm described next, employs the historical price and profit information of the seller to update the price during the next interval.

Model-Optimizer Algorithm

A seller using the MO algorithm maintains its price-vs.-profit profile over the last h intervals, where h denotes the size of the history window of the seller, as shown in Figure 2 for h = 5. The MO algorithm works as follows:

1. Assign weights to the last h points in the price-vs.-profit profile of the seller. The weight of a point expresses its relevance to current market conditions. Older points are less relevant and are assigned lower weights; more recent points are more relevant and are assigned higher weights.
2. Fit a polynomial over the h points in the history window of the seller using a nonlinear regression approach.
3. Use a nonlinear optimization scheme, like the Nelder-Mead algorithm (Nelder & Mead, 1965), to determine the price that corresponds to the maximum profit.

Figure 2. The operation of the MO algorithm with h = 5

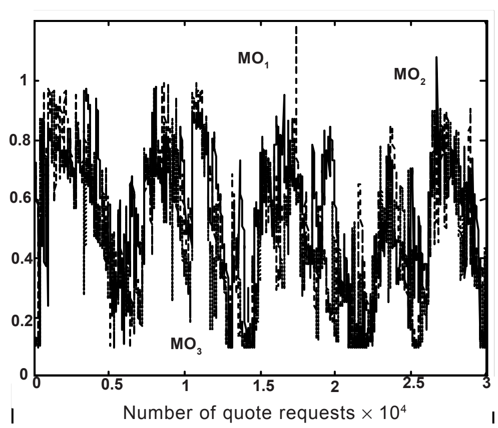


Although a large history window h might yield accurate results, it increases the time required for calculating the price for the next interval. If the seller is relatively slow in dynamically updating its price, its competitors might outperform it. Therefore, the value of h should be selected carefully to balance accuracy with rapidity in price calculation.

Figure 3 shows the variation in prices over time for three competing sellers in a market using the MO algorithm. As shown in the figure, the sellers using the MO algorithm engage in repeated cycles of price wars with each other. The reason for the price wars is that there are buyers with different preferences in the market. For simplicity, we assume that there are only two types of buyers.

- A-type buyers that do not have price as the preferred attribute. Such buyers select a seller using

Figure 3. Price-vs.-time profile of three sellers using the MO algorithm



other undetermined criteria, which we model as selection at random.

- B-type buyers that have price as the preferred attribute. Such buyers shop for the lowest price in the market and select the seller offering the lowest price.

Based on a survey of online markets (Clark, 2000), we assume that the ratio between A-type and B-type buyers in the market is 1:3. Because B-type buyers are greater in number, they generate the majority of the revenue for the sellers. Therefore, the sellers reduce the price of the commodity in successive intervals so that they can attract the maximum number of B-type buyers by offering the lowest price among competitors, thereby undercutting each other. This price war continues until each seller's price reaches the production cost p_{co} of the commodity. Each seller has zero marginal profit in such a scenario. At this point, the sellers realize that they can make more profit by increasing the price of the commodity to attract A-type buyers instead of charging p_{co} to attract B-type buyers. Therefore, the sellers reset their prices to a high value and another cycle of the price war ensues.

The drawback of the MO algorithm is that it charges a uniform price to all buyers irrespective of the buyers' preferences. However, this uniform pricing results in a loss of revenue from A-type buyers who are willing to pay a much higher price for a commodity than B-type buyers. Thus, the buyer population can be segmented into different clusters depending on the buyers' preferences, and a different price can be charged for each segment.

Although some online merchants such as Amazon have implemented dynamic pricing, it is yet to be adopted widely in e-commerce. The principal drawback of the dynamic pricing mechanism that those merchants have employed is that it offers identical products to different buyers at different prices, resulting in discontented buyers. A better pricing strategy would be to identify the preferred attribute of different buyers and charge a slightly different price for the product based on a buyer's preferred attribute as described below for the multiattribute dynamic-pricing algorithm.

Multiattribute Dynamic Pricing

As shown in Figure 1, a buyer compares the prices offered by different sellers based on his or her preferred product attribute. To make a competitive offer in response to a buyer's purchase request, a seller identifies the buyer's preferred attribute to offer a competitive price to the buyer on that attribute. The seller estimates the distribution f_{pa} of a buyer's preferences over the product attributes and then uses it to predict the preferred attribute of a buyer in response to the buyer's purchase request.

The algorithm for multiattribute dynamic pricing is based on collaborative filtering (CF), which enables a seller to predict a buyer's preferred attribute. Collaborative-filtering algorithms (Kleinberg & Sandler, 2003; Sarwar, Karypis, Konstan, & Reidl, 2001) collect potential buyers' opinions or preferences on products of interest, and recommend possible products to new or returning buyers. A seller's attribute-prediction algorithm for a potential buyer must adaptively respond to changes in the buyer's preferences. The buyer attribute-prediction algorithm described below achieves this adaptive response by dynamically updating the seller's model of the buyer's attribute preferences.

Buyer Attribute-Prediction Algorithm

In the buyer attribute-prediction algorithm, a seller constructs one buyer cluster for each product attribute. Suppose the seller maintains C clusters. A buyer with preferred attribute a_i is placed into cluster c_i with probability $w_{i,t}$ during interval t. These probabilities are updated dynamically in response to the buyer's accepting or rejecting offers made by the seller. When a buyer makes a purchase request, the prediction algorithm takes the history of $w_{i,t} - s$ and outputs the predicted cluster (preferred attribute) for the buyer. Sophisticated, rather complex algorithms have been developed for assigning buyers to clusters, determining appropriate prices for buyers within clusters, and revising assignments and prices in response to decisions by buyers to purchase or not (Dasgupta & Hashimoto, 2004).

FUTURE TRENDS

The collaborative-filtering algorithm described above enables online sellers to determine a buyer's preferences over multiple product attributes and to update the posted product prices efficiently in a competitive market. More powerful learning techniques such as Q-learning (Mitchell, 1997) and multi-objective, evolutionary algorithms (Coello, Veldhuizen, & Lamont, 2002) offer mechanisms to enable sellers to search the profit landscape more efficiently. There are various trade-offs between the rapidity and accuracy of such learning algorithms. A naive but fast learning algorithm might compare favorably against a complex and accurate but slow learning algorithm in a dynamic environment like a competitive online market.

An interesting scenario arises when buyers' purchase preferences are dependent on the prices being charged by sellers. In such a scenario, a seller can attempt to learn not only the temporally varying buyer purchase-preference distribution, but also the variation in that distribution.

Probabilistic algorithms such as hidden Markov models and moving-target functions that estimate the dependence between temporally varying functions might be applied in such an environment.

CONCLUSION

We have described different algorithms that an online seller can use for the dynamic pricing of products in a posted-price market, where the seller announces the price of a product on its Web site. We have also described techniques that an online seller can use to determine the price of a product, including multiattribute dynamic pricing and adaptive response, in which the seller's model of the buyers' attribute preferences is updated dynamically.

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KEY TERMS

Auction: A type of market in which sellers post an initial price for the item being offered and a deadline by which the item needs to be sold. Buyers make bids on the offered item. The auction mechanism determines the dynamics of the prices bid by the buyers, the winner-determination strategy, and the bid-disclosure strategy. Common auction mechanisms include the English auction, Dutch auction, and Vickrey auction.

Buyer's Reservation Price: The reservation price of an item for a buyer is the maximum unit price that the buyer is willing to pay for an item. The buyer's reservation price is typically drawn from a uniform or normal distribution.

Collaborative Filtering: A technique that is used to collect user opinions or preferences for items of interest. A CF algorithm employs a correlation method to predict and recommend items to new or returning users based on the similarity of their interests with those of other users.

E-Commerce: Consists of techniques and algorithms used to conduct business over the Internet. Trading processes such as supply-chain management, strategic purchase planning, and market mechanisms for trading commodities online are implemented using e-commerce.

Intelligent Agent: Performs tasks that are given to it without continuous supervision. An agent can perceive changes in its environment and can perform actions to accomplish its tasks.

Marketplace: A type of a market that corresponds to a central location that enables buyers and sellers to rendezvous. A marketplace is typically implemented as a blackboard where sellers post information about items being offered. Buyers make offers to sellers, and sellers respond with counteroffers.

Pricebot: An intelligent agent that is used by an online seller to determine a profit-maximizing price for a product that it sells. A pricebot encapsulates the pricing algorithm used by an online seller and enables a seller to maintain an edge over its competitors in a dynamically changing market scenario.

Seller's Production Cost: The production cost of an item for a seller includes the manufacturing and procurement costs for the item, and corresponds to the minimum price that the seller can charge for the item.

Shopbot: An intelligent agent that enables online buyers to determine and compare prices and other attributes of products from different online sellers.

E–Banking Application and Issues in Abbey National PLC

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INTRODUCTION

The financial service is facing a new delivery challenge in the shape of the Internet and e-commerce (Akamavi, 2005). The Internet as a channel for banking service delivery is fundamentally different from other channels such as branch networks, telephone banking, or automated teller machines (ATMs). The term e-banking is often used interchangeably with online banking, Internet banking, and PC banking. For example, Pikkarainen, Pikkarainen, Karjaluoto, and Pahnila (2004) define online banking as an Internet portal, through which customers can use different kinds of banking services ranging from bill payment to making investments. A bank's Web site offering only information without possibility to conduct any transactions is not qualified as online banking. Lbbotson and Moran (2003) use the term "electronic forms of banking", which includes telephone banking, PC banking, and Internet banking. In line with this definition, Lassar, Manolis, and Lassar (2005) refer e-banking as various formats or technologies, including telephone banking, direct bill payment, electronic fund transfer, PC banking, and online (Internet) banking. In this article, e-banking is referred to Internet banking or Online banking that it must enable Internet based transactions. This distinguishes e-banking from other electronic-based remote banking. E-banking can be carried out anywhere from a device with an Internet connection and it enables access to account information and conduct online transactions.

E-banking brings up unique types of challenges and requires novel solutions (Shah & Gupta, 2005; Southard & Siau, 2004). This article reviews how e-banking has been developed in Abbey National PLC (Public Limited Company) with a focus on the important issues when implementing e-banking applications[1].

BACKGROUND OF ABBEY NATIONAL

Abbey is one of the UK's leading personal financial services company. It was formed in 1944 by the merger of the Abbey Road Building Society and the National Building Society, two long established organizations. In 1989 Abbey National changed from a Building Society to a PLC. Abbey National PLC was acquired by Banco Santander Central Hispano SA in December 2004. The company operates in the UK, Europe, and the United States. It is headquartered in London and employs about 25,000 people. The company recorded revenues of £6171 million during the fiscal year ended December 2004. It offers a full range of personal financial services including mortgages and savings, bank accounts, loans and credit cards, long term investments policies, critical illness and unemployment cover, and household finance.

Abbey National's strategic aim is to become more customer and sales focused, growing the number of valuable customers through retention, and increasing the flexibility of offering in terms of product channel and service. The strategic aim illuminates Abbey National's e-business strategy development and implementation. Abbey National's e-business strategy is implemented through setting up a separate e-banking unit—Cahoot (www.cahoot.com) in addition to Abbey's online banking services (www.abbey.co.uk). Abbey National launched its retail e-banking service in May 2000, this allows existing customers to access their accounts via the Internet. One month late, the separately branded e-bank Cahoot was launched. Abbey National's Internet banking allows customers to: check account balance, transfer money between accounts, pay bills, and set up overdrafts. The service is available to current bank accounts, savings accounts, and credit card accounts. Cahoot offers customers current accounts, credit cards, flexible loan and share dealing. Cahoot does not allow high-risk groups (for example under 21 years old) to open accounts with them and this resulted in 40% rejection of all the applications. Customer credit rating is used to determine the acceptability of potential customers. Cahoot customers are offered with different interest rates, this is depended on the level of their credit rating and risks to the bank. The most popular product offered by Cahoot is the current account mainly due to its competitive rates.

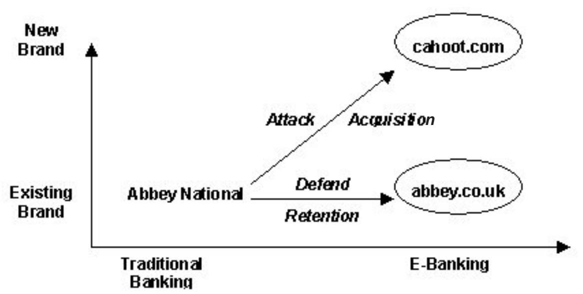
DESCRIPTION OF E-BANKING APPLICATION AND ISSUES

Abbey National's Hybrid E-Banking Model

Cahoot is owned by Abbey National PLC but with a new brand. The managing director perceives the potential to set up an online only bank in order to reach customers who do not already bank with Abbey National. Cahoot has gained Abbey National a vast amount of customers who they would not have been able to acquire by traditional banking methods. Abbey National's e-banking structure reflects a hybrid e-banking model, which is depicted in Figure 1.

Creating a new e-banking brand reflects the typical subsidiary model or spin-off model of e-business suggested by Chavez, Leiter, and Kiely (2000), who argue that the primary purpose of separating the e-banking unit is to target new market. Spinning off e-business unit has advantages in capitalization—raising funds from external sources, and running the new business independently to avoid any legacy impact from the parent company. However, Mols (1998) suggests that banks should use the Internet as an additional channel of distribution and must keep their traditional channels. This gives the banks the opportunity for a gentle transition from a branch banking strategy to e-banking strategy. Li (2001) endorses this notion by arguing that the legacy players that move

Figure 1. Abbey National's hybrid e-banking model



online seem to ultimately have an advantage over online-only startups. Despite the thorny issue of whether legacy players should spin off or integrate their online units, it is predicted that about 80% of the new economy will be dominated by the old economy companies that learn new tricks fast. Pure payers need to team up with legacy partners. The new brick-and-mortar of e-commerce is increasingly recognized as the winning formula. Pikkarainen et al. (2004) further suggests that pure online banks often use other channels as well, such as contact centers, and some have even established physical presences by establishing branch services.

Abbey National creates Cahoot with the aim to explore a new market, whilst establishing its own online banking services to retain existing customers. Cahoot's managers perceived that this model enabled Cahoot to benefit from avoiding large initial investment needed to run the banking business and the high risk of starting an online banking business. Abbey National had over one million customers sign up to their Internet banking service in less than 15 months, this makes Abbey National one of the fastest growing online banking facilities in the UK.

Customer Acquisition

In order to achieve its strategic goal of customer focus, to grow and retain valuable customers, Abbey National offered a competitive "take up" rate to attract customers to use Internet banking services. In addition, within most of Abbey's branches, Internet access computers were installed in order to increase awareness, and entice people to use the e-banking facility.

Cahoot's customer acquisition focus is to attract customers by switching to Cahoot e-banking from other banks. Within their customer base, 80% are new customers and 20% are existing customers from Abbey National. This implies that the cannibalization effect between the two brands is low. However, this strategy may face great difficulty in the long run, Datamonitor (2000) suggests that the traditional UK retail banks are all launching Internet banking operations so internet banks are going to find it more difficult to compete for customers in a saturated market. When facing with increasing attractive interest rates offered by other e-banks, the managing director commented that if people choose to bank with a bank which is offering the best rates, those customers will tend to keep moving banks as better offers come up. Abbey National aims to create long and trusted relationships with its customers.

Launching and Marketing of the Online Brand

Abbey National regards engaging in e-banking and creating an e-banking unit as innovation, which has been driving the changes of the whole group. The primary purpose to create Cahoot is to reach customers from a new market that is being created by the Internet. The managers perceive that this is an attractive segment in the market that Abbey National could not reach with its traditional banking approach. They believe that there are a number of people who are willing to deal with new brands in a digital environment, thus creating Cahoot to target the non-Abbey National customers. Abbey National has successfully gained a number of customers that would not have banked with them, if they had not created Cahoot.

Managers from the two banks hold the same view that having the Abbey National brand name behind Cahoot is essential, as reassurance and confidence are crucial in e-banking. Cahoot gained reassurance of legitimacy by stating Abbey National as the parent company for Cahoot in the Web site. One of the managing directors commented that people are more likely to use Internet enabled facilities with well-known brands. Abbey national spent millions of pounds in advertising the Cahoot new brand. The form of advertising includes TV commercials, banners, press and posters, direct mail, as well as radio media. The efforts were paid off, as Cahoot achieved 50% brand recognition and contributed 25% to Abbey National's favorable recognition. It is reflected by the managers that an Internet bank needs a large parent company, such as Abbey National, to start up the business and fund it through until it makes profit. This reaffirms Shah and Gupta's (2005) argument that having an established brand was a critical success factor in e-banking. Yousafzai, Pallister, and Foxall (2005) explained that the main reason was that a household name gives customers added confidence to conduct business online.

Security Issues of E-Banking

Privacy and security concerns have been regarded as significant obstacles to the adoption of online banking (Sathye, 1999). Security issues will further crush already fragile customer confidence, any security problems will affect the number of customers attracted to the Web sites (Datamonitor, 2000). Howcroft, Hamilton, and Hewer (2002) revealed that consumers' confidence in their bank in the UK was strong, their confidence in technology was weak. Shah and Gupta (2005) stress that security, which may include protection of consumers' personal data and safe transaction, is paramount for the growth of any sort of online trade including e-banking. They define e-banking security including secure transactions as well as secure front and back end systems. However, e-banking security has not been seen as a problem in e-banking leading country—Finland. Mattila, Karjaluoto, and Pento (2003) reported that security is an influential factor affecting mature customer adopting e-banking, but Finish Internet banking customers in general consider Internet banking safe in their earlier study. Pikkarainen et al. (2004) reaffirm Mattila et al.'s (2003) finding by stating that online banking channel has proven to be safe to use and no misuse has been reported by the media in Finland.

Abbey National had not experienced major security problems with the launch of their Internet add-on and Cahoot, but recognized customers' concern on the security of e-banking due to customers' lack of understanding. Hence, Abbey National had to reassure people about their security measures, that is, using high level encryption for all e-banking transactions by both Abbey National and Cahoot. In addition, Abbey National published a "Peace of mind guarantee" on their Web site stating that, if any loss is made due to Internet insecurity, Abbey National will reset the accounts into the position where they were before. The managers expressed that they were happy with their current security measures, but security can always be improved. The tightness of security measures needs to be cost effective. Cahoot also has a privacy policy, which is published on its Web site. The manager emphasized that individual had a lot to do with security. For example, the behavior of using computers for e-banking (i.e., where they access their accounts from), whether customers leave the computer unattained but logged on, whether customers keep passwords confidential and choose appropriate passwords, etc. A manager stated that security will not necessarily have a negative effect on growth, unless there are some major scandals that are well documented and wide spread, so that people may lose trust and confidence in security over the Internet as a new channel for banking.

The Risks of E-Banking

There are many risks associated with e-banking. Traditional banking risks are magnified in an electronic medium (Pennathur, 2001). Firstly, business risks may be over or under estimated. Internet banking can attract the hit and run customers, who maintain an account with an Internet only bank until special offers expire. Secondly, reputation risk due to e-banking as a new banking venture. Any hitches or failures of systems tend to be spread quickly in the media, and reflected badly on banks' reputation. Many UK banks, when launching their Internet offerings, have had problems. For example, customers from Barclays Bank reported that they were able to see other customers account details. The problem followed with an upgrade to the system (Leyden & Lynch, 2000). Cahoot's e-banking system only worked for 90 minutes and then crashed when started to launch on the first day. The system did not run smoothly until 24 hours after the incident happened. Only a few hundred people had opened accounts by the end of the first day. The problem was well documented in the media that the crash was due to the number of people trying to open the online account simultaneously, as preferential rates were offered to the first 25,000 accounts opened. Cahoot found that there was great media attention on the crash, but this was beneficial in some aspects later. When the media reported the story, it also printed Cahoot logo and the promotional interest rates. When Cahoot launched advertisements later, the campaign generated high responses of interest and applications. It seems that the negative media report actually posed some positive effects on consumers' awareness of the new brand. Lynch (2000) states that although most of these types of risks usually happen when the bank first goes online, problems tend to be remembered for a long time. Failure sticks in the mind of perspective customers, which could potentially harm their reputation. Thirdly, security risk. As Internet banking deals with sensitive financial information, critics are looking to exploit bank errors. Due to the structure and intention of the Internet to be an open network, high security risks are involved with financial transactions because of criminal intent attack: for example, hackers actively probe the bank's system to gain access to data for inappropriate use; casual hackers and flaws in the bank's Internet system, which may lead to security breaches.

Benefits of E-Banking

Benefits of e-banking can be viewed in two facets. One is for banks, and the other is for customers (Lassar et al., 2005). The notable benefit of e-banking for banks is cost saving (Pikkarainen et al., 2004). Akamavi (2005) explains that an automated Web site is accessed 24 hours a day, 7 days a week, without the need for human operators to keep it functioning. Not only does this clearly offer increased convenience to the growing number of people with Internet access, it also represents significant cost savings for the bank. E-banks can avoid substantial investments for delivery channels and the high cost of staff required to "man" these delivery channels. E-banks do not have the costs of the legacy systems as the traditional banks have. E-banking expenses are thought to be only 25-30% of traditional banking services (Hansman, Van Den Bosch, & Volberda, 2001; Lu, Liu, Jing, & Huang, 2005). Low cost can enable e-banks to offer special competitive rates to entice customers to bank with them. Secondly, e-banks can potentially reach more customers than a fixed branch network. For traditional banks, the risk of not offering Internet banking service is to lose existing customers who want to bank online. Thus Internet banking becomes an inevitable weapon to retain existing customers and to react to competition. Jayawardhena and Foley (2000) suggest that banks that are unable to respond to requests for new services risk losing existing customers to competitors. Thirdly, e-banking offers the opportunity for banks to solidify and extend their relationship with a customer (Lbbotson & Moran, 2003). The Internet enables banks to customize their products and services to suit individual customer's needs and preferences. Lastly, the Internet can be an effective way of communicating to customers (Aladwani, 2001) and expanding business into non-traditional banking areas (Colgate, 1998; Jun & Cai, 2001). For example, e-banks can cross sell motor insurance by providing interactive online services.

The main advantage of e-banking for consumers is to allow customers access their account information from anywhere with an Internet connection. Convenience, time saving, accuracy and timeliness are some of the notable benefits when customers choose online banking. Other benefits include flexible choice of banking, competitive offerings and better tools to manage and compare information.

Factors Hamper the Adoption of E-Banking

UK consumers seem cautiously stepping into e-banking and some consumers prefer a multi-channeled banking approach. MORI (2001) reported that Internet banking in Britain appears to be following the U.S. pattern, where people who do most of their banking online still want choice and the reassurance of a high street presence. Report by Datamonitor (2001) shows that 63% of UK consumers indicate personal visit is their preferred method for dealing with banking products, a figure which rises to 88% elsewhere in Europe. This is reinforced by Lbbotson and Mortan (2003), who reported that lack of personal contact is the main reason that SMEs in Northern Ireland are not using remote banking, in addition to security concern. Another reason is that pure E-banks do not have a branch network, and is lack of personal contact for immediate assistance (where additional assistance may be provided over the phone, but it is often charged with high call rates). Other factors include deposits need to be sent to the e-bank by post, which means a delay in the deposit being credited. E-banks have to use other bank's services, for example, ATMs, the usage of these services may be charged.

The Future of E-Banking

The managers hold the view that e-banking is not appropriate for all segments of the banking market, and is not suitable for all types of banking products. There are people who have never used the Internet and never want to. However, the Internet could reach a larger potential market, but this will take a long time. Internet-based banking has only been around for a relatively short period of time and branch based banking has been around for hundred of years. In terms of products suitable for e-banking, one manager emphasized that people prefer to carry out simple transactions over the Internet at the moment, but there is potential for complicated products to be offered online in the future.

THE IMPACT OF E-BANKING

The Internet is transforming the retailing banking industry as well as consumers' awareness and behavior of banking. Firstly, the adoption of e-banking strategy reshapes the bank's organizational structure. Traditional banks are largely working on a defense strategy by creating Internet add-ons to prevent customers from defection. Pure e-banks tend to work on an attack strategy by offering preferential rates to attack the traditional banks' customer bases. A successful strategy demonstrated by Abbey National is their pure e-bank is backed by the parent company, which forms a successful hybrid e-banking structure.

Another impact is on developing a deep and broader relationship with customers. Two trends emerged from launching the e-banking service: more transactions are carried out over the Internet than that in branches; more customers are moving from telephone banking to Internet banking, rather than from branch to the Internet. Abbey National's experience shows that e-banking appeals to people who are happy not to have face-to-face contact. These types of customers are empowered to bank with Abbey National or Cahoot when and where they want to.

E-banking also influences consumers' banking behavior directly. One the one hand, with more and more people are getting connected to the Internet with broadband technology, and more media exposure of online banking, more customers will be switching to e-banking in the long run. On the other hand, competitive offerings and aggressive marketing from e-banks will reduce consumers' loyalty to their traditional banks. Internet banking makes easier for customers to change bank accounts than it used to be (Clarke, 2001). This creates challenges for both online and traditional banks as to how to retain these switching customers.

CONCLUSION

E-banking is a cost-effective channel for banks to develop and deliver a broad range of products and services. E-banking also brings many benefits to customers including convenience and better products and customer services. However, the concerns over e-banking security, and the inhuman nature of e-banking hold many people back from taking the advantages of e-banking. From banking industry point of view, e-banking is becoming a common practice of banking as well as a new battlefield of competition, although at the present, only limited transactions are carried out on the e-banking platform.

Some lessons can be learned from Abbey National's experience. Firstly, develop a strategic goal of e-banking, either focusing on retaining customers through Internet add-ons, or emphasizing acquiring new customers through e-banking channel, or achieving both. The conibalization effect between the traditional banking channel and the e-banking channel needs to be continuously analyzed in order to determine the strategic direction of the company and the operational tactics of e-banking. Secondly, a new e-banking brand needs to be associated with well-known brands of the parent company, and needs effective marketing effort. Thirdly, educate consumers on e-banking security and build trust. The focus should not lie only on implementing encryption mechanism, firewall procedures, intrusion detection and virus controls, but also on reassurance of consumers of these security measures adopted publicly, and the guarantee of consumer rights including liabilities, compensation, privacy, data protection etc. It will also be beneficial to educate consumers on how to securely use the e-banking services. Fourthly, in order to reduce operational and reputation risks, accurate forecast of potential Web traffic seems essential to the smooth launching of online banking. In addition, sufficient test of the Web site with large volume of data needs to be conducted and a contingency plan needs to be in place to deal with system errors or unexpected incident. Lastly but not the least, the e-banking products and services provided should be viable and competitive to sustain long-term success. Although acquiring new customers through preferential rates proved to be successful, the challenge is how to retain e-banking customers who appear less loyal than traditional customers. Retaining customers and sustaining long term success should be on the top agenda of senior managers of e-banks.

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ENDNOTE

1 Data about Abbey National was collected from interviews with the director of Internet banking at Abbey National and the managing director of Cahoot in 2002. Other data was searched from published sources and the Internet.

eBay's Dominance in Internet Auctions

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BACKGROUND OF THE BUSINESS: INTERNET AUCTIONS

Internet auctions began in 1995 and have been growing rapidly since. As of May 2001, the estimated total revenue of Internet auctions reaches $556 million. Since the beginning of Internet auctions, *eBay* has maintained a dominant leading position although the popular attention and the profitability of eBay induced entries of two biggest e-commerce firms, Yahoo!, in October 1998, and Amazon.com, in March 1999. An eBay vice president said in January 2000 that eBay's market share in the Internet auctions market remained at approximately 90% (see Lucking-Reiley, 2000). As of fall 2001, it is believed to be more than 80%.

Internet auction sites such as eBay and *Yahoo!Auctions* acts as listing agents, allowing individual sellers to register their items on their Web sites and running Web-based automatic auctions on their behalf. Actual exchanges including payment and shipment are worked out by the buyer and the seller on their own. The English auctions have been the most dominant format in Internet auctions. However, sellers usually have some control over these Web-based auctions, choosing a set of different parameters for each auction such as the duration days, an opening value, an optional secrete reserve price, and so forth.

A variety of goods are auctioned in Internet auctions, but the largest category by far has been the collectibles. Each Internet auctions site has different categories, and there is usually no one top-level category that includes all the types of collectibles. Between September 27, 2001, and November 1, 2001, 59% of listings on eBay belonged to one of the categories such as antiques and art; collectibles; books, movies, music;,coins and stamps; dolls and doll houses; or toys, bean bag plush. During the same time period, 54% of listings of Yahoo!Auctions were included in one of the following categories: antique, art and collectibles; sports cards and memorabilia; toys and games and hobbies; or coins, paper money and stamps.

Table 1. Auction mechanism

	eBay	Yahoo!Auctions
auction format for a single item	English auction	English auction
proxy-bidding	Optional	Optional
secret reserve price	Optional	Optional
duration (days)	3, 5, 7, or 10	2 - 14
feedback-and-rating	Available	Available
buy it now	Optional	Optional
early close	Optional	Optional
auto extension	Not Available	Optional

DESCRIPTION OF THE BUSINESS: eBay vs. Yahoo!Auctions

Yahoo!Auctions has kept a distant second place in the Internet auctions market although it has offered a little bit more options in *auction mechanisms* and lower *listing fees* compared to the leader, eBay. As shown in Table 1, both sites offer similar auction mechanisms (in terms of auction formats and auction parameters), but Yahoo!Auctions offers an additional option, auto extension, in the closing rule and more flexible duration dates.

Despite similar auction mechanisms between eBay and Yahoo!Auctions, these two sites charge *distinctively different* fees to sellers. During the first 17 weeks of the year 2001, eBay charged two types of basic fees to sellers: insertion fees and final-value fees. The insertion fees of eBay range from $0.30 to $3.30, depending on the opening values (called also reserve prices or minimum bid levels), whereas the final value fees are 5% of the final value (called also sale price or closing value) up to $24.99, 2.5% from $25.00 up to $1,000.00, and 1.25% over $1,000.00. On the other hand, Yahoo!Auctions charges only insertion fees ranging from $0.20 to $1.50. As indicated in Table 2, eBay charges higher insertion fees for all the ranges of opening values. A seller can ex ante choose a secret reserve price as well. If the secret reserve price is not met by the close of the auction, the item will not be sold. The fees for the secret reserve price auctions are fully refundable if the item is sold. If an item is not sold, the seller can relist the same item subject to insertion fees. On eBay, the insertion fee for the second listing is refundable if the item is sold in the second round.

Table 2. Listing fees

		eBay	Yahoo!Auctions
Insertion Fees			
Opening Value	$0.01-$9.99	$0.30	$0.20
	$10.00-$24.99	$0.55	$0.35
	$25.00-49.99	$1.10	$0.75
	$50.00-$199.99	$2.20	$1.50
	$200.00and up	$3.30	$1.50
Final-Value Fees			
Closing Value	$0-$25		
		5%	Free
	$25-$1000	$1.25 + 2.5%	
			Free
	over $1000	$25.63 + 1.25%	Free

The basic fees of Internet auctions have not changed frequently. Indeed, Yahoo!Auctions began to charge insertion fees only from the beginning of the year 2001. At the same time, eBay raised its insertion fees a little bit to the levels shown in Table 2. As will be discussed below, these changes of fees had significant impacts on the number of listings on Yahoo!Auctions.

Despite more options in the closing rule and lower listing fees on Yahoo!Auctions, eBay's dominance is evident in terms of both the number of listings and Web site usage. The data employed in the article is unique because it is unusual to obtain the data of the number of listings and Web site usage on any auctions site other than eBay. Our data of the number of listings are obtained from the *Downtown Magazine's Wednesday Report*. The *Downtown Magazine* is an unbound magazine available via the Internet (www.dtmagazine.com) and reports its counts of the number of auction listings updated every Wednesday by noon, Eastern Time. In this counting, eBay listings do not include eBayMotors or Great Collections but include Business Exchanges and UltimateBid Tickets and Experiences, whereas Yahoo!Auctions listings include Yahoo!'s Business Marketplace.

This weekly data of the number of listings for eBay and Yahoo!Auctions were collected from the first week of the year 2001. However, from the second week of April 2001, the Wednesday Report ceased counting the number of weekly listings on Yahoo!Auctions and began to report the number of listings on a monthly basis.

As illustrated in Figure 1, during the first 17 weeks of 2001, the number of listings on eBay remained between 5 million and 5.7 million after an increase in the first week. On the other hand, the initiation of fees on Yahoo!Auctions in the beginning of the year 2001 had a dramatic impact on the listings of Yahoo!Auctions. The number of listings on Yahoo!Auctions declined drastically from more than 2 million to about 250,000 by the seventh week of the year 2001, and then stabilized around 220,000. According to the *Downtown Magazine*, Yahoo!Auctions had highs of 2.5 million listings in mid 2000. In what follows, therefore, our data analysis will focus on the period of the 7th week to the 13th week (the third week of February to the first week of April) after the changes of the fee schedules were fully absorbed in sellers' listing behavior.

The data of weekly Web site usage (measured by "*unique visitors*" and "*page views*") of these two auctions sites are obtained from Nielsen//NetRatings for the first 17 weeks of the year 2001 (except in the first week of March for eBay and the first week of January for Yahoo!Auctions). *Unique visitors* is the estimated number of different individuals who visit a firm's Web site, and *page views* is the number of unique visitors multiplied by the average unique pages viewed per visitor. This usage data from Nielsen//NetRatings is unique in the sense that the weekly usage of Yahoo!Auctions is counted separately from the entire site of Yahoo!. Unlike the number of listings, however, the changes of fees had no substantial effect on Web site usage. As illustrated in Figures 2 and

Figure 1. Listings

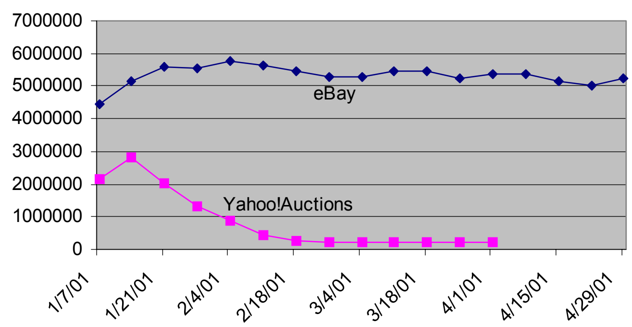


Figure 2. Unique visitors

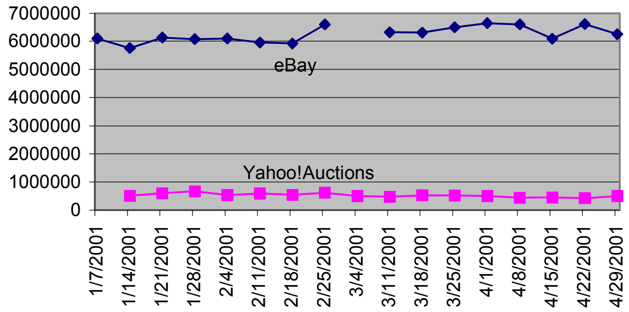
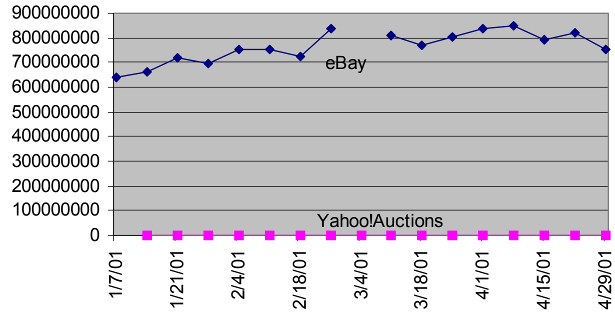


Figure 3. Page views



3, between the seventh week and the 13th week of 2001, eBay had about 6.3 million unique visitors and 763.6 million page views on weekly average, whereas Yahoo!Auctions had about 530,000 unique visitors and 1.7 million page views. It is quite puzzling that the initiation of fees on Yahoo!Auctions incurred the drastic decrease of listings but had no significant impact on Web site usage. One possible explanation is that before the initiation of fees, many sellers on Yahoo!Auctions might have kept listing their items over and over until they were sold and thus the number of the listings were substantially overcounted.

The data of the number of listings and Web site usage shown in Figures 1 through 3 clearly indicate that eBay has much larger Web site usage (measured by either unique visitors or page views) and much more listings than Yahoo!Auctions.

The number of *potential bidders* faced by a specific seller on an Internet auctions site, however, may not be exactly equal to the number of Web site usage of the site. Because different sellers may list similar (or substitutable) items in the overlapping time periods, we may infer that Web site usage per listed item is more relevant than the Web site usage itself.

As discussed above, Web site usage is typically measured by either unique visitors or page views. When we look into our data of unique visitors and page views as well as the number of listing, we can confirm that page views per listed item is more relevant to the number of potential bidders. It is *striking* to note that during the period in concern (the 7th week to the 13th week of 2001), unique visitors per listing are on average 1.2 on eBay but 2.3 on Yahoo!Auctions whereas page views per listing are on average 148.4 on eBay but 7.3 on Yahoo!Auctions. As reported in Bajari and Hortaçsu (2001), the average number of (actual) bidders for U.S. mint/proof coin sets was 3 on (traded) eBay auctions. Considering that unique visitors (including sellers) per listing are on average 1.2 on eBay, we can infer that unique visitors per listing may not be appropriate for the number of potential bidders. Moreover, page views reflect the multiple roles of a unique visitor in Internet auctions: A (same) unique visitor may act as a seller, a potential bidder, or both, possibly in the multiple different auctions.

Different listed items may face competitions from different groups of similar (or substitutable) items, and some buyers may not be interested in bidding some items. Hence, the number of potential bidders faced by a specific seller may be item specific. Therefore, we assume that the number of potential bidders faced by a seller is an increasing, item-specific function of Web site usage per listed item. Under this assumption, a seller faces more potential bidders on eBay. Because eBay has more listings, we can infer a *positive correlation* between the number of listings and the number of potential bidders in Internet auctions.

LESSONS LEARNED: NETWORK EFFECT AND THE FIRST-MOVER'S ADVANTAGE

Park (2005) showed that the positive correlation between the number of listings and the number of potential bidders is generated by the *network effect* in Internet auctions. As discussed, eBay, the pioneer of the Internet Auctions, has been very profitable and dominated the Internet auctions market despite less options in the closing rule and higher listing fees than Yahoo!Auctions. The positive feedback effect (or network effect) between buyers' Web site usage and sellers' listing behavior occurs because sellers list more items on the site with more potential bidders (i.e., the seller's *expected* auction revenue increases with potential bidders) and more potential bidders log on to the site with more listings. This network effect is the reason for this eBay's profitability and dominance. Refer to Katz and Shapiro (1994) and Park (2004) for the review of the literature of network effects.

To demonstrate the existence of the network effect in Internet auctions, we need to show that the eBay auctions have higher seller's expected auction revenues with more (potential) bidders. As an example, we collected the data of the Barber Quarter Dollar auctions on eBay and Yahoo!Auctions closed between November 28, 2001, and December 4, 2001. As well known, coins are a popular collectible, and collectibles are the most popular category of Internet auctions. The Barber Quarter Dollar is a particular kind of Barber Quarter coins, which have 74 regular issues between the year 1892 and the year 1916. The comparison of Internet auctions on eBay and Yahoo!Auctions, however, may not be straightforward because eBay stored all the closed (traded or not) auctions data while Yahoo!Auctions kept the data of only traded auctions. Keeping this restriction in mind, we will proceed to describe our observations.

During the time period, we observe 188 closed auctions but only 90 traded auctions on eBay whereas there were 24 traded auctions on Yahoo!Auctions. In our sample, therefore, eBay has about four times as many traded auctions as Yahoo!Auctions, and the conversion rate (the number of traded auctions divided by the number of closed auctions) on eBay auctions is a little bit less than 50%. Note that the Goldman Sachs study found about 50% conversion rate on eBay auctions. Although we do not have any direct information of the conversion rate on Yahoo!Auctions, we suspect that the conversion rate is much lower on Yahoo!Auctions. Indeed, it is reported that 22.5% of Web site users actually made purchases on eBay but only 4.4% on Yahoo!Auctions (see Nielsen//NetRatings & Harris Interactive eCommercePulse, May 2001). Because unique visitors per listing are on average 1.2 on eBay and 2.3 on Yahoo!Auctions, we infer that the conversion rate on Yahoo!Auctions is only 37.5% of the conversion rate on eBay. Hence, if the conversion rate on Yahoo!Auctions is about 19% (50% times 0.375), the total number of closed auctions on Yahoo!Auctions will be about 126.

In our sample, the average sale price (final value) of the traded auctions is $41.1 on eBay and $14.65 on Yahoo!Auctions, respectively. On average, the minimum bid level (opening value) is $26.47 on eBay and $6.55 on Yahoo!Auctions, respectively. Hence we can infer that more expensive coins of the Barber Quarter Dollar are traded on eBay, and the opening-value-to-final-value ratio is higher on eBay.

Although eBay has a higher average sale price, it does not necessarily imply that a seller's expected auction revenue is higher on eBay, because the quality of coins auctioned on these two sites may be different. To control quality differences of auctioned coins, we calculate the ratio of sale-price-to-book value. Because the data of closed auctions usually contain the description of the auctioned coins, we can find matching book values from the *Official National Bestseller 2002 Blackbook, Price Guide to United States Coins*. We found these matching book values for 17 Yahoo!Auctions and 73 eBay traded auctions. The average sale-price-to-book-value ratio turns out to 1.35 on Yahoo!Auctions and 1.36 on eBay. At a first glance, this result seems surprising. However, if we consider a possible big difference of the conversion rate between these two sites, the expected sale-price-to-book-value ratio (prior to auctions) must be higher on eBay. For instance, as discussed above, suppose that the conversion rate is 19% on Yahoo!Auctions (and 50% on eBay). Suppose also that a seller's reservation value for the coin is the book value. Then, the expected (prior-to-auction) sale-price-to-book-value ratio will be 1.07 on Yahoo!Auctions and 1.18 on eBay. Hence, in this case, the eBay premium will be about 10%.

In our sample, the average number of bidders in the traded auctions turns out to be 4.5 on Yahoo!Auctions but 4 on eBay. The maximum number of bidders is 9 on Yahoo!Auctions and 13 on eBay, but many traded auctions received only 1 bid on both sites: 45.6% (41.7%) of traded auctions on eBay (Yahoo!Auctions) had only 1 bidder. Note that, in Bajari and Hortacsu (2001), the average number of bidders for the U.S. mint/proof coin sets was 3 on eBay auctions. Yahoo!Auctions, ceteris paribus, may attract more entries of potential bidders because it offers longer duration days and has less expensive coins auctioned with lower opening values. In our sample, the average duration day of the traded auctions is 9 days on Yahoo!Auctions and 6.7 days on eBay. However, if we consider a possible big difference of the conversion rate between these two sites, the average number of bidders in all the closed auctions may be higher on eBay. For instance, as discussed above, suppose that the conversion rate is 19% on Yahoo!Auctions (and 50% on eBay). Then the average number of bidders in all the closed auctions will be 0.9 on Yahoo!Auctions and 1.9 on eBay.

To sum up, our sample suggests that eBay generates higher expected auction revenues to sellers and attracts more bidders at the same time. The expected sale-price-to-book-value ratio is 1.07 on Yahoo!Auctions and 1.18 on eBay whereas the average number of bidders in all the closed auctions is 0.9 on Yahoo!Auctions and 1.9 on eBay.

The e-commerce has been hailed as a frictionless competitive market (e.g., Bakos 1991, 1997). It is widely believed that the Internet drastically reduces buyers' search costs (for prices, product offerings, and shop locations) and lowers barriers to entry and exit. The low search costs and the low barriers to entry and exit induce strong price competition, leading to low profit margins and low deadweight losses. Consistently, some case studies have found that e-commerce has on average lower prices than the conventional retail market (for the review of these studies, see Bailey 1998; Brynjolfsson & Smith 2000). However, as argued in Ellison and Ellison (2004), the overhead costs in e-commerce may not be as low as anticipated, and thus severe price competition may lead to the Bertrand paradox (with prices so low that firms cannot cover their overhead costs). Hence, the long-term viability of the e-commerce firms is often in question. The turmoil of e-commerce firms' stock prices since the year 2000 highlights the worry of the long-term viability.

More recently, however, several empirical studies (e.g., Brynjolfsson & Smith 2000; Clemons, Hann, & Hitt, 2002; Johnson, Moe, Fader, Bellman, & Loshe, 2003; Loshe, Bellmam & Johnson, 2000) indicate some frictions in e-commerce: (a) compared to the conventional retail market, e-commerce has low prices on average but high market concentrations; (b) an e-commerce firm with the highest market share does not charge the lowest price and often charges a price higher than the average; and (c) the price dispersion is higher in e-commerce than in the conventional retail market. Hence, attentions have been directed to the possibility and sources of the *first-mover's advantage* which explains the reason that the pioneering firms, such as Amazon.com, Yahoo!, E*Trade, and eBay, have dominant market shares despite their higher prices. Some studies indicate that this first-mover's advantage may be caused by switching costs in the on-line brokerage market (Chen & Hitt, 2002) or by loyalty in the Web portals (Goldfarb, 2003). In Internet auctions, the network effect is widely considered a source of this first-mover's advantage.

The competition between eBay and Yahoo! Auctions indicates that eBay, the first-mover's in Internet auctions, took the full advantage of network effects and dominated the market despite later entrants' low prices with more features to offer. The timing of entry would be the most important factor of success in e-commerce when network effects are significant.

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E-Business Planning and Analysis Framework

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INTRODUCTION

This article reports on a framework that has been successfully used to analyze the e-business capabilities of an organization with a view to developing their e-capability maturity levels. This should be the first stage of any systems development project. The framework has been used widely within start-up companies and well-established companies both large and small; it has been deployed in the service and manufacturing sectors. It has been applied by practitioners and consultants to help improve e-business capability levels, and by academics for teaching and research purposes at graduate and undergraduate levels.

This article will provide an account of the unique e-business planning and analysis framework (E-PAF) and demonstrate how it works via an abridged version of a case study (selected from hundreds that have been produced). This will include a brief account of the three techniques that are integrated to form the analysis framework: quality function deployment (QFD) (Akao, 1972), the balanced scorecard (BSC) (Kaplan & Norton, 1992), and value chain analysis (VCA) (Porter, 1985). The case study extract is based on an online community and dating agency service identified as VirtualCom which has been produced through a consulting assignment with the founding directors of that company and has not been published previously. It has been chosen because it gives a concise, comprehensive example from an industry that is relatively easy to relate to.

BACKGROUND

Kalakota and Robinson (2001) argued that organizations must bear in mind not to focus too much on the 'e' component, but also on the business requirements. The greatest threat to an organization is either failing to deploy the Internet, or failing to deploy it strategically and therefore without efficacy (Porter, 2000). Organizations should deploy an e-service only if it is concordant with its strategic needs. Not all e-business mechanisms are right for every organization (Lord, 2000). The correct application must be chosen or developed with both the process it supports and the strategic objectives of the company in mind. A deadly assumption would be to believe that technology is the answer to all process and strategic weaknesses; in response to this concern, this e-business planning and analysis framework was developed.

There are many types of analysis frameworks available (Ballantyne & Brignall, 1992). According to Wu (1992), good frameworks should be able to guide managers towards a method or solution uniquely suitable to a particular situation in question. On the whole, frameworks should not be too complex to use, and information interaction within the framework should be clear and concise to avoid information overload. Lee and Ko (2000) proposed a framework for strategic business analysis, by integrating SWOT (strengths, weaknesses, opportunities, and threats), balanced scorecard, quality function deployment, and "Sun Tzu's the art of business management strategies" techniques. In a similarly proposed framework, Lee, Lo, Leung, and Ko (2000) integrate the SWOT (de Witt & Meyer, 1998) BSC, QFD, and the Malcolm Baldrige National Quality Award's (MBNQA) education criteria, to formulate policy for vocational education in Hong Kong.

While many analytical techniques such as the SWOT, SLEPT (social, legal, economic, political, technical) (de Witt & Meyer, 1998), and the BSC analyses can be used to identify the strategic needs of an organization, none provide a direct mechanism to prioritize the needs and convert them into operational processes, or to then translate those processes into a specification that can be used to develop or acquire supportive software systems. In contrast, other analytical techniques such as Porter's (1985) value chain analysis (VCA) facilitates the analysis of processes within a company, but does not provide an easy mechanism to link these to high-level business objectives. One analytical tool that does provide the ability to convert high-level business objectives ("what" the business wants), into processes ("how" the business delivers those "whats") is QFD, which has had these benefits discussed widely by Akao (1972), Mazur (1992), and more recently by Ko and Lee (2000) and Lee et al. (2000). However, QFD has its own weaknesses; two of

Table 1. The three techniques of the E-PAF

	Analysis Technique		
	Balanced Score Card (BSC)	Value Chain Analysis (VCA)	Quality Function Deployment (QFD)
Primary Purpose	Establishes strategic objectives	Establishes the high-level logic of the value-adding activities within customer facing business processes	Analyzes and manages the trade-off between business objectives ("whats") and business processes ("hows"), and *deploys* these to lower levels of definition for detailed systems design
Main Strength(s)	Sets high level business vision	Defines high-level, value-adding activities (primary and secondary)	Can deploy high-level objectives and processes (e.g., users requirements) into detailed tasks and systems requirements
Main Weakness(es)	Difficult to translate these into detailed processes or system requirements	Does not generate high-level vision; difficult to translate value-adding activities into system requirements	Difficult to generate initial business vision and high-level value chain

these lie in the initial generation of the "whats" and "hows". The analytical framework presented in this article deals with these weakness by marrying up QFD with two other complementary analytical techniques:

1. BSC to generate a set of high-level business objectives, targets, measures, and initiatives for finance, internal operations, learning and growth, and customer satisfaction. The outputs from this analysis (including the weightings) become the 'whats' in the initial QFD analysis.
2. VCA to generate detail about operational processes. The outputs from this analysis become the 'hows' in the initial QFD analysis.

The relationships between these are summarized in Table 1. Through the complementary use of the BSC, VCA, and QFD, a comprehensive yet easily understandable E-Business Planning and Analysis Framework has been developed.

THE E-BUSINESS PLANNING AND ANALYSIS FRAMEWORK

An eight-step approach is followed to apply the E-PAF as shown in Figure 1 (Tan & Tang, 2002; Tan, Tang, & Forrester, 2003, 2004). Note that more detail of Step 1 is shown in Table 2 and more detail of Step 2 in Figure 2. The eight steps are identified as:

- **Step 1:** Using BSC to develop "whats" for QFD Matrix I
- **Step 2:** Using VCA to develop "hows" in QFD Matrix I
- **Step 3:** Completing QFD Matrix I
- **Step 4:** Identifying critical business processes from QFD Matrix I
- **Step 5:** Inputting critical business processes to QFD Matrix II's 'what'
- **Step 6:** Listing e-service applications to QFD Matrix II's "how"
- **Step 7:** Completing QFD Matrix II
- **Step 8:** Identifying critical e-service applications from QFD Matrix II

The article outlines how the framework has been applied to VirtualCom, a recently established online start-up company specializing in providing community groups and dating services; it presently has relatively low e-capability maturity. It should be noted that E-PAF (Figure 1) should be applied within the initial analysis stage of a systems development lifecycle, the remaining stages being the logical design, the physical design, testing, implementation, and maintenance, which for reasons of conciseness are not discussed in this article.

Firstly, prior to applying the framework, the situational factors (e.g., political, economic, social, technological, environmental, and legal) behind the business strategy need to be established. In brief, it was observed that the majority of the environmental drivers are pro-online dating. However, despite the fact that online dating has been around since 1998 (e.g., match.com), there are still many new entrants coming in on a monthly basis, making the industry highly competitive. The nature of the competition is such that well-known, trusted online brands

Figure 1. E-business planning and analysis framework

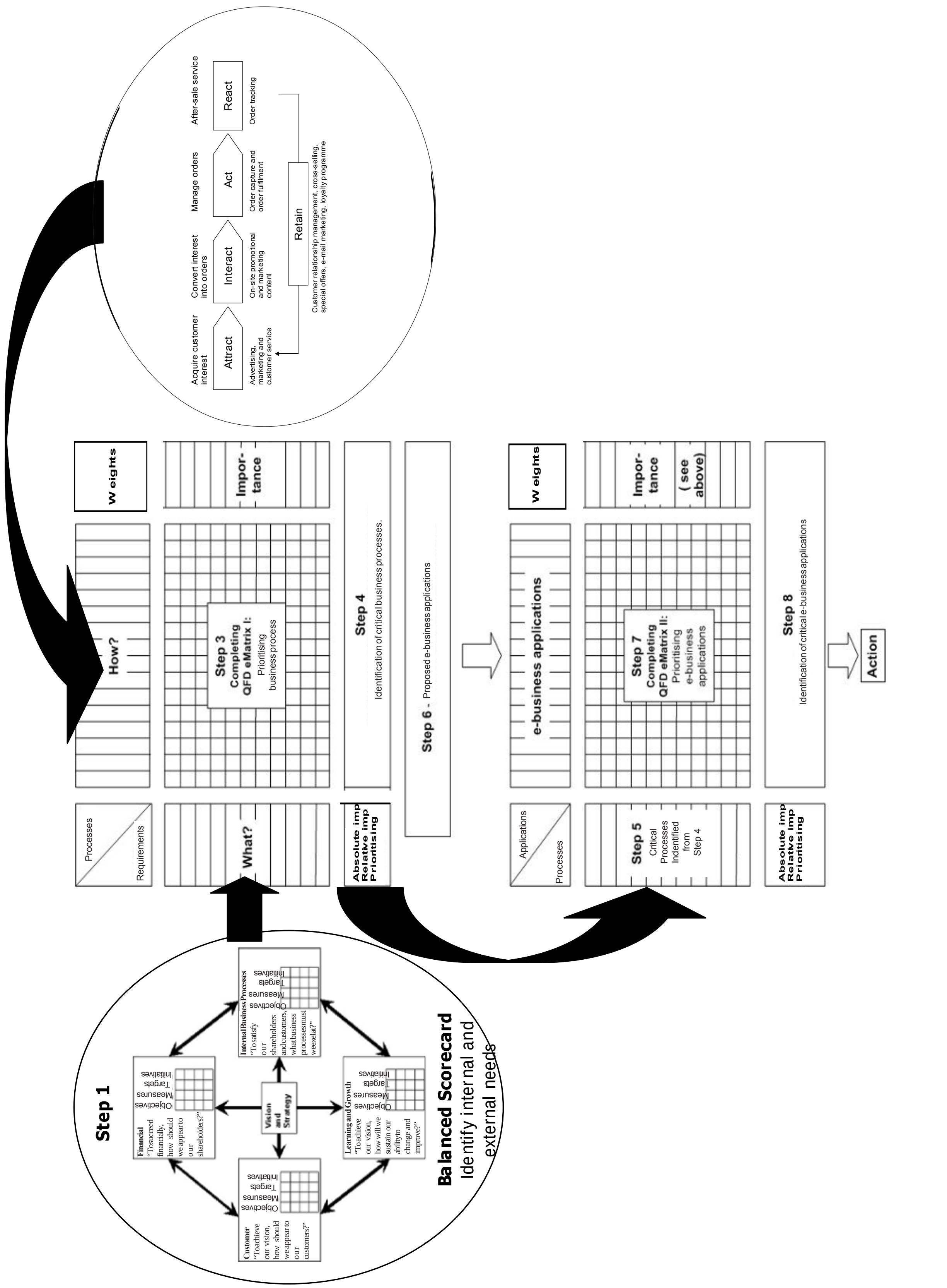
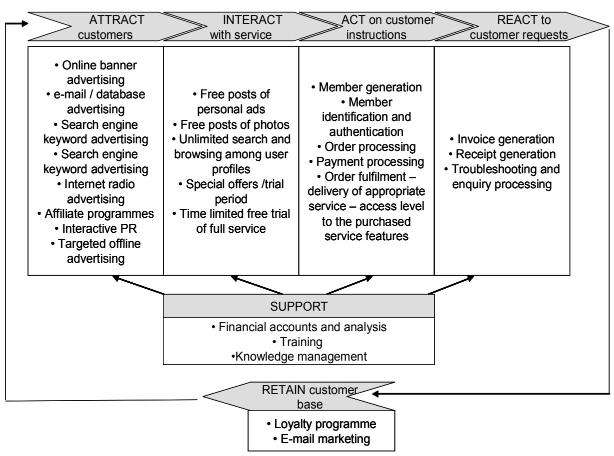


Table 2. Summary of BSC analysis

	Objectives	Measures (either increase or decrease is expected)	Target/Initiative	Weighting (1 low, 5 high)
Customer	Expand Customer Base	Increase number of new customers, build brand awareness and image, reduce attrition rate of visitors	1 year: 100,000 paying members—increase 400% from potential decrease to 20,000 3 months: attrition rate <90%	3
Internal Business Process	Quick Transactions	Increase efficiency of automation—reduce application response times, reduce database interrogation time (system resources/time)	6 months: make all Web pages max 5 clicks from login homepage. 6 months: clean database quarterly	5
Learning and Growth	Training	Increase percentage of employees at sufficient level of training for all relevant operating procedures, investment of time and costs incurred on training	1 year: retain services of online marketing agency 2 years: double technical personnel	4
Financial	Increased Profitability	Increase net contribution (daily, weekly, monthly subscriptions); monitor contribution of each different revenue stream (subscription fees, advertising revenue)	3 months: change from banner adverts and keyword sponsoring to affiliate payments	5

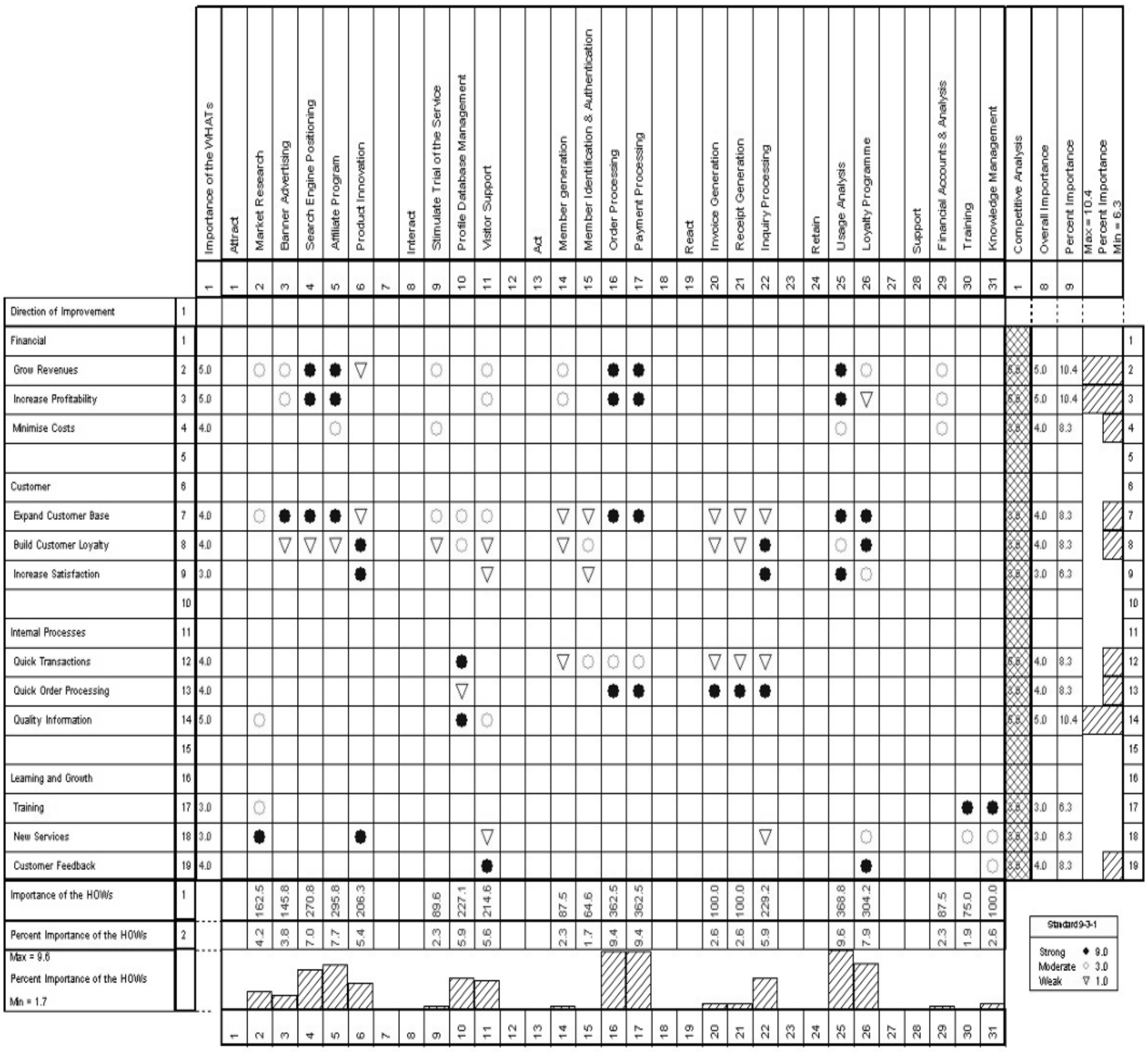
Figure 2. Key factors in VirtualCom's value chain analysis



attract most of the new users, thus becoming bigger and bigger and leaving the competition behind, as the size of a particular community is a key basis of sustainable competitive advantage. Due to the increasing number of competitors, margins are shrinking and profits decreasing. Moreover, the majority of new entrants are offering free services to attract visitors and seek revenues from other streams, such as banner advertising and database marketing. The bargaining power of customers is significant, as substitutes are just a click away, making it hard to create switching costs; any successful attempt to differentiate from the pack tend to be copied immediately, and advantage lost. The main switching barrier seems to be related to the attraction of belonging to the community itself, since users hopefully develop personal relationships, and in some cases strong feelings of belonging and even addiction.

Finally, many vendors are working on substitutes, such as mobile dating applications, taking advantage of specific mobile functions, such as location-based

Figure 3. QFD I matrix: VirtualCom's business objectives and key business processes



services (LBS) and nonstop attainability. However, there are many indicators that the most successful community services of the next decade will be those that will be able to merge Internet and mobile technologies into a seamless user experience. All of the above factors, combined with low-entry barriers, make the industry highly competitive. This means that a company must have a clear understanding of its systems development lifecycle, particularly in the initial stages. Each step is now explained further using VirtualCom as an example.

Step 1: Balanced Scorecard

A BSC analysis was conducted for VirtualCom to give objectives, targets, measures, and initiates to the financial, internal process, learning and growth, and customer perspectives; an exert of this can be seen in Table 2 (one example for each category is shown as an example; others used in the case study are simple identified by name in the QFD I).

Step 2: Value Chain Analysis

Concurrently to the BSC analysis being performed, a value chain analysis (VCA) was also generated for VirtualCom. As VirtualCom is a service-based company, it was more appropriate in this case to use the commerce value chain analysis by Treese and Stewart (1998) as opposed to the generic value chain analysis by Porter, which would be used if a manufacturing-based company were being analyzed. The factors identified for VirtualCom's

Figure 4. QFD II matrix: VirtualCom's key business processes and candidate software solutions

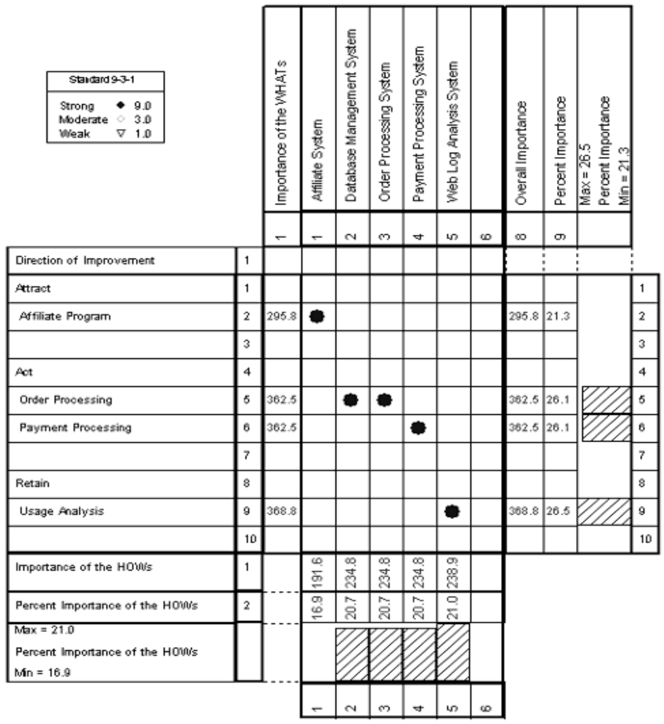


Table 3. Solution: Possible e-business application types for VirtualCom

Stage of Service Value Chain	Candidate Software Solution Types
Attract	Affiliate system
Act	Database management system
	Order processing system
	Payment processing system
Retain	Web log analysis system

value chain based on Treese and Stewart's work (1998) can be seen in Figure 2.

Steps 3-4: QFD I Matrix

The factors produced by the BSC analysis then become the "whats" in the QFD I analysis, and the factors from the VCA become the 'hows' for the QFD I analysis (Figure 3). From the QFD I analyses of the interrelationships between "whats" and "hows", the top four critical business processes identified to delivering customer needs were:

1. **Usage analyses** process (score = 368.8) ranked first. This process is critical to aligning the service with the customer's desires and thereby increasing loyalty. It is not presently performed but is of critical importance for sustainable revenue generation and providing evidence for how best to present the service to a first-time visitor.
2. **Order processing** and **Payment processing** processes jointly ranked next highly (scores = 362.5). These are both closely related to one of the new business model objectives (e.g., improvement of financial performance by the introduction of subscription fees).
3. **Affiliate program** process (score = 295.8) ranked fourth. This process is important to obtain critical pre- and post-purchase behavior of visitors and members.

The results demonstrate a high dependence on efficient order and payment processing to ensure the business survives. Additionally, usage analysis enables the online company to further understand the needs and behaviors of its users, and affiliate programs would further enhance the experience and perceived benefits by its users and members.

Steps 5-8: QFD II Matrix

Having determined the critical e-business processes, the next step is to conduct a second QFD analysis to identify critical e-business *applications*. In this step the output of QFD I becomes the input to QFD II, so that "hows" in QFDI become the "whats" in QFD II. Since VirtualCom is an existing online service, the only e-business applications considered were those that qualified as potential enablers of identified missing or under-performing e-business processes (see Figure 4).

At this stage candidate e-business application types are short-listed for VirtualCom (see Table 3). The results from the QFD II Matrix showed that the e-business applications under the heading of "Retain" came in first (score = 238.9), while the three e-business applications under "Act" came in jointly second (score = 234.8). The affiliate system, under the "Attract" heading, came in third (score = 191.6). Note that there are no application types suggested for 'React' and 'Interact', as there were no critical process identified in that stage.

The validity of these results can be further reinforced with the following explanations:

1. VirtualCom requires a tool for *site usage* analysis (e.g., a Web logger or Web transaction application) in order to determine the users' behavior. This will help to contribute in the design of the services to increase customer loyalty, as well as increasing the rate of conversion for first-time visitors into repeat customers. Thus, a Web log analysis system enables the capture of accurate first-hand data in order to understand its visitors' and customers' online behavior better.
2. The *order processing* and *payment processing* applications under the *Act* heading will enable VirtualCom to streamline order and payment processes as it replaces the existing manual processes. The database management system on the other hand will provide the necessary database upgrade to meet the new demands on the database management system, due to the introduction of different statuses and privileges of free and paying members (after the planned introduction of subscription fees).
3. The *affiliation* system will provide VirtualCom with a more cost-effective method of attracting new customers rather than using banner advertising or keyword sponsoring. This is because an affiliation system is used to pay affiliates only when they actually *deliver* new fee-paying members, whereas banner advertising and keyword sponsoring costs VirtualCom the same amount regardless of how many visitors actually convert into paying customers.

Once the initial analyses phase has been conducted, the next phases of the system's development lifecycle can commence. This will start with the logical and physical design of the system, defining what will be outsourced to external vendors and what will be developed in-house.

FUTURE TRENDS

Organizations will continue to develop their online e-business capabilities. It will not be sufficient to merely maintain existing technologies, applications, and business models. It will be necessary to continually assess changing customer requirements and competitor performance against incumbent practices and systems. It will therefore require business development managers to use a planning and analysis framework that has the capability of capturing the planned business vision and standard operating procedures, which can then be deployed down into technical requirements that are understandable to information systems designers.

The speed of change will accelerate in the future, technological solutions will become more proliferated, and inter and intra business connectivity requirements will become increasingly more important. As the emergence of mobile devices for customers and employees becomes more profound, and radio frequency identification (RFID) is increasingly applied to product and inventory management systems, it will add yet another level of complexity to e-business planning.

CONCLUSION

In conclusion this article draws together three well-established management and design tools into an integrated planning and analysis framework (referred to as E-PAF) to help develop e-business capability maturity levels. None of these tools alone meet these needs, but together they have proved to be very successful. Hundreds of examples have been produced in a combination of industrial projects, consultation and research assignments, and in academic teaching scenarios.

The outlined case given here has been taken from a practical project conducted with a new company in the service industry. It formed the analysis phase of a standard systems development approach. The E-PAF has also been applied successfully in the manufacturing sector, and has demonstrated itself effective in both large and small organizations in many countries. A suggestion of the possible outcomes is indicated by this case study.

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KEY TERMS

Balanced ScoreCard (BSC): A tool for developing "measures", "objectives", "targets", and "initiatives" for "financial", "customer", "internal process", and "learning and growth" categories derived from the overall company vision statement.

E-Business Planning and Analysis Framework (E-PAF): A combination of QFD, VCA, and BSC that supports strategic e-business initiatives.

E-Capabilities: The abilities that an organization is able to leverage off in order to deliver online products and services. These are often described in terms of their "maturity levels".

E-Capability Maturity Level: The conceptual model describing how advanced an organization is in the adoption of Internet-based solutions that support their strategy and operations. The levels range from "low" (little adoption) to "high" (sophisticated levels of adoption).

Location-Based Service (LBS): A service that uses a mobile device and a location-specific transmission, usually within a relatively small personal area network (PAN).

Online Service: The provision of an intangible value-adding activity using Internet-based technology.

Quality Function Deployment (QFD): A tool for converting user requirements into functional requirements that facilitates trade-off analysis, benchmarking, and deployment of requirements from a high level down to a detailed specification. It attempts to build-in quality from the initial stages of any systems development project.

Systems Development Lifecycle: A logical and iterative sequence of activities that highlight the phases of any development project. These phases typically include analysis, logical design, physical design, test, measurement and implementation, and maintenance, and are often performed as concurrently as possible.

Value Chain Analysis (VCA): A tool for mapping business processes that are either primary to the business operations or serve as support processes. Variants of the model are produced for service and manufacturing sectors.

Category: Concepts, Trends, and Challenges

E–Business Process Management and IT Governance

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INTRODUCTION

E-business process management (e-BPM) entails management of e-business processes with the customer initiating the process and involves non-linear processes with strong focus on value networks leveraging collaboration and alliances, rather than just business processes within the confines of the organization (Kim & Ramkaran, 2004). E-BPM requires organizations to take a process approach to managing their e-business processes (Smith & Fingar, 2003). The advent of business process reengineering (BPR) (Davenport, 1993; Hammer & Champy, 1993) resulted in numerous organizations initiating BPR programs. While BPR aims to enhance an organization's process capability by adopting engineering discipline, e-BPM goes a step further and targets to improve the organizational process management capability (Smith & Fingar, 2004).

Organizations target end-to-end business processes that deliver maximum customer value through e-BPM (Smith & Fingar, 2003). However, by their very nature, end-to-end business processes more often than not span multiple enterprises incorporating their individual value chains (Porter, 1985; Smith & Fingar, 2003; Smith, Neal, Ferrara, & Hayden, 2002) and involve e-business processes (Kim & Ramkaran, 2004). Integrating fragments of processes across multiple functions and organizations not only involves shared activities and tasks among business and trading partners, but also the capability to integrate disparate IT systems (Kalakota & Robinson, 2003). Effective management of e-business processes depends to a great extent on the enabling information technologies. In fact, Smith and Fingar in 2003 have stated that BPM is about technology. Porter's value chain is about end-to-end business processes needed to get from a customer order to the delivery of the final product or service (Porter, 1985).

The pervasive use of technology has created a critical dependency on IT that demands for a specific focus on governance of IT (Grembergen, 2004). Explicitly or implicitly, organizations specify business activities as business processes, and without realizing these tend to be e-business processes. However, given the current business conditions and a clear understanding by organizations about the complexities of their e-business processes, management of e-business processes is taking center stage (Smith et al., 2002). In the current business scenario where e-business processes, along with information are considered key organizational assets and management of business processes a strategic capability (Kalakota & Robinson, 2003), it is imperative that organizations clearly delineate the need for relevant and pertinent information as it provides visibility and transparency. Additionally, IT being the single most important predictor of the business value of IT (Weill & Ross, 2004) drives the need to analyze and understand the implications of e-BPM on IT governance.

The key objective of this article is to investigate the implications of e-BPM on IT governance through the analysis of available literature. In particular, the article argues that a direct influence of e-BPM on IT governance performance is inevitable. While the importance of both effective e-BPM and IT governance is intuitively clear, there is currently little research on elements of IT governance that get enabled by e-BPM. More importantly, there is the lack of a theoretical framework that could be used to analyze. To address this shortcoming, the article also presents an analysis framework. The analysis framework is particularly useful as it incorporates elements from prevalent IT governance frameworks. Using the analysis framework, the article then examines the implications of e-BPM on IT governance and develops research propositions. The aim of developing the propositions is to enable further investigation and research thereby contributing to IT management theory.

BACKGROUND

E-BPM and Its Current State of Adoption

E-BPM views business processes from an end-to-end perspective (Smith & Fingar, 2003). Successful e-BPM adoption views end-to-end processes as a crucial element as these possess characteristics that make their management imperative and technology has not been able to cope with the reality to such processes (Smith et al., 2002).

According a survey conducted by the *BPM Institute*, the three most critical factors that enable organizations to gain the highest return on BPM initiatives are (BPM Institute, 2004):

- Identification of high value e-business processes in areas such as compliance and regulatory requirements, risk management, customer-facing services and supply chain operations.
- Developing metrics to achieve measurable, quantifiable results through improvements in operational efficiency, process visibility and control and business agility (Weill, Subramani, & Broadbent, 2002).
- Establishment of long-term goals to evolve from process improvement to process excellence.

It is obvious that organizations to be effective in addressing all the three critical factors mentioned above must have a high level of e-process management capability. In order to enhance their e-process management capability organizations must address it from dimensions that include the levers that have the ability to make the capability change happen and the capability levels itself (Fisher, 2004).

IT Governance

Firms manage their key assets that typically include—human assets, physical assets, financial assets, intellectual property assets, relationship assets, and information/information technology assets. Maturity across the governance of the key assets varies significantly with financial and physical assets typically best governed and information assets among the worst (Weill & Ross, 2004). IT implementations to make these happen require both large upfront and ongoing investments. Changing business needs and to some extent changing technologies necessitates this (Weill & Ross, 2004). Organizations must get acceptable value from their investments in IT. Top performing organizations generate returns on their IT investments up to 40% more than their competitors (Weill & Broadbent, 1998). Effective IT governance is the single most important predictor of the value (Weill, 2004; Weill & Ross, 2004).

Developing an Analytical Framework

Two IT governance frameworks (i.e., the COBIT Framework of the IT Governance Institute (ITGI) and the IT Governance Design Framework specified by the MIT Sloan's Center for Information Systems Research (CISR)) are considered for analyzing the implications of e-BPM on IT governance.

The CISR IT Governance Design Framework (Weill & Ross, 2004) takes a two-dimensional stakeholder approach to IT governance. It considers IT as one the six key assets needing governance as part of overall corporate governance. The IT Governance Design Framework addresses critical issues along two dimensions presented as the Governance Arrangement Matrix (Weill 2004; Weill & Ross, 2004):

- **Decision Categories:** Major categories of decisions that organizations must make in order to ensure effective management and use of IT. These are: (1) IT principles, (2) IT architecture, (3) IT infrastructure, (4) Business application needs and 5) IT investment and prioritization.
- **Governance Archetypes:** Structures and stakeholders for specifying decision rights; the framework identifies six archetypes for various decisions. These are: (1) business monarchy, (2) IT monarchy, (3) feudal, (4) federal, (5) duopoly, and (6) anarchy.

ITGI's COBIT Framework (IT Governance Institute, 2000a) takes a one-dimensional control oriented approach to IT governance (IT governance Institute, 2000a). COBIT is a business process oriented and therefore addresses itself in the first place to the owners of these processes. This approach stems from the fact that the process owners are responsible for the performance of their processes, where IT is an integral part (IT Governance Institute, 2000b). The COBIT framework provides a set of 34 high-level control objectives, one for each of the IT processes, categorized into four domains: (1) planning and organization, (2) acquisition and implementation, (3) delivery and support, and (4) monitoring.

Additionally, the COBIT Framework provides management guidelines that are action oriented and generic management directions for controlling the enterprise's information processes, for tracking organizational goals, for IT process performance monitoring and for benchmarking organizational achievements (IT Governance Institute, 2000b) through the (1) IT governance maturity model to assess and benchmark IT governance capabilities and maturity, (2) critical success factors that specify the most critical implementation guidelines to achieve control over IT processes, (3) key goal indicators that determine whether an IT process has achieved its business requirements, and (4) key performance indicators that indicate how well an IT process is performing and whether it is on target to achieve its business goals. Deeper analyses of both frameworks reveal similar underlying issues. Presented below is a proposed mapping between the two frameworks and the underlying commonalities are amply evident.

- **IT Principles:** Focuses on high-level statements on how IT is used and maps to PO1, PO3, PO4, PO6, and PO7 of the COBIT Framework.
- **IT Architecture:** Focuses on the organization logic for data, applications and infrastructure captured in a set of policies, relationships and technical choices to achieve desired business and technical standardization and integration and broadly maps to PO2, PO3, PO4, PO10, PO11, DS5, and DS11 of the COBIT Framework.
- **IT Infrastructure:** Focuses on coordination between shared IT services that provide the foundation for the enterprise IT capability and maps to AI1, AI2, AI3, AI4, AI5, AI6, DS1, DS2, DS3, DS4, DS5, DS7, DS8, DS9, DS10, DS12, and DS13 of the COBIT Framework.
- **Business Applications Needs:** Specifies the business need for purchased or internally developed IT applications and maps to PO6 and PO8 of the COBIT Framework.
- **IT Investment:** Focuses on decisions about the how much and where to invest and maps to PO5, PO9, PO10, PO11, and DS6 of the COBIT Framework.

This article analyzes the implications of BPM on IT governance by anchoring it around the above discussed governance frameworks. This approach provides three advantages.

1. The governance frameworks, though different in approaches, provide a fairly clear, stable and solid specification covering *what*, *how*, and *why* of IT governance. This enhances the probability of the analysis to have the necessary rigor.
2. The governance frameworks are based on corporate best practices (IT Governance Institute, 2000a; Weill & Ross, 2004), thereby making the analysis practical and pragmatic.
3. To some extent the differences between the governance frameworks can be bridged through identification of underlying commonalities during the analysis.

Emerging Research Propositions

The COBIT Framework clearly mentions that the 34 high-level IT processes and control objectives are primarily meant for business process owners to get relevant and pertinent information about their core e-business processes (IT Governance Institute, 2000a). Hence, the business process owners are the key stakeholders in governing IT, and that information about core e-business processes is key to managing IT (IT Governance Institute, 2000b). On the other hand, the CISR Framework identifies multiple stakeholders and groups them into six archetypes (Weill & Ross, 2004). Among the archetypes, *Federal* and *Duopoly* forms mention business process owners. E-BPM by definition is for business process owners managing their core business processes (Fingar & Smith, 2003; Smith et al., 2002). Hence the research proposition is:

Proposition 1: Organizations adopting e-BPM are more likely to favor either federal or duopoly governance structures.

Empirical evidence has revealed that most common archetype is either *Federal* or *Duopoly* (Weill & Ross, 2004). While the positive linkage between e-BPM and federal archetype has been discussed above, it is to be noted the successful e-BPM adoption and implementation depends a great deal on deploying BPM Systems (Delphi BPM Market Milestone Report, 2003; Smith et al., 2002; Smith & Fingar, 2004). This drives the need for considerable involvement of the IT group within the organization to assess, select, deploy and maintain complex BPM Systems. Hence the research proposition is:

Proposition 2: Adopting e-BPM is likely to encourage desirable governing structures thereby positively influencing IT governance performance.

In the wake of Enron, WorldCom, and Tyco episodes, there has been a renewed interest in corporate governance. This has given rise to increased compliance and regulatory requirements like the Sarbanes-Oxley Act (Moeller, 2004) and BASEL II (Chorfas, 2004). A McKinsey study found that investors are willing to pay large premiums for investments in firms with good governance standards. The Organization for Economic Co-operation and Development (OECD) has published in 2004 the "OECD Principles for Corporate Governance" to help organizations adopt best practices (OECD, 2004). Corporate governance is primarily about governance of key organizational assets, e-BPM on the other hand is about the need to govern an organization's core end-to-end business processes, a key asset (Hammer & Champy, 1993; Smith & Fingar, 2003). However, typical business processes are most likely to have elements from all other key assets. Thus governing and managing business processes, a core element in corporate governance, forces organizations to: (1) define critical and optimized business processes that provide maximum customer value, (2) specify business rules that govern the processes, (3) derive business rules from clearly defined and documented organizational policies and maintain complete traceability between them, (4) build clear accountabilities/ decision rights through enhanced process visibility, (5) define process performance measures (business measures) needed to monitor, control and improve business processes, (6) define information needs of business processes, (7) Quickly compose and execute newer processes to meet customer requirements, and (8) benchmark processes against accepted/derived standards. Hence the research proposition is:

Proposition 3: Organizations adopting e-BPM are more likely to have effective corporate governance practices.

Organizations expect good process management systems to have the capability to quickly compose e-business processes that deliver customer value by allowing them to take advantage of emerging business opportunities through agile practices (Kalakota & Robinson, 2003; Sadiq & Racca, 2003). However, in most occasions, fragments of such end-to-end (composite) business processes reside in multiple disparate IT applications and systems (Sadiq & Racca, 2003). Creating composite e-processes requires BPM systems the ability to integrate disparate IT applications in a seamless manner (Sandoe, Corbitt, & Boykin, 2001). Process owners in specifying such composite e-business processes must be fully aware of the business intent and IT capabilities required to fulfill the intent (Kalakota & Robinson, 2003). This results in closer business-IT alignment (Henderson & Venkatraman, 1993). Hence the research propositions are:

Proposition 4a: Using BPM systems to enable process driven integration of disparate IT systems and applications is more likely to result in clearer IT principles.

Proposition 4b: Specifying composite e-business processes through BPM systems is likely to result in sound expression of business application needs.

Proposition 4c: Organizations with effective process management capabilities are likely to make better decisions regarding IT infrastructure.

The Open Group Architecture Framework Version 8.1 Enterprise Edition (TOGAF) groups different aspects of Enterprise Architecture into four categories. These are business process architecture, applications architecture, data architecture and technology architecture (The Open Group, 2003). As a guideline in its Architecture Development Methodology, TOGAF recommends organizations to develop their business process architecture prior to specifying the remaining three architectures (The Open Group, 2003; Zachman 1999). This is because of the fact that data, applications and technology architectures are all driven by an organization's process architecture (Bernus, Nemes, & Schmidt, 2003; Perks & Beveridge, 2003). E-BPM fundamentally involves defining the Business Process Architecture, preferably taking advantage of industry specific and publicly available process frameworks like the supply chain operations reference (SCOR) model and the Enhanced Telecom Operations Map (eTOM) to enhance process visibility and transparency and managing those processes in a continuous manner (Poirier, Ferrara, Hayden, & Neal, 2004; Smith & Fingar, 2003). Hence the research proposition is:

Proposition 5: Organizations adopting e-BPM are likely to make better decisions regarding their IT architectures resulting in overall robust enterprise architecture.

Organizations struggle in finding suitable mechanisms that would fit their requirements and culture (Grembergen, De Haes, & Guldentops, 2004; Weill & Broadbent, 2004). Generally, organizations use a multitude of governance mechanisms. Research has evidenced that certain governance mechanisms work better with certain governance structures. Hence, decisions to choose a certain set of governance mechanisms also depends on the structures organizations prefer (Weill & Ross, 2004). Besides, one of the key leadership principles for effective IT governance is implementing common governance mechanisms across the six key assets (Weill & Ross, 2004). E-BPM demands clear policies, unambiguous rules, exception handling, optimized processes, focus on customer value, clear accountabilities, visibility and transparency, measurement orientation, and agility (Smith & Fingar, 2003). Hence the research proposition is:

Proposition 6a: Organizations adopting e-BPM are likely to find their IT governance mechanisms more effective and impacting.

Proposition 6b: Adoption of e-BPM in organizations is likely to facilitate and encourage implementation of common governance mechanisms.

While several organizations are now starting to adopt e-BPM, there are several areas of differences in adoption (Delphi BPM Market Milestone Report, 2003; BPM Institute, 2004). Some of these include: (1) the fundamental reasons for adopting e-BPM, (2) the extent of adoption (i.e., the kinds of business processes impacted, (3) process governance practices, (4) the extent to which BPM Systems are part of the overall adoption, (5) groups within the organization that are driving adoption, (6) the complexity of the e-business processes, (7) role of BPM deployments, (8) extent and complexity of systems integration desired, (9) extraction and abstraction of business rules, and (10) benefits anticipated and sought. With BPM organizations aim to move from their "as-is process management capability" to "to-be process management capability" (Smith & Fingar, 2004). Hence organizations adopting BPM assess their "as-is" and "to-be" BPM Maturity based on a specified BPM Maturity Model (Fisher, 2004; Smith & Fingar, 2004). Through the earlier research propositions the paper argued that, in general good process management capabilities positively influences IT governance performance. Further, effective IT governance is the single most important predictor of business value of IT (Weill & Ross, 2004). Hence the overall research propositions are:

Proposition 7a: Organizations with higher process management maturity levels are likely to exhibit higher IT governance maturity levels.

Proposition 7b: Organizations adopting process management are likely to have more effective IT governance practices, thereby leading to higher business value of IT.

FUTURE RESEARCH

It is suggested that research propositions in this article based on theory and exploration be verified with empirical studies. Specifically, there are at least three areas of theoretical and empirical studies that seem particularly plausible. These are:

1. Investigating the propositions in a larger field study to validate whether these propositions are applicable and whether they can be generalized for theory advancement and development.
2. Investigating the differences in process management maturity and its impact on IT governance issues like decision categories, archetypes, governance mechanisms and their impact of IT governance performance, including disadvantages and associated risks, as propositions reflect general statements. Such studies should preferably be longitudinal in nature in order to capture the long-term impacts in differing business, market and technology scenarios.
3. Development of a generic IT governance design framework along with an implementation toolkit that harmonizes e-BPM with IT governance.

CONCLUSION

The impact of e-BPM on various aspects of IT governance was examined and presented as research propositions for further exploratory research. Increasingly being faced with the phenomenon of "productivity paradox" (Brynjolfsson, 1993), and organizations struggling to justify IT investments, governance of IT assumes a critical role in this scenario. However, the first step in having a formal IT governance program and freely using it to improve the IT function and overall business performance is the recognition that information and IT are key organizational assets that need to be closely governed and skillfully managed along with five other key assets. Business process orientation provides one of the approaches to elevate the status and criticality of information and IT to an organization. The harmonization of business processes and IT is natural and logical in most enterprises because cross functional and cross enterprise composite business processes are e-business processes and depend on information flows that transcend organizational boundaries and need to be supported by the IT infrastructure. The paper discussed the implications of e-BPM on IT governance in detail and generally argued that it positively influences IT governance performance and helps organizations to extract more business value from their IT investments. The analysis also proved to be useful in briefly comparing and contrasting two prevalent IT governance frameworks. The underlying theories in these frameworks allowed deriving several research propositions.

While the overall positive influence of e-BPM on IT governance were presented and argued, it is also important to discuss and elaborate the consequences of taking this approach. Firstly, as discussed in propositions 2a and 2b, BPM is likely to favor certain archetypes and decision mechanisms for IT governance. An organization on the other hand may not be prepared for such a shift given its current culture, political environment and business needs. Hence managers need to assess this aspect very closely. Secondly, of late many organizations are using outsourcing of IT capability as a management strategy, sometimes successfully. Organizations typically outsource commodity IT services and perhaps co-source other services. Outsourcing as a quick fix motivated by frustrations with IT is a symptom of problems in IT governance. Managers in such organization (which seem to be increasing) need to carefully evaluate the role IT plays in an organizational context and then seek to address IT governance issues.

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KEY TERMS

COBIT: The COBIT (**C**ontrol **OB**jectives for **I**nformation and related **T**echnologies) is an IT Governance Framework specified by the IT Governance Institute. The COBIT model describes the "control objectives" for 34 IT processes and the management guidelines, implementation guidelines and outcome measures for the processes.

Governance Archetype: Archetypes typically involve various stakeholder constituencies and their decision rights within the purview of IT governance.

Governance Decisions: These represent the most crucial domains of IT decisions that are key to good IT governance, and includes IT principles, IT architecture, IT infrastructure, Business application needs and IT investment management.

Governance Mechanism: These are approaches adopted by organizations to implement and institutionalize governance structures and practices.

IT Governance: The decision rights and accountability framework to encourage desirable behaviors in the use of IT (Weill & Ross, 2004). The locus of enterprise decision-making authority for core IT activities (Sambamurthy & Zmud, 2000).

IT Governance Maturity Model: This is part of the COBIT management guidelines and is a five stage maturity model of IT governance and a series of tool kits, audit guidelines and implementation guidelines. The levels ranging from "non-existent" to "optimized" represent progressively higher degree of effective governance practices and processes.

E-Commerce Agents and Payment Systems

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INTRODUCTION

An emerging outcome of the popularization of the Internet is the electronic commerce and payment systems, which present great opportunities for businesses, reduce transaction costs, and provide faster transaction time. Research has been conducted with new technologies, like mobile Internet used by business models (Baek & Hong, 2003). However, before using the Internet, it is essential to provide security in transferring monetary value over the Internet. Quite a number of protocols have been proposed for these secure payment systems, including NetBill, NetCheque, Open Market, iKP, Millicent, SET (Sherift & Serhrouchni, 1998), E-Cash (Brands, 1995), NetCash, CAFÉ (Mjolsnes & Michelson, 1997), EMV cards (Khu-Smith & Mitchell, 2002), and so forth. These systems are designed to meet diverse requirements, each with particular attributes.

Automation and intelligence is another issue that poses challenges in the development of e-commerce. Agent technology has been incorporated into the area of e-commerce to provide automation and intelligence for the e-trade process. Agent is a software program, which is capable of accomplishing tasks autonomously on behalf of its user. Agents must provide highly trustworthy consistency and fault tolerance to avoid eavesdropping and fraud. Also, they should have roaming capability so as to extend their capabilities well beyond the limitations of owners' computers. This article will discuss some related components under the Secure Agent Fabrication, Evolution, and Roaming (SAFER) architecture (Guan & Hua, 2003; Guan & Yang, 2004; Guan & Zhu, 2002; Ng, Guan, & Zhu, 2002; Zhu, Guan, Yang, & Ko, 2000) and propose an agent-based payment scheme for SAFER.

Different types of electronic payment systems have been developed to meet their diverse requirements, which generally include integrity, authorization, confidentiality, availability, and reliability for security requirements (Asokan & Johnson, 1997). Payment systems can be classified in a variety of ways according to their characteristics (Dahab & Ferreira, 1998), such as the exchange model (cash like, check like or hybrid), central authority contact (online or offline), hardware requirements (specific or general), payment amount (micropayment), and so forth.

Among all the available payment schemes in the market, e-cash is one of the best in terms of security, flexibility, and full anonymity. E-cash is a cash-like online system that uses electronic coins as tokens. E-cash has its unique advantages, such as flexibility, integrity, and full anonymity that cannot be found in electronic check and credit card-based systems. It uses cryptographic techniques to provide full anonymity. The agent based payment scheme for SAFER adopts some similar principles and concepts of e-cash.

Software Agents in E-Commerce

Attributes of Agent-Based Systems for Electronic Commerce

Agents are bits of software performing routine tasks, typically in the background, on behalf of the user. Gathering, filtering, and presenting information are some of the small and well-defined tasks given to simple agents. An agent distinguishes itself from any other software by its intelligence. Intelligent agents are capable of "thinking" and producing intelligent feedback (Guan & Yang, 1999; Guan, Zhu, & Maung, 2004). Agents are increasing in the degree and sophistication of automation, on both the buyer's and the seller's sides, commerce becomes much more dynamic, personalized, and context sensitive. These changes can be beneficial to both the buyers and sellers (He, Jennings, & Leung, 2003).

The requirement for continuity and autonomy derives from the desire that an agent be able to carry out activities in a manner that is responsive to changes in the environment, without requiring constant human guidance or intervention. According to (Bradshaw, 1997), agents have the following attributes, as shown in Table 1.

There are several software agent prototypes under development, which will be capable of doing even more on behalf of buyers and sellers. One is Kasbah, wherein agents would proactively seek out potential sellers and negotiate with them on the buyer's behalf, making the best possible deal, based on a set of constraints specified by the buyer, including the highest acceptable price and a transaction completion date. (Chavz & Maes, 1996). A disadvantage of this software agent is that it always accepts the first offer that can meet its asking price, when

Table 1. Attributes of software agents

Attribute	Description
Reactivity	The ability to selectively sense an act
Autonomy	Goal-directness, proactive, and self-starting behavior
Collaborative behavior	Can work in concert with other agents to achieve a common goal
Communication ability	The ability to communicate with persons and other agents
Personality	The capability of manifesting the attributes of a believable character such as emotion
Temporal continuity	Persistence of identity and state over long periods of time
Adaptivity	Being able to learn and improve with experience
Mobility	Being able to migrate in a self-directed way from one host platform to another

there might be even better offers. This disadvantage is resolved by AuctionBot, which is a general-purpose Internet auction server. *AGENTics* is another agent prototype, which develops what is referred to as "*online catalog integration for e-commerce*." AGENTics products shield the user from the technicalities of "where" and "how" the information was gathered, while synthesizing many information pieces into a coherent whole (Mougayar, 1997). Some agents can select desired items based on preferences, search databases to look for selected pieces of information, and conduct transactions. An example of such adaptive agent is the SAFER architecture for e-commerce.

SAFER is a Web-based distributed infrastructure to serve agents to query, buy, and sell goods in e-commerce and establishes necessary mechanisms to transport, manufacture, and evolve all different types of agents. The goal of SAFER is to construct open, dynamic, and evolutionary agent systems for e-commerce (Zhu & Guan, 2000). There will be SAFER-compliant and noncompliant communities coexisting in the whole e-commerce network. Each SAFER community consists of several mandatory components: owner, butler, agent, agent factory, community administration center, agent charger, agent immigration, clearinghouse, and bank. Agent community is the basic unit in SAFER e-commerce, which offers virtual regions and vehicles to host and administrate mobile agents during roaming, transaction, and evolution. An owner is in charge of all his or her agents, and making respective authorizations to mobile agents and his or her agent butler, which is a 24-hour online watcher who would handle most of the tasks on behalf of the owner. When agents are sent out roaming in the network, the butler has the responsibility of keeping track of agents activities and locations by sending and receiving messages with agents. At least one financial institution, usually a bank, which can link all value-representation to real money, must also be involved. The payment scheme designed for SAFER is expected to fulfill flexibility and interoperability, which means diverse representations of value will have the possibility to emerge in one framework for users' convenience. Given that, it is important that funds represented by one mechanism be easily converted into funds represented by others (Neuman & Medvinsky, 1995).

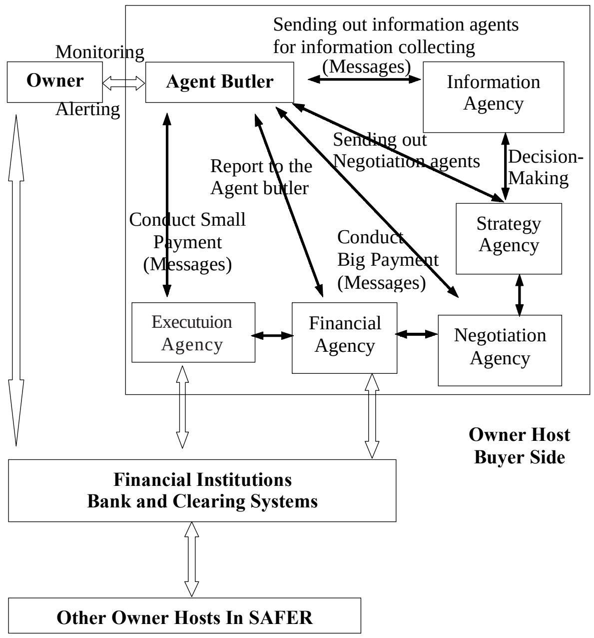
DESCRIPTION OF E-PAYMENT SCHEME

The payment module in the agent-mediated SAFER e-commerce architecture must contain several essential components: the market place, agents (including mobile agents, static agents, and agent butlers), financial institutions, and users. In SAFER, a community will offer virtual regions, factories, administration tools, vehicles to manipulate and administrate mobile agents during any activity and provide security so that users can trust it. Different types of agents fabricated by an agent factory of SAFER are running under the payment scheme for respective functions and tasks. They are briefly described in Figure 1.

In this scheme, a subsystem called "agency" is mentioned. Similar to the definition given by Dr. Larry Kerschberg in his DPSC project (Kerschberg & Banerjee, 1997), an agency can be thought as a multilayered agent group or a federation of agents with specific goal and functional role in the architecture. It is also like a collection of cooperating intelligent agents with particular expertise.

If the owner is interested in some items, he will assign tasks to his or her butler and agents. The agent butler will then send out information agents from agency, taking

Figure 1. Cooperating agents for the SAFER payment scheme



note of the items of interest, and set parameters such as due date (by which the item should be purchased), desired price, and highest acceptable price. The information agents used to sift, filter, and process information will roam in SAFER or even non-SAFER communities under a certain transport protocol, which is explained in the paper (Guan & Yang, 1999).

It can help with dozens of purchasing decisions and thus lower the cost and gain great efficiency. While roaming, agents are well tracked by the agent butler, by sending messages to report their activities and locations, which is described in detail in Zhu, Guan, and Ko (2000). After gathering enough information, the information agent forward all to the strategy agency, which will analyze the new data and settle down for decision for the user. All the recommendations will be reported to the agent butler in the first hand. Once a recommendation has been reported, the agent butler activates the negotiation agency, which will send out negotiation agents to the shortlist merchant hosts. Negotiation is defined as follows: “negotiation is the communication process of a group of agents in order to reach a mutually accepted agreement on some matter” (Green, 1997, p. 21). If the negotiation agent and the receptionist agent reach an agreement, the result will be reported to the butler in the first hand. The butler will inform the financial agency to initiate the contract for certain goods and make a transaction decision, according to the amount of money involved, the distance from host to the destination vendor, and so forth. Financial agents will take charge of the goods reception and payment transaction under the authorization of the butler. They communicate with the merchant host, autonomously make payment request, and sign contract order against the right good.

Implementation

The implementation of SAFER is under way. The overall architecture consists of several closely related but separate modules: roaming module, evolution module, fabrication module, negotiation module, and electronic payment module.

The implementation of the payment module began with the development of the agent butler, which is defined as a combination of several separate functions, as is shown in Figure 2. They are authorization manager, e-payment coordinator, transport assistant, heartbeat monitor, agent tracer, and evolution coordinator.

In the e-payment coordinator module, communication channels are set up between agent butler and all agencies of diverse functionalities, each of which is running in a separate thread. User interfaces are designed so that the user can assign tasks, define needs and requirements, check records, and read alerting messages reported by his or her agent butler.

Figure 2. Prototype of agent butler

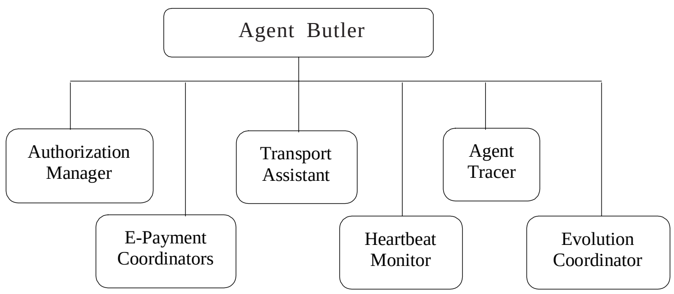
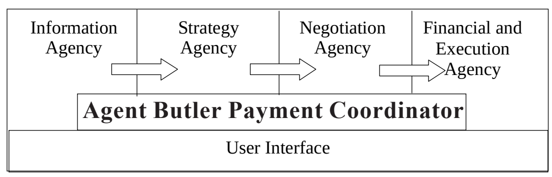


Figure 3. Payment coordinator



Making all types of agents and merchant hosts available to fit in the same framework will be difficult in the current research stage, because the attributes that agents require to communicate may differ. Given that, we have chosen to implement a limited number of typical agents to test the system functionality, and will consider how the work could be generalized to e-commerce in the future.

IMPACT OF SAFER-BASED PAYMENT SYSTEMS

The payment system proposed in this chapter is agent based and built for the SAFER e-commerce architecture. As such, in compliance with the SAFER architecture, this system provides a flexible and secure financial infrastructure for Internet commerce. The payment module contains several essential components to manipulate and administer the mobile agents while providing security to the users.

CONCLUSION

The agent-based SAFER e-commerce payment scheme incorporated agent technologies and took advantage of some well-known secure payment transaction protocols. It aims to simulate and even enhance physical cash and is designed to support a multitude of currency types. By incorporating the concepts of agent, the system is expected to provide security, efficiency, flexibility, autonomy, and intelligence. It is designed to provide anonymity against other parties, and audit ability (traceability) for the owner (or agent butler). At last, a number of potential improvements, practical aspects, and some open issues have been identified for future work.

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KEY TERMS

Adaptability: The ease with which software satisfies differing system constraints and user needs.

Agents: A piece of software that acts to accomplish tasks on behalf of its user.

Anonymity: The degree to which a software system or component allows for or supports anonymous transactions.

Client: In this article, "client" refers to customers who pay for good and services.

Confidentiality: The nonoccurrence of the unauthorized disclosure of information.

Cryptography: The art of protecting information by transforming it (*encrypting* it) into an unreadable format, called cipher text. Only those who possess a secret *key* can decipher (or *decrypt*) the message into plain text.

Flexibility: The ease with which a system or component can be modified for use in applications or environments other than those for which it was specifically designed.

E-Commerce and Mobile Commerce Applications Adoptions

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INTRODUCTION

E-commerce applications are primarily used at home and in the workplace. Utilitarian elements, including cognitive beliefs of perceived usefulness, perceived ease of use (at the individual level), industry pressure, organizational readiness, economics, and trust (at the business level) are key determinants contributing to the usage of e-commerce applications. Mobile devices redefine the meaning of workplace. The use of mobile services could be in and outside the workplace. Hedonic elements, such as fun, culture, life style, and hype are key determinants contributing to the usage of mobile commerce applications. The purpose of our article is to discuss and clarify immediate determinants of e-commerce and mobile commerce applications based on the technology acceptance model.

BACKGROUND

A joint study by eMarketer and Forrester (2005) estimates that business-to-customer (B2C) revenues in the U.S. will reach $229.9 billion by 2008 and business-to-business (B2B) revenue will reach $8.8 trillion in 2005. According to the Computer Industry Almanac (ClickZ Stats, 2005), by 2007 the number of Internet users will grow to 1.46 billion worldwide with the U.S. market representing only about 20% of worldwide Internet users. It is clear that e-commerce (EC) is becoming a global transactional forum.

Along with the dominance of EC comes an increased demand for mobile commerce (MC). The total number of mobile telephone subscribers in the world grew to 1.34 billion in 2003 from 317 million in 1998 (International Telecommunication Union, 2003). More than half of Americans (158 million) were mobile telephone subscribers in the United States. Unlike EC, only a very limited number of MC applications are making profit (Beck & Wade, 2002). The difference in the adoption pattern of EC and MC prompts practical reasons as well as research motives to investigate what drive consumers to purchase or use a particular EC and MC application.

The goals of adoption of EC and MC applications can be grouped into two broad categories: utilitarian (productivity-oriented) and hedonic (pleasure-oriented). *Utilitarian* elements are those determinants of productivity and usefulness that should be considered by a rational user or company before deciding to adopt a particular EC or MC application. For instance, an individual uses e-banking and online job search engine to improve personal productivity. A company adopts e-marketplace or Internet EDI applications to improve operational efficiency, reduce cost, and increase customer services. *Hedonic* elements are those determinants that are associated with personal enjoyment and pleasure. (See Table 1.) A user subscribes to a gaming or dating service to meet friends who share common interests. Knowing the dichotomizing difference between utilitarian and hedonic goals can help us understand why we accept a particular EC or MC application.

E-COMMERCE AND M-COMMERCE ADOPTION

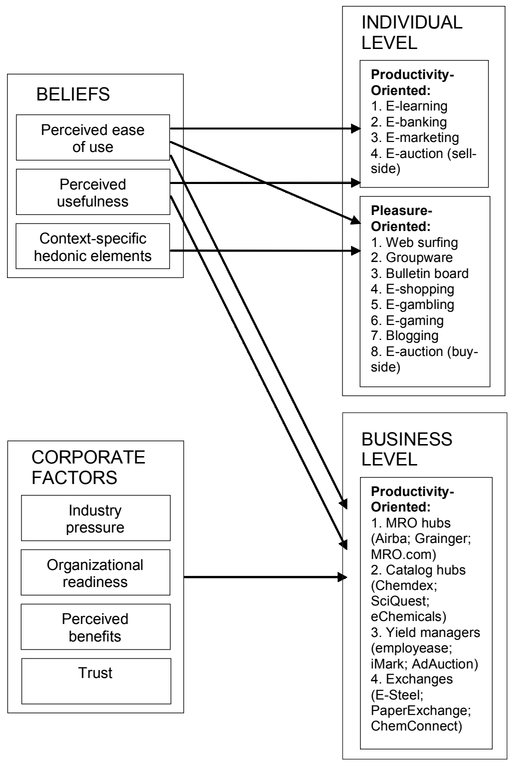
E-Commerce Adoption

Electronic commerce (EC) refers to electronic business with a broader meaning than just buying and selling on the Internet. EC is the process of transacting, transferring, or exchanging products and services over communication networks, including the Internet (Turban, King, Lee, & Viehland, 2004). Note that the underlying network may encompass different broadband (i.e., > 1 Mbps) segments such as DSL, cable modem, power line, Asynchronous Transfer Mode (ATM), and Gigabit Ethernet. Straub (2004) defined all forms of EC organizations as Net-enhanced organizations. Many EC applications are available to support the operation of Net-enhanced organizations. EC applications that are widely adopted at the individual level include e-tailing, Internet marketing, online travel services, online banking, e-grocery, online gaming, e-auction, etc. EC applications at the business level facili-

Table 1. Summary of utilitarian and hedonic factors of EC and MC adoption

	E-Commerce	M-Commerce
Utilitarian Factors (Firm)	Industry pressure, organizational readiness, perceived benefits, trust	Critical mass, perceived benefits
Utilitarian Factors (Individual)	Perceived ease of use (PEOU), perceived usefulness (PU)	Perceived ease of use (PEOU), perceived usefulness (PU), cost, perceived system quality
Hedonic Factors (Individual)	Perceived playfulness, perceived enjoyment, network size, perceived user resources	Social influence, entertainment, hype, lifestyle

Figure 1. Immediate determinants for the adoption of EC applications



tate the inter- and intra-organizational transactions over communication networks.

There are four basic types of B2B applications: sell-side market, buy-side market, many-to-many marketplaces, and collaborative commerce (Turban & King, 2003). Sell-side applications comprise of online catalog (e.g., Cisco's Connection Online service), e-auction, and online intermediary (e.g., Boeing's Part Analysis and Requirement Tracking service). Buy-side applications are primarily e-procurement management (e.g., Schlumberger's Oilfield Services), internal and external aggregation (e.g., Grainger.com and allbusiness.com), reverse auctions, and e-bartering. Many-to-many marketplaces allow many buyers and sellers to conduct transactions in an online pubic or private marketplace (e.g., epapertrade.com, mro.com, chemconnect.com, and employease.com). Collaborative commerce enables business partners to collaborate with each other by engaging in non-transactional activities.

Factors driving the adoption of EC applications can be examined at two levels of analysis: individual and business. At the individual level, both utilitarian and hedonic factors are responsible for customers' adoption of EC applications. At the business level, utilitarian factors (organizational productivity) are primarily responsible for adoption in for-profit and not-for-profit organizations (Figure 1).

Utilitarian and Hedonic Perspectives of Adopting EC Applications

The Technology Acceptance Model (TAM) (Davis, 1989) is recognized as the most robust and influential model that predicts an individual's adoption behavior of information technology (Davis, Bagozzi, & Warshaw, 1992; Venkatesh & Morris, 2000). At the individual level, the TAM provides a utilitarian perspective of EC adoption. This model asserts that perceived ease of use (PEOU) and perceived usefulness (PU) are important in forming customer attitude, satisfaction, and trust towards EC applications (Devaraj, Ming, & Kohli, 2002). Favorable attitude, satisfaction, and trust can lead to the adoption of EC applications. These two cognitive beliefs—PEOU and PU—have adequately explained the widespread adoption of personal productivity-oriented EC applications (i.e., most B2C applications).

However, the TAM is weak in explaining hedonic EC applications. Many studies extended the model to correct the weakness. For instance, along with PEOU and PU, perceived playfulness (Moon & Kim, 2001) and perceived enjoyment (Davis, Bagozzi, & Warshaw, 1992; Teo, Lim, & Lai, 1999) are immediate determinants for the adoption of the Internet. Perceived critical mass or network size is another complementary factor for the adoption of online groupware (Luo & Strong, 2000). Perceived user resources is the immediate determinant for the adoption of bulletin board system (Mathieson & Chin, 2001). Compatibility (Chen, Gillenson, & Sherrell, 2002) and intrinsic motivation of online users (Venkatesh & Morris, 2000) directly result in the adoption of virtual stores (Chen, Gillenson, & Sherrell, 2002). Social influence and flow experience are direct causes of the adoption of online activities that require the total involvement of online users, such as betting on sports events, gambling (Hsu & Lu, 2004), and shopping online.

Blogging is another prevalent online activity. The clustering of demographics (age, geography, ethnics, and lifestyle) and common interests (MTV, sports, gardening, traveling) into a network of virtual communities resulted in the mass adoption of blogging applications (Kumar, Novak, Raghavan, & Tomkins, 2004). When entertainment and fun are the goals of EC applications, the TAM alone is inadequate to predict and explain their adoption. Extending TAM by incorporating hedonic factors in different contexts can better explain the adoption behavior of hedonic EC applications.

EC applications at the business level differ from those at the individual level in the difficulty of measuring benefits, unselective release of confidential information to competitors (trust) and insufficient time to develop internal new skills (Teo & Ranganathan, 2004). Hence, there are additional factors leading to the adoption of EC applications beyond the utilitarian elements of PEOU and PU (Igbaria, Parasuraman, & Baroudi, 1996). Other corporate factors maybe as important as utilitarian factors, including industry pressure, organizational readiness, perceived strategic value (Grandon & Pearson, 2004), perceived cost, and trust.

Industry pressure originates from inter- and intra-industry competition, business partners, standards organizations, regulatory bodies, and government. These environmental factors can influence the adoption of B2B EC applications. RosettaNet (EDI for computer industry), UN/EDIFACT (EDI for commerce and transportation industry), and other XML-based EDI e-marketplaces are products of industry pressure. Industry-level compliance can lower the degree of asset specificity and uncertainty (imperfect information) but increase the number of input resources (Williamson, 1981). From the comparative institutional perspective, B2B e-marketplaces can potentially achieve three cooperative and exchange gains: (1) creating awareness of gains through joint efforts, (2) discouraging parties from bargaining their own gains, and (3) enforcing agreed-upon agreements (Hennart, 1994). Industry pressure increases existing network size and increases perceived benefits of adopting B2B EC applications. Hence, industry pressure is a direct determinant for the adoption of B2B EC applications.

The organizational readiness factor is concerned with the availability of financial and technological resources and alignment of B2B EC applications with a company's vision, values, culture, and preferred work practices (Grandon & Pearson, 2004). The varying degree of organizational readiness among business partners contribute to their difference in PEOU and PU (Iacovou, Benbasat, & Dexter, 1995).This contextual variable influences the successful adoption of B2B EC applications.

Many B2B EC applications fail to help companies realize their benefits primarily because sellers and buyers misjudge their perceived scope of benefits (Pandya & Dholakia, 2005). Primary benefits of B2B EC applications for buy-side marketplaces (e.g., GE's Global Exchange Services) include lowering purchasing price, streamlining the bidding process, and reducing requisition cycle time. Benefits of B2B EC applications for sell-side marketplaces (e.g., Intel, Cisco and Dell) range from the reduction of operation costs and cycle time, to the improvement of inventory control. Adoption of a particular B2B EC application depends on whether the application can deliver specific perceived benefits for different users of the e-marketplace.

EC applications applied to many-to-many marketplaces have different adoption issues because they requires companies to collaboratively plan, transact, design, and develop products and services. Unreliable and insecure B2B EC applications can have profound impacts on a company's operation. Trust in B2B EC can be improved from (1) organizational and economic, (2) technological, and (3) behavior perspectives (Ratnasingam & Phan, 2003). Issues about the adoption of B2B EC applications implicitly incorporate the perspective of technological trust (Ratnasingam & Pavlou, 2003). Therefore, when considering whether to adopt a B2B EC application the trust of business partners in B2B EC applications must be ensured.

Mobile Commerce Adoption

Mobile commerce (MC) is the process of buying, selling, or exchanging products and services wirelessly over mobile communication networks. MC is conducted on the Internet via mobile devices that are able to connect to the Internet via wireless application protocol (WAP) or conventional hyper-text transfer protocol (HTTP). Although most of the MC transactions take place on the Internet, MC can occur over any public or private network. The most important characteristic of MC is that products and services are made available to the customer independent of the customer's location (Turban & King, 2003). B2B MC applications include different classes, such as financial applications, inventory management, service management, product locating, business process reengineering, and data retrieval. On the other hand, B2C MC applications include classes such as financial applications, advertising, inventory and service management, product locating and shopping, auction or reverse auction, entertainment, mobile office, distance education, and data retrieval (Varshney & Vetter, 2002).

Similar to factors driving the adoption of EC, utilitarian factors heavily influence the decision to adopt EC at the business level; at the individual level, both utilitarian and hedonic factors contribute to the adoption (Coursaris & Hassanein, 2002; Haque, 2004). Note that since a wireless laptop computer essentially emulates the experience of a networked desktop computer, we will instead focus our attention on MC over handheld devices. In addition, we will place our emphasis on the consumer in our consideration of hedonic factors in adopting MC.

Utilitarian and Hedonic Perspectives of Adopting MC Applications

At the business level, one important factor is critical mass (Carroll, Howard, Peck, & Murphy, 2002), or the increased externalities of mobile devices ranging from Internet-enabled cellular phones and personal digital assistants (PDAs) to networked laptop computers. In 2002, the number of cellular phones exceeded that of fixed wireline phones on a global scale (International Telecommunication Union, 2003). In the U.S., over half of the population already carries a cellular phone. The number of network-capable mobile devices is also increasing rapidly. The growing number of MC-capable devices indicates that more service providers will be willing to develop and deploy new MC applications.

Another factor is the demonstrable benefit of adopting MC applications for businesses. With the increased diversity of data services and contents that can be delivered over wireless networks, organizations are beginning to adopt more MC applications. Many of the MC application deployments are vertical applications and aim to serve a specific company or industry need. Examples are fleet tracking, field sales force, and education. These applications typically have clearly defined goals (e.g., to streamline a specific process) and have well-defined net present value (NPV) justifications. Businesses typically develop these applications in-house or utilize content enablers and middleware.

At the individual level, both utilitarian and hedonic factors are important (Coursaris & Hassanein, 2002; Haque, 2004). Mobile voice communication is still the most successful mobile wireless application. Mobile voice is a focused application in that it concentrates a user's attention on one thing—conversation, and it is easy to use. Time and attention are more critical for mobile applications because users have a limited time span and may be distracted by their environment (Turban & King, 2003). It is clear now that PEOU is a factor that made mobile voice communication successful. PEOU is also an important factor in users' adoption of MC on modern networked handheld devices (Pagani, 2004). Another factor contributing to adoption is PU (Pagani, 2004). MC can be beneficial to the user, the benefit being that the user is able to carry out business activities, and conduct business transactions any where, any time. In addition, users are able to leverage unproductive time (e.g., during commute and travel) for productive tasks (Perry, O'Hara, Sellen, Brown, & Harper, 2001).

The third factor is the cost of using mobile devices (Haque, 2004). Accessing the Internet and checking e-mails using network-capable devices represent a lower-cost and higher-accessibility alternative to using a traditional personal computer (PC). The fourth factor is perceived system quality (Kleijnen, Wetzels, & Ruyter, 2004). Mobile devices have more limited bandwidth than their fixed counterparts, so it is important to ration the amount of information to be downloaded to the device (Treese & Stewart, 2003). In addition, network quality (e.g., unnoticed latency, jitters control and high resilience) has to be excellent so that problems arising from weak signal strength do not frustrate the users and distract them from their tasks.

Other hedonic factors such as culture, fun, hype, and lifestyle are also important to a user's decision to adopt. The widespread use of mobile devices is becoming a social phenomenon, especially among high-school and college age students. These users have grown up in a time when mobile devices are already popular. Many users in this age group will consume more MC services once they start working and will already be comfortable with making purchases and transacting via mobile devices (Turban & King, 2003). Kleijnen, Wetzels, and Ruyter (2004) cite social influence as an antecedent in adopting mobile financial applications, and Lu, Yu, Liu and Yao (2003) also suggest social influence in their proposed theoretical model as an antecedent in adopting wireless Internet.

Recent research has begun to suggest fun and hype as emerging factors in adoption. Pagani (2004) cites enjoyment as a factor after conducting an exploratory study with focus groups in six countries (i.e., Brazil, Germany, Italy, Singapore, United Kingdom, and U.S.) and a survey study of 1,000 mobile users in Italy. Haque (2004) also cites entertainment as an antecedent as a result of his survey in Malaysia. In terms of hype, consumers are constantly bombarded with images such as "…executives reclining on sun drenched beaches, cheerfully pecking away at their laptops, or strutting, like alpha males through airports checking their stock portfolios on PDAs and mobile phones" (Sherry & Salvador, 2001, p. 108). In spending millions on advertising, companies expect to have a positive impact on their sales. In fact, Pagani (2004) cites perceived innovation as a factor in the adoption of 3G mobile multimedia services, the perception of which is also affected by various innovations.

Carroll, Howard, Peck, and Murphy (2002) identified lifestyle as an antecedent in the continued use of SMS in their survey of 16 to 22 year-old mobile device users in Australia. Lifestyle is often defined as a way of life or style of living that reflects the attitudes and values of a person. It is reasonable to treat lifestyle as an important factor leading to continued use; if device use is part of a user's way of life already (e.g., communicating with friends via SMS instead of face-to-face), its continued use is facilitated.

Overall, from a hedonic perspective, "killing time" may be the "killer application." Even for mobile users that use mobile devices for utilitarian reasons (e.g., work productivity), it is reasonable to suggest they would turn to their mobile devices for entertainment when they have a few minutes in between tasks or meetings. In addition, in those parts of the world where owning a mobile device costs less than owning a desktop PC, mobile devices may be the primary source of electronic entertainment (Coursaris & Hassanein, 2002).

FUTURE TRENDS OF E-COMMERCE AND MOBILE COMMERCE APPLICATIONS

As far as EC applications are concerned, EC applications have become diversified and more sophisticated after many years of development. In the future, however, EC applications need to overcome a variety of problems which Dekleva (2000) grouped into four themes: (1) trust, (2) legal framework, (3) information infrastructure, and (4) benefits maximization. Different issues exist in each of these themes. Regarding the trust theme, privacy, security, as well as PEOU and PU of EC applications will remain to be important issues. Regarding legal framework, laws related to taxation, intellectual property protection, and payment systems will continue to evolve. Regarding information infrastructure, reliable Internet infrastructure, effective systems integration, and common industry standards will continue to be needed to support future EC applications. Lastly, regarding benefits maximization, organizations will continue to institute systems to measure benefits and costs of adopting EC applications. In addition, new EC applications will emerge to address issues present in each one of these four themes. For example, digital rights management (DRM) applications have already emerged to address the issues of trust and legal framework related to the transmission and consumption of entertainment-related contents (e.g., music and movies).

As far as MC applications are concerned, several trends are emerging in MC which can be examined in terms of the (1) mobile device, (2) network, and (3) application. Regarding the mobile device, there is clearly a trend toward the convergence of several functions into one physical device (Turban & King, 2003). For instance, the PDA/phone combination allows users to not only look up a phone number directly in the PDA and dial it, but also avoid carrying multiple devices while traveling. Furthermore, mobile devices now possess more hedonic features such as still-image camera, camcorder, and music player.

Regarding the network, wireless networks will continue to offer higher data-rate services. In wireless wide-area networks (WWANs), network operators have continued to deploy next-generation systems, such as General Packet Radio Service (GPRS) and Universal Mobile Telephone Service (UMTS). GPRS, which is based on a packet-switched core network, offers data rates of between 50 and 60 kbps. UMTS, which has both a packet-switched core network and an enhanced air interface, provides a higher data rate of at least 384 kbps. In wireless local-area networks (WLANs), wireless hot spots have continued to proliferate, covering hotels, airports, convention centers, and coffee shops. These networks, although nowhere near ubiquitous, offer stationary users much higher data rates ranging from 11 Mbps (peak for 802.11b) to 54 Mbps (peak for 802.11g and 802.11a). These higher-speed mobile networks can enable those applications that traditionally have been run on desktop PCs, such as e-mailing large attachments and distance learning (Varshney & Vetter, 2002).

Regarding the application, the increased data rates and more coverage areas will enable new kinds of MC applications to emerge. Many of these applications will target the hedonic elements of MC. We have already seen that mobile entertainment is one factor contributing to the success of I-Mode service in Japan. In the U.S., consumers can download full-length music titles to their phones and store them locally on the phones. In video services, mobile users in Korea routinely watch live television broadcasts streamed to their cell phones. With the advent of 3G networks, higher data rates will help improve the mobile user's gaming experience (Coursaris & Hassanein, 2002; Harmer, 2001). Furthermore, with the popularization of online blogging, many mobile users are now engaged in mobile image blogging (i.e., recording their daily activities in pictures taken by cellular phones and uploading them to a Web site).

CONCLUSION

Tim Berners-Lee, the inventor of the World Wide Web (WWW) and the director of WWW Consortium (W3C), foresees the emergence of a more open "resource description framework" (Klyne, Carroll & McBride 2004, p. 1) that can draw connections between all sorts of objects and information via wired and wireless devices. The first step towards the realization of this vision depends upon the adoption of EC and MC applications. A framework for including utilitarian and hedonic considerations to clarify reasons for the adoption of EC and MC applications by individuals and businesses is proposed in this article. EC applications at the individual level need to address both utilitarian factors of perceived usefulness and perceived ease of use, and hedonic factors of perceived enjoyment in different contexts. Immediate utilitarian determinants to the adoption of EC applications at the business level include industry pressure, organizational readiness, perceived benefits and trust. MC applications have different adoption issues to resolve. These issues can also be grouped into utilitarian and hedonic categories. Utilitarian determinants include the perceived ease of use and perceived usefulness. Hedonic determinants range from culture, fun, and hype to lifestyle.

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KEY TERMS

E-Commerce: The process of transacting, transferring, or exchanging products and services over communication networks, including the Internet.

Electronic Data Interchange (EDI): The transfer of data between different companies using value-added networks, including the Internet.

M-Commerce: The process of buying, selling, or exchanging products and services wirelessly over mobile communication networks.

Perceived Ease of Use (PEOU): The degree to which a person believes that using a particular system would be free of effort (Davis, 1989, p. 320).

Perceived Enjoyment: The extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated (Davis, Bagozzi, & Warshaw, 1992, p. 1113).

Perceived Usefulness (PU): The degree to which a person believes that using a particular system would enhance his or her job performance.

Short Message Service (SMS): The transmission of short text messages to and from mobile devices, including cellular phones and PDAs.

Technology Acceptance Model (TAM): A user-behavior theory which states that user acceptance of information technology can be explained by two beliefs: perceived usefulness and perceived ease of use.

E-Commerce Challenges and Policy Considerations in Nigeria

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INTRODUCTION

Electronic commerce (or *e-commerce*) is the popular term for doing business electronically. According to Haag, Cummings, and McCubbrey (1998), for businesses, electronic commerce includes performing transactions with customers over the Internet for purposes such as home shopping, home banking, and electronic cash use; performing transactions with other organizations through the use of electronic data interchange (EDI); gathering information relating to consumer market research and competitors; and distributing information to prospective customers through interactive advertising, sales, and marketing efforts. Benefits of e-commerce to companies include a wider potential market (i.e., global access); lowering of transaction costs; increase in the speed of transactions; improved economies of scale; minimization of human intervention in business processes; and unlimited access to product information for customers (Sesan, 2000; Wood, 2003).

While a few developing countries such as Costa Rica are making inroads into electronic commerce (Travica, 2002), many others are slow in its adoption. For example, a study, which rated 42 developing countries on their "e-readiness," found that Taiwan and Estonia had emerged as leaders among developing countries in the ability to conduct e-commerce, whereas Russia, much of the Middle East, and Africa were lagging behind (Anonymous, 2000). One of the countries included in the study but that rated poorly in its e-commerce efforts is Nigeria. In this articl, we shall be discussing the challenges being faced by the country as it grapples with the adoption of e-commerce.

BACKGROUND

Electronic commerce developed as a result of synergism between two industries, namely business and information technology. In the business industry, e-commerce is viewed as a buying and selling process that is supported by electronic means (Wood, 2003) whereas in the information technology industry, it is viewed as an electronic business application aimed at commercial transactions systems. In general, there are four types of e-commerce (Rayport & Jaworski, 2001):

1. **Business to Business (B2B):** B2B refers to e-commerce that takes place between business organizations. The foundation of B2B e-commerce, according to Haag et al. (2002), is electronic data interchange (EDI). EDI is the direct computer-to-computer transfer of transactions information contained in standard business documents such as invoices and purchase orders, in a standard format. EDI replaces paper documents with digital records exchanged between trading partners' computers.
2. **Business to Consumer (B2C):** B2C involves e-commerce sites that sell products and services, or provide information services directly to consumers. B2C (or retail) e-commerce has spawned many new businesses that have no physical stores but can deliver a wide variety of goods on request (National Science Board, 2002). B2C also includes services such as banking, education, consulting, retailing, gambling, and governance (Iyer, Taube, & Raquet, 2002).
3. **Consumer to Business (C2B):** C2B is e-commerce in which the Internet makes it possible for many consumers who want to buy the same or similar products to band together in order to obtain volume discounts from a business.
4. **Consumer to Consumer (C2C):** C2C involves consumers dealing with each other, either through an auction site or directly in one of the peer to peer networking applications.

In terms of product suitability, certain products/services appear more suitable for e-commerce while others remain more suitable for offline sales. The most successful purely virtual companies deal with digital products, including information storage, retrieval, and modification, music, movies, education, communication, software, photography, and financial transactions. Virtual marketers can sell some nondigital products/services successfully. Such products have a high value-to-weight ratio, are embarrassing purchases, typically go to people in remote locations, or are typically purchased by shut-ins (Wikipedia, 2004). Purchases of pornography and of other sex-related products and services fulfill the requirements of being virtual (or if nonvirtual, generally high value) and of potential embarrassment; unsurprisingly, provision of such services has become the most profitable segment of e-commerce.

Products such as spare parts, both for consumer items like washing machines and industrial equipment like centrifugal pumps, also seem good candidates for selling online. Retailers often need to order spare parts specially, since they typically do not stock them at consumer outlets –this means that e-commerce solutions in this area do not compete with retail stores, only with other ordering systems. Products unsuitable for e-commerce include products that have a low value-to-weight ratio, products that have a smell, taste, or touch component, products that need trial fittings, and products where color integrity appears important (Wikipedia, 2004).

Globally, consumers have accepted the e-commerce business model more slowly than its proponents originally expected (Humphrey, Mansell, Paré, & Schmitz, 2004). Even in product categories suitable for e-commerce, electronic shopping has developed only slowly. Several reasons have been adduced for the slow uptake, including:

1. Concerns about security. Many people will not use credit cards over the Internet due to concerns about theft and fraud. This is in addition to the lack of credit card culture in many developing countries (Travica, 2002).
2. Lack of instant gratification with most e-purchases (nondigital purchases). Much of a consumer's reward for purchasing a product lies in the instant gratification of using, and being seen to use the product. This reward does not exist when one's purchase does not arrive for days or weeks.
3. The problem of Internet access, particularly for developing countries. Low penetration rates of Internet access (see Table 1) greatly reduce the potential for e-commerce in developing countries, especially in Africa, Asia, the Middle East, and Latin America.
4. The social aspect of shopping. Some people enjoy talking to sales staff, to other shoppers, or to their cohorts: this social reward does not exist in online shopping.

CURRENT STATUS OF E-COMMERCE IN NIGERIA

Nigeria—which has been long locked and dragged back by brick-and-mortar methods in governance, education, and business—is at last taking steps to cross the digital divide. With the ongoing revolution in technology and the realization that no country can move forward without first advancing technologically, Nigeria has joined the countries currently reveling the online bug. In the educational sector, seven examination bodies, including the Joint Admissions and Matriculation Board (JAMB) and West African Examinations Council (WAEC) now allow students to register for examinations and to check and to print out their results online. Also, through the initiatives of AfriHub Inc., of the United States, the first phase of electronic learning facilities were recently launched at the two campuses of the University of Nigeria (UNN) at Nsukka and Enugu (Akpore, 2005). The facilities, which are meant to provide real time online training to university students, will be extended to 38 other tertiary institutions across the six geopolitical zones in Nigeria. Access to the Internet in almost all parts of Nigeria has also made it easier for Nigerians to acquire international information technology certifications such as Microsoft, Linux, and Sun certifications.

Table 1. World Internet usage and population statistics (From InternetWorldStats.com, September 30, 2004)

World Regions	**Population (2004 Est.)**	Internet Usage, Latest Data	Usage Growth 2000-2004	Penetration (% Pop.)
Africa	893,197,200	12,937,100	186.6 %	1.4 %
Asia	3,607,499,800	257,898,314	125.6 %	7.1 %
Europe	730,894,078	230,886,424	124.0 %	31.6 %
Middle East	258,993,600	17,325,900	227.8 %	6.7 %
North America	325,246,100	222,165,659	105.5 %	68.3 %
Latin America/Caribbean	541,775,800	55,930,974	209.5 %	10.3 %
Oceania	32,540,909	15,787,221	107.2 %	48.5 %
WORLD TOTAL	6,390,147,487	812,931,592	125.2 %	12.7 %

Banks and financial institutions have also made progress in providing online services starting with First Atlantic Bank of Nigeria's introduction of electronic banking service in November 2001 (Huang, Makoju, Newell, & Galliers, 2003) to the recent commencement of on-line banking in 106 branches of the Union Bank of Nigeria (Anonymous, 2004). Banks now offer services ranging from daily fund transfer to access to account information.

In the area of governance, the federal government and some state governments have launched their e-government programs. A typical state program involves the floating of a Web site for disseminating information about government activities to its citizens as well as the provision of e-mail addresses for sending comments to various officials in the legislative and executive branches of government. Useful application forms, along with their necessary instructions, are also made available for the citizens to download and use.

Despite these various e-commerce efforts, there are still major constraints slowing down the growth and use of e-commerce in Nigeria. According to Ilori (2001), some of these constraints are poor or obsolete communication facilities; erratic and unreliable electricity supply; poor implementation of computerization; computer phobia, which has led to inadequate use of the computer among the citizenry; and absence of secure, online payment methods. Although Dungor (2001); Amosa, Adenawo, and Adekigbe (2001); and Adibe (2001) agree with Ilori that the inefficient communication system in Nigeria is the greatest drawback in implementing e-commerce in the country, they also believe that lack of awareness in the business communities is equally inhibiting its growth. Furthermore, Amosa et al. (2001) view the negative attitude of government agencies through inadequate funding, low-income level, and inadequate sustainability of manpower as additional constraints to the effective practice of e-commerce in Nigeria. They submitted further that, although the question of insecurity in e-commerce transactions is a global phenomenon, Nigeria's peculiar situation rather disturbingly reflects that while other countries are taking proactive measures in their local environments to minimize or eliminate risks that are associated with e-commerce transactions, Nigeria has yet to evolve a coordinated survival *policy* as a credible playing nation in the emerging commercial terrain.

THE WAY FORWARD FOR E-COMMERCE IN NIGERIA

In support of the growth of e-commerce, there are some promising signals in the Nigeria's national information technology (IT) policy that was approved in March 2001. The IT Policy sets out certain objectives concerning some of the country's economic sectors, including agriculture, arts, culture and tourism, and the nascent e-commerce sector. In broad terms, the objectives in the e-commerce sector include the creation of an enabling environment for e-commerce to improve productivity and the nation's global competitiveness; the development of information infrastructure; and creating an e-commerce culture for easy, quick, and cost-effective national and international transactions. In order to achieve these lofty objectives, the following strategies should be adopted:

- **Infrastructure Development:** There should be the establishment of National Information Infrastructure (NII) as a fundamental national mission, and involving the planning, designing and configuring of a scalable National Information Infrastructure Backbone to achieve a minimum capacity of 2.5 gigabytes per second, using combination of optical fibres, satellite communications, and wireless technology. In the creation of the NII backbone, nodes should be set up in each state and local government for easy and effective implementation. Existing facilities such as power grids and railways infrastructure should be used to enhance the creation of the NII Backbone, encouraging the private sector, through relevant incentives to build interfacing NII of fibre transmission systems designed strictly to provide transmission capabilities on lease basis to service providers essentially for data transmission and not for telephony.
- **Human Resource Development:** There is a need for an appropriate IT education philosophy for sustained human expertise at all the levels (primary, secondary, and tertiary) of the Nigerian educational system. According to the African Information Society Initiative framework drawn up by the United Nations Economic Commission for Africa, the focus on capacity building is important since the adoption of appropriate information and communication policies would be futile if a country's institutions do not have the capacity and the incentives to ensure effective policy implementation.
- **Appropriate Legislation:** The National Information Technology Development Agency (NITDA) should ensure that the government forwards all relevant bills that will facilitate electronic commerce to the National Assembly to be passed into law and to remove existing legal impediments as contained, for example, in existing legislation and legal principles that are predicated on the presumption of paper-based transactions. According to Bamodu (2004), there is undoubted need for legislative provisions concerning the legal recognition

of the use of electronic signatures, as these are important to the conduct of e-commerce. It is suggested however that a single consistent comprehensive e-commerce legislation covering various relevant aspects (e.g., the role and liability of service providers, private international law considerations, online dispute resolution, formation of contracts) is preferable to piecemeal legislations. A basic model or framework for e-commerce legislation of some international recognition is the amendments to the Model Law on Electronic Commerce (1996), which was drafted by the United Nations Commission on International Trade Law. It has influenced e-commerce legislation in a number of countries and regions, including the United States, the European Union, and Singapore.

- **Institutional Framework:** There is also a need for a body overseeing the development of e-commerce. Already, Nigeria's national IT policy provides for the establishment of a National Electronic Commerce Council (NECC). In this connection, NITDA should ensure that NECC is inaugurated and be made to start to function without any delay. Also, the Council's functions and operations should be made clearly facilitative of e-commerce rather than being of a heavy-handed regulatory nature that might end up perversely being an impediment to the growth of e-commerce.

CONCLUSION

In this article, we have reviewed the current state of e-commerce in a developing country, Nigeria. We also discussed the models for the diffusion of e-commerce growth and the constraints inhibiting the growth of e-commerce in the country. Also, we proposed strategies that could be used in eliminating these constraints, especially in the areas of infrastructure and human resource development, appropriate legislation and strengthening of the existing institutional framework. We believe that if these strategies are followed, then Nigeria should be reaping the benefits of e-commerce in the very near future.

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KEY TERMS

Developing Country: A country with a relatively low per capita gross national product (GNP).

Electronic Commerce: Commerce accelerated and enhanced by information technology.

Electronic Data Interchange: The direct computer-to-computer transfer of transaction information contained in standard business documents.

Information Technology: Information technology encompasses all forms of technology used in the processing and disseminating information.

Internet: A vast network of computers that connects millions of people worldwide.

Mobile Commerce: Electronic commerce conducted over a wireless device such as a cell phone or PDA.

Policy: A public statement of intentions and behavioral norms that is usually formalized and made explicit by a sovereign government, institution, corporation or other organizational entity.

E-Commerce Consumer and Product Characteristics

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INTRODUCTION

Retailers having an online selling facility, or considering doing so, would benefit from a better understanding of the factors that influence consumers' willingness to purchase online. This understanding would help them to plan their Internet strategies better, to design Web sites more effectively, to select the assortment of goods more likely to sell online, and to convert mere browsers into actual buyers. In fact, despite the worldwide diffusion and ever-increasing use of the Internet, e-commerce remains a limited phenomenon compared with the sales figures of traditional retailing: while an ever-increasing number of people use the Internet for gathering information, comparatively few buy online (Citrin, Stern, Spangenberg, & Clark, 2003; Dall'Olmo-Riley & Scarpi, 2005).

This article aims at providing Internet marketing academics and practitioners with an account of the drivers and barriers to e-commerce, identified from a state-of-the-art literature review. The review is structured around the two main factors that appear to influence behavior on the Internet: consumer and product characteristics. Researchers agree that, although product characteristics play a role in e-commerce, the effects of attitudes, risk perception, and expertise are dominant. Hence, we first consider consumer characteristics.

BACKGROUND

Numerous Internet users appear reluctant to shop online and use the Internet only as a means of gathering information, before purchasing in traditional brick-and-mortar environments. For instance, Dieringer Research Group (cited in Mazur, 2003) report that in the past year $138bn were spent by U.S. consumers for purchasing products off-line after seeking information online, compared with $95bn spent for shopping directly online.

According to the literature there are two key factors influencing purchase behavior on the Internet: consumer-related factors and product-related factors. Although the literature considers these two factors from numerous different perspectives, there is shared agreement about their importance for understanding (and directing) consumers' behavior online. Appropriate retailer factors (i.e., retailers' Internet strategies and tactics) are further key elements influencing how the Internet is used (e.g., for buying rather than browsing), and how the overall online shopping experience is evaluated (see Cowles, Kiecker, & Little, 2002). Conversely, while new technologies can enhance the shopping experience, their application "must be tailored to the unique requirements of consumer segments and product categories" (Burke, 2002, p. 411). Thus, consumer- and product-related factors must be taken into account for providing useful managerial implications in the online medium.

From an extensive review of the existing literature, we identify four main consumer-related dimensions relevant to the understanding of the adoption of e-commerce:

1. **Consumers' Attitudes** (Helander & Khalid, 2000; Goldsmith & Bridges, 2000; Venkatesh, 2000; Childers, Carr, Peck, & Carson, 2001; Goldsmith & Goldsmith, 2002; Hoffman, Novak, & Duhachek, 2002; Sénécal, Gharbi & Nantel, 2002; Citrin et al., 2003; Joines, Scherer, & Scheufele, 2003; Lee & Tan, 2003; Meuter, Ostrom, Bitner, & Roundtree, 2003; O'Cass & Fenech, 2003)
2. **Risk Perception** (Wee & Ramachandra, 2000; Forsythe & Shi, 2003; Kau, Tang, & Ghose, 2003; Lee & Tan, 2003)
3. **Previous Experience** (Goldsmith & Goldsmith, 2002; Forsythe & Shi, 2003; O'Cass & Fenech, 2003; Dall'Olmo-Riley & Scarpi, 2005)
4. **Price Consciousness** (Goldsmith & Newell, 1997; Degeratu, Rangaswamy, & Wu, 2000; Fenech & O'Cass, 2001; Joines et al., 2003; O'Cass & Fenech, 2003; Shankar, Smith, & Rangaswamy, 2003)

On the other hand, there is no doubt that also products play a key role. First of all, not all products are equally suited to be sold online; for instance, products whose core essence is of an intangible and informative nature are more suited to be distributed through the Internet than others (Girard, Silverblatt, & Korgaonkar, 2002; Kau et al., 2003). Similarly, products can be categorized on the basis of the balance between "search" and "experience" attributes they possess (Klein, 1998; Citrin, 2003). For "search products", full information on the most important attributes can be obtained prior to purchase, while for "experience" products, it cannot, or is more costly/difficult than direct experience. Thus, by facilitating the acquisition of information and by lowering the cost of searching, the Internet not only suits search products, but may also enable the transformation of "experience" products into "search". For instance, the attributes of clothes (fit, quality of material, feel, etc.) can be assessed before purchase when bought in a traditional brick-and-mortar environment, but shift towards becoming 'experiential' when sold online. Furthermore, most researchers agree that consumers are more likely to shop online for goods with well-known brands and from well-known retailers, and it has been postulated that brand equity could have higher impact online than off-line.

Basing on these considerations, we identify and focus upon two product-related dimensions:

1. **Products and Services Typology** (Bowen, 1990; Van den Poel & Leunis, 1999; Fenech & O'Cass, 2001; Girard et al., 2002; Lee & Johnson, 2002; Citrin et al., 2003; Forsythe & Shi, 2003; Kau et al., 2003; Lee & Tan, 2003; Marzocchi, Misso, & Bononcini, 2003; Dall'Olmo-Riley & Scarpi, 2005)
2. **Brand Names** (Klein, 1998; Degeratu et al., 2000; Harvin, 2000; Balabanis & Reynolds, 2001; Citrin et al., 2003; Kau et al., 2003; Lee & Tan, 2003)

Indeed, the characteristics of the good/service have to be considered in conjunction with the peculiarities of the Internet if one wants to gain a deeper insight and derive useful implications for practice. The next paragraphs address these topics in more detail.

CONSUMER AND PRODUCT CHARACTERISTICS

Attitudes

Consumers' attitudes towards e-commerce have a significant influence upon the usage of online retailers, and could even discriminate between e-buyers and non-e-buyers (Helander & Khalid, 2000; Goldsmith & Bridges, 2000; Goldsmith & Goldsmith, 2002); for instance, consumers' likelihood of buying online is found to depend on their expectations of the benefits to be obtained from doing so (Lee & Tan, 2003).

Enjoyment and ease of use were identified as a strong predictor of attitude toward Internet shopping in a study by Childers et al. (2001), but O'Cass and Fenech (2003) also found that pleasure-driven "recreational" shoppers have a more positive attitude towards e-commerce than goal-oriented "economic" shoppers, who see shopping as a duty or a task. Consistently, a positive relationship has been suggested between the experience of "flow" and the hedonic value of consumers' online experiences (Hoffman et al., 2002; Sénécal et al., 2002).

Attitudes toward the use of technology also influence the perceived value of e-commerce (e.g., Venkatesh, 2000). Just like Massara and Scarpi (2004), who suggest that attitudes could discriminate between buyers and non-buyers better than demographic variables, Meuter et al. (2003) suggest that "technology anxiety" is a better predictor of using the Internet than demographic variables. Indeed, the level of technology anxiety was found to be inversely related to the use of the Internet and to the likelihood of engaging in positive word of mouth.

Hence, managers should keep their Web sites easy to use and avoid the use of non-essential technological complexity, in order to minimize the technology anxiety of some users (Meuter et al., 2003; O'Cass & Fenech, 2003). At the same time, similarly to atmospheric variables in off-line retailing, the use of colors, music, and other sensory features of the Web site should be carefully considered and selected to provide a "pleasurable" shopping experience to hedonic consumers (Citrin et al., 2003; Joines et al., 2003). This will not only prevent the "abandoned chart" syndrome, but also increase consumers' perceptions that the Web is a valuable way of shopping.

Risk Perception

As risk perceptions appear to affect Internet browsers much more than shoppers (Forsythe & Shi, 2003), this may help differentiate between the two groups of consumers. Lee and Tan (2003, p. 879) state:

Since Internet shopping is a high technology form of non-store shopping, consumers will tend to perceive a higher level of risk when purchasing products…the perceived product and service failure rates will be higher under online shopping than under in-store shopping.

Specifically, four types of perceived risk may prevent browsers from becoming shoppers: financial risk, time/convenience risk, product performance risk, and privacy concerns.

Other risks frequently associated with e-commerce include credit card fraud, inability to touch the product, and problems of returning unsatisfactory goods (e.g., Wee & Ramachandra, 2000; Kau et al., 2003). As difficulties in building trust in an online site may affect customers' willingness to purchase and to return to the site (e.g., Lynch, Kent, & Srinivasan, 2001), managers should consider offering a money-back guarantee, price reductions, clear explanations of the return and billing processes (e.g., amazon.com, paypal.com), possibly alongside third-party reviews and endorsement. Furthermore, a tracking system should be used to keep the purchaser up to date (by e-mail) with the status of the order, again helping to overcome possible risk perceptions.

Previous Experience

Researchers agree that expertise with the Internet has a positive influence on the frequency and number of online purchases, no matter what the product is (e.g., Goldsmith & Goldsmith, 2002; Forsythe & Shi, 2003; O'Cass & Fenech, 2003). Heavy users of the Internet evaluate the Internet more favorably than light users (O'Cass & Fenech, 2003); expert online buyers have more positive attitudes toward the Internet in general (Goldsmith & Goldsmith, 2002) and feel less technological anxiety toward than novices (O'Cass & Fenech, 2003). All in all, expertise emerges in the recent literature as one of the key predictors of online buying and overall evaluation of the online shopping experience (Dall'Olmo-Riley & Scarpi, 2005). Hence, managers should consider providing incentives to attract first-time buyers and to encourage customers' trial of the site. Vouchers, discounts, free gifts, and special offers (e.g., free delivery and returns) are possible incentives, alongside quick registration processes, free trials, and toll-free complaint hotlines.

Price Consciousness

In contrast with common belief, price sensitivity or price consciousness has not been found to be a strong discriminator between Internet shoppers and non-shoppers (Fenech & O'Cass, 2001; O'Cass & Fenech, 2003). Goldsmith and Newell in 1997 noted that shopping innovators were on average less price sensitive than later buyers. Furthermore, since innovators usually have high income, they tend to value reliability and quality of information more than price (Shankar et al., 2003). Consistently, researchers tend to agree that price sensitivity may be lower online than off-line (Degeratu et al., 2000; Shankar et al., 2003).

Nonetheless, the success of low-cost airlines in using the Internet as a distribution channel suggests that price *can* indeed be effectively used as an incentive to overcome the fears and the reluctance of consumers to purchase online. Indeed, Joines et al. (2003) found that economic motivations were positively related *both* to the percentage of time spent looking for information online *and* to the amount of online shopping undertaken.

However, the extent to which consumer-related factors facilitate (or hamper) Internet purchase probability is often dependent upon the interaction with product-related factors. This leads us to examine product characteristics as possible facilitators and barriers to e-commerce.

Products and Services Typology

It has been suggested that: (1) cost, (2) frequency of purchase, (3) value proposition, (4) degree of differentiation, (5) degree of tangibility, and (6) informational nature of the goods determine whether the Internet is a suitable distribution channel (e.g., Girard et al., 2002). For instance, tangible goods purchased frequently, low in cost, and with low potential for differentiation (e.g., milk and eggs) are less likely to be sold online, unless they can be bundled with other goods, like in online grocery shopping. In contrast, intangible and informational goods can be easily sold online. Furthermore, the Internet should not alter significantly the core essence of services purchasing, since they are by definition rich in experience attributes and are therefore hard to evaluate prior to use also off-line. Indeed, since services do not require a "tactile input" prior to buying, consumers might find it easier to purchase services rather than products online.

However, two considerations need to be made. First, typical high contact, customized, personal services in the off-line world (Bowen, 1990) may be very hard to deliver online, since they rely to a great extent on personal requirements (Dall'Olmo-Riley & Scarpi, 2005); thus customers are reluctant to forfeit any kind of face-to-face interaction with the provider. Instead, typically moderate contact, standardized off-line services such as booking of airline tickets (Lovelock, 1984) appear perfectly suited to online delivery, since for this kind of service customers value speed, consistency, and price saving the most (Kau et al., 2003; Dall'Olmo-Riley & Scarpi, 2005). This may explain the high acceptance of the Internet more as an information source and reservation device (e.g., Lee & Tan, 2003).

Second, the propensity to purchase a good via the Internet decreases as one moves from lower priced items to higher priced ones, since the risk associated with making the wrong purchase increases (Van den Poel & Leunis, 1999; Citrin et al., 2003), although experience with e-purchases acts as a moderating factor (Fenech & O'Cass, 2001; Forsythe & Shi, 2003).

Hence, it would be a mistake for sellers to stop offering the opportunity to engage in a face-to-face interaction experience in favor of a purely Web-based distribution. For some goods at least, the complete lack of tangible cues in buying straight from the Internet could make consumers feel uneasy and uncertain (Girard et al., 2002). At the same time, search goods such as books, CDs, and software not only score high in consumers' declared purchase preference from an Internet retailer (e.g., Girard et al., 2002), but also top most of the online sales statistics (e.g., Lee & Johnson, 2002).

These findings have relevant practical implications, and suggest that technology should be a fundamental consideration of online managers. In fact, technological solutions (e.g., the 'virtual model' available at www.landsend.com) can provide customers with cues overcoming the need of touching the product or of interacting face to face, and also illustrate more effectively product characteristics through a combination of video images and text, rather than by text only or by still pictures alone (Marzocchi et al., 2003). Moreover, video streams and music can also enhance the perceived hedonic value of the site.

Brand Names

Brands may have an important role in shifting consumers' perceptions away from experience attributes such as tactility, to search attributes such as reputation, and a well-known brand is an important risk reliever for consumers shopping online (e.g., Citrin et al., 2003). Indeed, most researchers agree that consumers are more likely to shop online for goods with well-known brands and are more likely to shop from well-known retailers (Kau et al., 2003; Lee & Tan, 2003). As Klein (1998) remarks, the brand's name is an important extrinsic cue, facilitating consumers' choices whenever it is difficult or costly to collect and examine intrinsic product attributes such as flavor, color, size, and texture. Hence, for all goods that either cannot be properly evaluated prior to online purchase or involve a high degree of purchase risk, brands fulfill a key role (e.g., Harvin, 2000; Balabanis & Reynolds, 2001).

Thus, brand equity could have higher impact online than off-line (Degeratu et al., 2000). Well-established retailers have an advantage over new start-ups in electronic retailing, since they can capitalize on their reputation and brands to reduce the risk-aversion of consumers (Lee & Tan, 2003). Managers operating online should therefore particularly invest into building the reputation of their own brands, while firms new to e-commerce could try to target the less risk-averse consumers as their initial segment, or they should carry well-known third-part brands.

FUTURE TRENDS

Practitioners and researchers should keep in mind that, although consumers are going to move a portion of their purchases online, they will still have relationships with regular stores. The dynamics and the advantages of managing multiple channels of distribution are still far from being completely understood, yet they are extremely important. Firstly, regular brick-and-mortar stores allow prospective Web shoppers to interact directly with the products or with the service provider before online purchase. Secondly, there are implications for branding, since a failed attempt to purchase from a retailer online is likely to have a negative effect on purchases from the same retailer off-line. Furthermore, the issues of satisfaction and word-of-mouth need to be further investigated with regards to the multi-channel retailing context.

Finally, there are many possible ways of reducing or even overcoming the barriers preventing consumers from increasing the proportion of purchases they do online. Conversely, firms may decide to focus more on providing information and better services over the Internet, rather than on selling (Bradford, 2001).[1] These barriers, strategies, and solutions need a systematic analysis and comparison, for a better understanding of the dynamics underlying e-commerce and its future development.

CONCLUSION

Through a review of the literature, this analysis has focused on two key features of e-commerce, namely consumer and product characteristics. It has examined the role that attitudes, risk perception, past experience, and price consciousness play in consumers' adoption of e-commerce, as well as how brand names and the type of product can affect online purchasing and retailers' strategies.

Without forgetting the perspective of practitioners, this article has discussed how e-retailers' marketing efforts can be used to overcome the barriers to e-commerce resulting from specific product- and consumer-related characteristics. The intent has been to provide a sound analysis of the extant literature, as well as clear and easy-to-implement recommendations to managers.

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KEY TERMS

E-Retailer: A collective term applied to any Web site that sells a product or service, accepts payments, and fulfills orders; a retailer who has an online storefront.

Flow: Holistic sensation that people feel when they act in total involvement.

Hedonic/Recreational Consumers: Consumers who enjoy shopping for its own sake, not just for the items they purchase; they are driven by fun, pleasure, curiosity, and exploration.

Perceived Risk: The uncertainty that consumers face when they cannot foresee the consequences of their purchase decisions.

Technology Anxiety: A state of apprehension, uncertainty, and fear relative to implementing technology (*here*: in the buying/shopping process).

Utilitarian/Economic Consumers: Consumer who consider the shopping expedition as a task to be fulfilled; they are goal oriented, do not derive pleasure from the act of shopping, and value quick shopping expeditions.

Virtual Experience: A psychological and emotional state consumers undergo when interacting with visual products; an indirect experience in which the product affordances do not originate from the sensory and motor systems, but are provided by interactive virtual images/simulations.

ENDNOTE

1 This is, for instance, the strategy of insurance companies in the U.S., where online sales make up only 1% of the insurance market, but the large majority of firms provides consumers with the ability to do self-service online.

Category: Concepts, Trends, and Challenges

E-Commerce in a Digital Economy

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INTRODUCTION

A digital economy is a convergence of communications, computing, and information. The essential in the new economy is a structural shift from the industrial economy toward an economy characterized by information, intangibles, and services, and a parallel change toward new work organizations and institutional forms (Gronstedt, 2001; Harreld, 1998; Sharma, Wickramasinghe & Gupta, 2004; Woodall, 2000). The new economy or digital economy is based more in the form of intangibles, information, innovation, and creativity, to expand economic potential (Sharma, 2004; Tapscott, 1996, 1998) and is based on the exploitation of ideas rather than material things. The essential elements of the digital economy are:

- Digitalization and intensive use of information and communication technologies (ICT);
- Codification of knowledge;
- Transformation of information into commodities; and
- New ways of organizing work and production.

This implies that extensive information and many services are available online. A widely distributed access to the networks, the intranet and Internet, and of skills to live and work in the Information Society, is the basis for the digital economy. In a digital environment, the Internet's growth and e-commerce begins to create fundamental change to government, societies, and economies with social, economic and political implications (Boulton, Libert, & Samek, 2000; McGarvey, 2001). E-commerce has already improved business value by fundamentally changing the ways products are conceived, marketed, delivered, and supported. The relationship and interaction of various stakeholders such as customers, suppliers, strategic partners, agents, or distributors is noticeably changed. The real impact of e-commerce is its ability to reduce costs and prices and make doing business more efficient (Zwass, 1998). These savings permeate the entire value chain and impact significantly in business interactions with other businesses (Bernardes, 2000; Sharma, 2004; Sharma & Gupta, 2003a).

BACKGROUND

As e-commerce continues to grow rapidly, it could have significant effects on the social and economic structures. The impacts of these changes are diverse and may even widen the digital divide among nations, alter the composition of trade, disrupt labor markets, and change taxation (Anonymous, 2000). Widespread use of the Internet for e-commerce may have ramifications for intellectual property rights, privacy protection, and data filtering etc. Therefore, in the digital economy, it is becoming imperative to know how e-commerce affects organizations and society for economic and social concerns. Some of these effects of e-commerce are unintentional and create adverse business and personal conditions that could have societal consequences. Social and economic aspects of information and communication technologies (ICTs) have been studied by a wide variety of researchers and practitioners for over fifty years (Dutton, 1999). However, the influences of e-commerce are far bigger than previously imagined (Sharma & Gupta, 2003b; Sharma & Gupta, 2001).

E-commerce continues to show strong growth and has been influencing the social and economic growth of nations. While e-commerce technologies have helped nations to accelerate their economic growth and to provide more opportunities for businesses to grow, but it has also created many challenges and effects across numerous domains of society, and policy makers. These unintended consequences of e-commerce have raised concerns about whether e-commerce benefits only the privileged few. This article describes the various unintended socioeconomic impacts and influences that have been created by the e-commerce in a digital economy.

UNINTENDED CONSEQUENCES OF E-COMMERCE

As the digital economy expands, we are beginning to see the effects at both the individual and aggregate levels (Granovetter, 1985; Sharma, Wickramasinghe, & Gupta, 2004). Some unintended consequences are discussed in the next paragraph.

Increasing the Digital Divide

The use of ICTs for e-commerce deepens and intensifies the socioeconomic divisions among people, businesses, and nations. On one hand, e-commerce has provided new opportunities for economic growth; on the other hand, it has created a social problem of digital divide. Digital divide refers to the disparity between those who have use of and access to ICT, and those who do not. More than two-thirds of the world population is still deprived of access to ICTs. There is a complicated patchwork of varying levels of ICT access, basic ICT usage, and ICT applications among socioeconomic groups; many disparities are getting even larger (Sharma, 2004). Hindered by poverty and a poor telecommunications infrastructure, the gap between developing nations and developed nations is widening further and therefore, those nations who are not able to join the e-commerce bandwagon and have poor access to the Internet, suffer from great disparity in wealth (Rombel, 2000; Sharma, 2004).

E-Commerce and Marginalization

The use of ICT for e-commerce has brought greater than the existing marginalization. These sentiments are echoed by the World Employment Report (2001), which says that the use of technologies such as e-commerce is positively correlated with economic growth—both on a national and organizational level. It also states that in countries where ICTs are relatively expensive, many people (particularly previously marginalized, e.g., rural people) are further marginalized. These persons are marginalized to a greater degree than before (i.e., they are being excluded from the electronic market place and are simply ignored by "electronic players"). Those organizations or business people who do not have access to such facilities are unable to respond. Again, they are left out of the mainstream of activities (Sharma, 2004).

Social Isolation

E-commerce has been an important facilitator of new flexible work forms. Types of flexible work refer to; the location of work, with a flexible location (e.g., working on the move, working from home, and working from telecentres or satellite offices). E-commerce has far reaching implications in a social context. On one hand, it provides all the comfort of shopping from home, on the other side, it removes old-fashioned human interactions for social needs (Gershuny, 2000). E-commerce makes it possible for consumers to purchase almost all their needs from home and have those items delivered, but this phenomenon leads to social isolation. Due to such phenomenon, there are fewer people active in their neighborhoods than in the 1960s.

Privacy

The emergence of ever pervasive and intrusive technologies is representing a threat not only to privacy, but to fundamental freedoms as citizens (Ambrose & Gelb, 2001). Computers can monitor every aspect of our online activities. In the work place, electronic monitoring of employees is not unusual. The threats to our freedoms are even wider than ever imagined (Gupta & Sharma, 2001; Miyazaki & Fernandez, 2000; Zaret & Sawyer, 2000).

Privacy remains an important issue while doing e-commerce. Two-thirds of Internet users are concerned with the confidentiality of the Internet (Cranor, Reagle, & Ackerman, 1999; Hoffman, Novak, & Peralta, 1999; Pew Research Center, 2000) and an equal number see the Internet as a threat to their privacy (Cole, 2001). Privacy threats may lower participation in commercial and social activities online (Pew Research Center, 2000) and are of particular concern to new users (Pew Research Center, 2000). A content analysis of leading e-commerce sites by the Federal Trade Commission found that only 20% met the agency's standards (FTC, 2000). These guidelines entail disclosure of privacy policies, providing consumers choice and consent, access to their data, and security of the data that is collected. Independent studies have revealed continuing gaps in online privacy practices (Culnan, 1999, 2000; Miyazaki & Fernandez, 2000; Miyazaki & Krishnamurthy, 2002).

Survival of Local Businesses

Whitten and Steinfield show that as electronic commerce grows, it will create an important socioeconomic side effect which will increase competition with the traditional businesses in any given local community (Steinfield, Mahler, & Bauer, 1999a, 1999b). Their study indicates local merchants are ill-prepared to take full advantage of electronic commerce due to various reasons, and thus are unlikely to see gains from it. Distant Web-based businesses have several advantages over their local physical businesses. Using transaction cost theory, one can conclude that electronic commerce implies new competition for local retailers, particularly those offering products that are readily obtainable from other sources, and that are easily transported (Steinfield & Whitten, 1999; Steinfield, Mahler, & Bauer, 1999, Uzzi, 1997).

Community Level Impacts of Electronic Commerce

E-commerce has many positive influences at the individual level whereby local buyers gain more value and greater access to suppliers, however, the results at the aggregate community level may be undesirable for local residents. Some of the community level social costs of electronic commerce are; job losses, particularly in relatively unskilled areas already quickly disappearing in the digital economy. However, not all communities will be affected equally, and some may even find that electronic commerce leads to significant growth in jobs, tax revenues and service levels (Steinfield & Whitten, 1999; Steinfield et al, 1999).

Impact on Tax, Trade, and Regulatory Policies

E-commerce has a strong impact on taxation and tax policy. Concerns have been expressed that e-commerce could result in the erosion of tax bases. Consumption taxes are levied on the principle of taxation at the place of consumption and according to rates set in individual countries, or in individual states in the case of federal nations. Tax planning for an e-business differs from tax planning for a traditional bricks-and-mortar company. Historically, the generation of income depended on the physical presence of assets and activities. This physical presence, or permanent establishment, generally determined which jurisdiction had the primary right to tax the income generated. Because of the growth of electronic commerce, new e-business models (including digital marketplaces, online catalogs, virtual communities, subscription-based information services, online auctions, and portals) have emerged. Each allows taxpayers to conduct business and generate income in a country with little or no physical presence in that country. The separation of assets and activities from the source of the income represents a significant departure from historic business models. This change creates new tax planning, challenges, and opportunities (Anonymous, 2000; Olin, 2001; Penbera, 1999; Sharma, 2004).

Impact on Employment and Labor Policy

Since e-commerce may create more knowledge-based products, it is likely to drive widespread changes in the labor market, shifting the composition of workers required to produce and deliver a product or service (Anonymous, 2000). There will be shifts in the kind of skills needed. Faster rates of innovation and diffusion may also be associated with a higher turnover of jobs. This may create more turbulence as workers will need to enhance their skills from time to time. This may result in reallocation of labor to the changing needs of the economy (Sharma & Gupta, 2003b; Anonymous, 2000). Businesses will incur ICT costs including cost of new applications, developer time, software licenses, any hardware or software, support and maintenance costs, and business costs associated with making the transition to the new system. (Penbera, 1999).

Competitive Environment-Influence on Monopolistic Trends

Since e-commerce would transcend geographical boundaries, many big firms of known brands may not only expand their markets, but also may enter into new business activities across the broad spectrum of business activities. E-commerce, especially, facilitates enterprises whose success depends on network effects—“winner-takes-all” situations for companies with significant market share—which further facilitate their growth and market dominance. This effect may create problems for competition and antitrust policy. Certain players may become monopoly holders which will have greater consequences for competition. The recent evidence from a Microsoft case has shown that there is considerable potential for weakening the competitive process (Bakos, 1997; Sharma, 2004; Sharma & Gupta, 2003b; Uzzi, 1997).

The Threat to SMEs

From a theoretical perspective, small business and rural enterprises can benefit greatly with e-commerce as they gain access to more customers (even globally) and can even compete with large businesses since e-commerce is a “level playing field”. But in reality, this may not be true. As indicated in the previous paragraph, many big firms of known brands may not only expand their markets but also may enter into new business activities across the broad spectrum of business activities and thus may kill many SMEs (Auger & Gallaugher, 1997; Sharma, 2004).

FUTURE TRENDS

The Internet provides considerable opportunities for firms to streamline their business operations, as well as offering greater choices and lower prices to customers shopping online or alternatively obtaining product information before making a store or catalogue purchase. A large number of enterprises have migrated to Internet-based systems for increased efficiencies, lower costs, and the ability to operate in real time across different platforms. E-commerce is changing business economics and as a result, many firms are reengineering their core business processes. Suppliers and retailers are able to collaborate on product forecasts, product flow, and inventory management decisions using the collaborative Internet-based networks between suppliers and retailers. Retailers are able to allow customers to mass customize orders based on virtually thousands of choices. The entire value chain makes better decisions collaboratively with the end result being vastly improved performance throughout the entire chain. The digital economy will result in lower prices for consumers, better information access and increased competitiveness of small and midsize businesses. It will also pave the way for a true global trading community.

CONCLUSION

As electronic commerce grows, there will be many unintended effects. Although, e-commerce technologies are helping organizations, societies and nations to accelerate their socioeconomic growth and to provide more opportunities for businesses to grow, but it has also created many challenges and effects across numerous domains of society. In this article, we have identified a comprehensive set of many of those unintended socioeconomic effects that are influenced by e-commerce. Further empirical validation could be done for these variables in different countries.

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KEY TERMS

Digital Divide: The digital divide is the disparity in access to technology that exists across certain demographic groups. A term used to describe the discrepancy between people who have access to and the resources to use new information and communication tools, such as the Internet, and people who do not have the resources and access to the technology. The term also describes the discrepancy between those who have the skills, knowledge and abilities to use the technologies and those who do not.

Digital Economy: Digital economy is defined as the economy that is based more in the form of intangibles, information, innovation, and creativity, to expand economic potential and is based on the exploitation of ideas rather than material things using digital infrastructure.

E-Commerce: Electronic commerce means doing business online or selling and buying products and services through Web storefronts. E simply means anything done electronically, usually via the Internet. E-commerce is the means of selling goods on the Internet, using Web pages.

Internet Economy: Internet economy is defined as that part of the economy that deals with information goods such as software, online contents, knowledge-based goods, the new media, and supporting technology industries using the Internet.

Knowledge Economy: The knowledge-based economy is all about adding ideas to products and turning new ideas into new products. Relationships with trading partners, customers and suppliers, distribution networks, intellectual property, patents, image, etc., are all elements of a knowledge economy. These elements represent intellectual capital.

Network Infrastructure: This comprises the Internet as well as all forms of telecommunications and broadcasting infrastructure including television, cable TV, wireless, and satellite networks.

Privacy: Privacy is the interest that individuals have in sustaining a "personal space", free from interference by other people and organizations. It is the interest an individual has in controlling, or at least significantly influencing, the handling of data about themselves.

E-Commerce in Developing Countries

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INTRODUCTION

Internet access in *developing countries* is growing rapidly. Developing countries accounted for one-third of Internet users worldwide by the end of 2003, and the catch up rate is getting faster. Between 2000 and 2003, developing countries increased their share of the Internet population of the world by nearly 50%. This has led some commentators, such as World Bank to claim that initiatives to close the *digital divide* are no longer relevant (Atkins, 2005). However, most residents of these countries still have no access to the Internet. For example, Internet access in Africa is less than two percent in a population of more than 900 million; the lowest rate of access in the world (Dunphy, 2000, UNCTAD 2004). *E-commerce*, *e-government*, and *mobile commerce* provide significant opportunities for developing countries, but their adoption will be slowed by technological, cultural, economic, political, and legal problems (Davis, 1999; Enns & Huff, 1999). Differences in e-readiness and related barriers to e-commerce will sustain substantial differences between regions of the world, between countries within regions, between urban and rural areas within countries, and between the genders and age groups.

Different opinions exist as to what benefits the use of information and communication technologies (ICTs) can offer developing countries. Do they provide developing countries with the opportunity to "leapfrog" ahead, skipping over certain stages of infrastructure development? Or do ICTs simply widen the gulf between the developed and the developing world even further (Economist, 2005)? The World Summit on the Information Society (WSIS) views ICTs as enabling technologies that can improve the quality of life for citizens of developing countries. Whereas Bill Gates view is that ICTs can provide little benefit to developing countries until more basic needs like clean water, health, and education have been met. In spite of this lack of agreement the reality is that if a basic communications infrastructure is available, options do exist to utilize e-commerce in developing countries. This article explores the potential opportunities that these technologies offer, and considers the barriers to uptake.

E-commerce involves buying and selling goods and services within an electronic marketplace, and also servicing customers, collaborating with business partners, and conducting electronic transactions within an organization (Turban, McLean, & Wetherbe, 2004). E-commerce can take place between one business and another (Business-to-business), and between a business and its customers (business-to-consumer).

E-government is the application of e-commerce technologies to the public sector. Developments in e-government have opened up the potential for governments worldwide to improve the services they offer to their citizens. A move towards e-government offers particular advantages to developing countries that may have difficulties interacting with their citizens through more traditional communication channels. E-government consists of two separate areas. First, it is concerned with changing internal government operations, inasmuch as information technology is used to support cooperation among government agencies (government-to-government). Second, it is used to support external government operations, in particular the interactions between citizens and companies, and the public sector, on a self-service basis (government-to-citizen) (Howle, 2003).

Mobile commerce offers the potential to bypass inadequate landline telecommunications infrastructure. Growth in the number of mobile telephone users worldwide has expanded from 50 million in 1998 to over 1.3 billion by 2004 (Turban et al., 2004). *Wireless technologies* have taken off even in relatively low-income areas of the world, where prepaid cards allow access without having to pass a creditworthiness check. At the end of 2003, Africa had more than 50 million mobile device users, whilst the number of fixed line telephone subscribers stood at only 25.1 million (ITU, 2004). Similar trends have been observed in Latin America and Asia, where handheld devices enable users to overcome the difficulties caused by low fixed line penetrations.

BACKGROUND OF E-COMMERCE WORLDWIDE

Table 1 shows the number of Internet users in the major regions of the world, reflecting vast differences in e-readiness. Less than 11% of the population in the developing regions of Africa, Middle East, Latin America and the Caribbean, and Asia were using the Internet in 2005 as compared to regions such as North America, Europe, and

Table 1. World Internet usage (Adapted from http://www.internetworldstats.com/stats.htm)

REGION	POPULATION (2005 Est.)	INTERNET USAGE (2005)	USAGE GROWTH 2000-2005	% IN REGION
Africa	900,465,500	12,937,100	187%	1.4%
Asia	3,612.363,200	266,742,420	133%	7.4%
Europe	730,991,100	230,923,400	124%	31.6%
Middle East	259,499,800	17,325,900	228%	6.7%
North America	328,387,000	218,400,400	102%	66.5%
Latin America/ Caribbean	546,917,200	55,279,800	206%	10.1%
Oceania / Australia	33,443,500	15,838,200	108%	47.4%
WORLD	**6,412,067,200**	**888,681,100**	**126%**	**12.7%**

Australasia where at least 30% of the population used the Internet.

Africa

The digital divide is largest in Africa, with only 1.4% of the population having access to the Internet, as compared to 50% in most advanced countries. However, local Internet connection is now available in all African capital cities. Business-to-business e-commerce is growing in South Africa, but there have been limited developments in the rest of the continent. There are some success stories in the business-to-consumer area, mostly in the traditional handicrafts area, where the Internet offers the opportunity for a niche player to access the global market of Africans living abroad.

Asia

Asia leads in the adoption of e-commerce among developing countries. This is partly due to demographics, but also because organizations tend to be more integrated into global trade flows than in other developing countries. Manufacturing enterprises in particular face pressure from their customers in developed countries to adopt e-commerce. China offers the greatest potential e-commerce market, and is now considered one of the top five nations in the world in terms of Internet use. While many Chinese are going online for the first time, less than 20% have done any online shopping (Hsu, 2003).

Latin America

Four countries, Argentina, Brazil, Chile, and Mexico, account for two-thirds of Internet users in the region. Most business use involves searching for contacts, and gathering information with limited use of transactions. However, business-to-consumer e-commerce is growing, with online car sales, consumer auctions, travel, computer hardware and software, and banking responsible for the highest revenue. Business-to-business e-commerce is being used mainly by large transnational corporations in the automotive sector.

Middle East

The number of Internet users is growing rapidly, with the two main drivers of demand being the Internet and e-mail. Only a handful of large companies have adopted business-to-business e-commerce. The development of business-to-consumer e-commerce is hindered by high communication costs, and the fact that many Arab consumers are more comfortable with cash than credit card payments. This has led to some companies, such as Lebanon's GetForLess convenience store, implementing a hybrid e-commerce system that enables customers to order online, yet pay by cash (Gibeily, 2001).

North America/ Europe/ Oceania

In the developed world the growth in e-commerce continues. The business-to-business area is growing faster than business-to-consumer, with Forrester Research Inc. (2001) forecasting that 26% of business-to-business sales in the United States will be traded online by 2006, business-to-consumer has progressed significantly in some sectors, such as software, music, and travel services.

OPPORTUNITIES AND BARRIERS

A number of organizations have frameworks that can be used to track developments in e-commerce and e-government (Jupp, 2003). The UN/ASPA five-stage model, shown as Table 2, is particularly appropriate for developing

Table 2. UN-ASPA five stages of e-government (Adapted from UN & ASPA, 2002)

STAGE	DESCRIPTION	SPECIFIC FEATURES
Stage One	**Emerging Web Presence** Static information on the government or organisation is provided	Postal Address Email Address FAQs
Stage Two	**Enhanced Web Presence** Information is kept up to date, official forms and documents can be downloaded	Updated regularly Search function Newsletters
Stage Three	**Interactive Web Presence** Citizens or consumers can search databases, and submit online forms	Downloadable forms Specialised databases Discussion Forum
Stage Four	**Transactional Web Presence** Transactions can be completed online, and sites are fully secure	Public user log on Online Payment Security Policy
Stage Five	**Fully Integrated Web Presence** A single customisable portal provides all services and links	Portal Complete information

countries. Though this model was specifically developed for e-government it can also be applied to e-commerce.

The model tracks a country's e-government progress. A stage one e-government presence (Web site) will be a basic public information source, often developed by employees of the agency rather than professional Web developers. At stage two the Web site will be regularly updated, some documents will be available for download, and e-mail will be available for queries and comments. Once stage three is reached, the government Web site begins to act as a portal with links to related sites, both government and non-government. At stage four, citizens will be able to complete transactions online, and Web sites will be secure. Stage five occurs when there is an integrated countrywide portal where all services offered by government can be offered through one integrated "one stop shop" site (Lallana, Pascual, & Soriano, 2002).

The UN-ASPA model can also be used to monitor the development of e-commerce in the private sector. At stage one for example a traveller may be provided with a Web site that gives the contact details for the local tourist office. At stage two they will be provided with information about local accommodation, and possibly download a brochure. Stage three is reached when the potential customer is able to search for different types of accommodation, and make a booking online. By stage four the Web site is fully secure, and the customer is able to use a credit card to pay for their accommodation online. The final portal stage is more relevant to larger companies that may want to set up such sites to link more closely with their major suppliers and trading partners.

In both the private and public sectors the use of Web sites and e-mail is widespread, though there is little transactive use. Larger multinational companies have well developed business-to-business systems. However for smaller organizations the main use of the Internet is for email; there is relatively little business-to-consumer e-commerce. Lack of e-readiness, or what might be called barriers to e-commerce, such as low credit card use, and poor logistics and fulfilment, inhibit fully developed e-commerce (UNCTAD, 2002).

Governments can develop *e-procurement* systems to purchase goods and services online from the private sector. As the government is usually the largest purchaser in an economy, this provides an incentive for local businesses to adopt ICTs. Although this does raise the danger that some small businesses may be left behind. One of the risks of e-procurement is that, smaller firms

Table 3. Barriers to e-commerce in developing countries

Unstable power supplies
Poor telecommunications service
Limited penetration and/or high cost of Internet connections
Lack of competition in international telephone traffic
Lack of suitable regulatory environment
Illiteracy
Low incomes
No tradition of mail order type shopping
Inadequate payment systems and low credit card usage
Fulfilment problems occasioned by poor physical infrastructure (road, rail, air)
Poor customer service
Shortage of technical skills
A preponderance of small and medium size enterprises that lack capital for development of e-commerce
Lack of critical mass

without online capability may find themselves excluded from the market. High population countries, such as Malaysia and Brazil, have introduced extensive e-procurement systems, but for smaller countries benefits can be gained from even minor changes such as posting information about current tenders online (UNCTAD, 2004).

Developing countries lack the well-developed commercial and logistics infrastructures of developed countries, which support the development of e-commerce. In order for goods ordered online to be delivered safely, there has to be a good quality transport system, and a reliable postal service. Table 3 lists the main *inhibitors of e-commerce* in developing countries.

As a result of the barriers, most e-commerce in developing countries takes place between organizations. Business-to-business e-commerce accounts for 95% of all e-commerce in developing countries. Much of this is driven by large multinational organizations. Business-to-business e-commerce applications have the potential to enable producer firms in developing countries to gain better information about global markets. E-marketplaces which link together many different producers and buyers can be a means of obtaining new customers. However the main effect of business-to-business e-commerce to date has been to reinforce relationships between existing trading partners; little business is generated with new firms (Humphrey, Mansell, Paré, & Schmidtz, 2003). Developing countries need to be aware that business-to-business e-commerce may favor multinationals at the expense of local businesses. Indigenous business-to-consumer e-commerce is usually small by comparison with business-to-business, the buyers are often offshore customers in the developed world, as is the case for the tourism, art, and handicrafts markets.

In order for e-commerce to take off the number of users needs to reach a critical mass. More businesses and more customers will be online if they know they can do transactions efficiently by e-commerce. In addition, more businesses in developing countries will be online if they know they can reach customers across the globe efficiently. With sufficient demand from businesses and customers, the level of *infrastructure* represented by Internet service providers and facilities for Web site development and hosting and processing if electronic payments will also become available. These developments are interrelated and self-reinforcing.

Most payments for online purchases are still accomplished by *credit card* in the developed world, an option that exists for a much smaller percentage of customers in developing countries. However, where there is sufficient population density, fulfilment of physical goods purchased through online stores can include payment at the time of delivery, as happens in a significant portion of such purchases in China.

On the demand or customer side, access is growing through shared facilities like Internet cafes and through growing individual and family computer ownership. These options are still only available to higher income individuals living in cities in the developing world. Nonetheless, the number of customers and the number of online businesses is expanding rapidly.

FUTURE TRENDS

The rapid uptake of mobile telephony in the developing world, particularly in Africa brings the opportunity to overcome the problem of an inadequate telecommunications infrastructure. Mobile phones can provide an "Internet in your pocket". Is this the technology that will allow developing countries to "leapfrog"? Illiteracy is no barrier when operating a mobile phone, neither is lack of English. The availability of prepaid cards means that no credit checks are necessary. Access to mobile phones is a lot more widespread than ownership numbers suggest. A telephone may be owned by one person in a village who runs a small business taking and receiving calls for the other inhabitants. Mobile phones are also being used to make payments for items as diverse as petrol, laundry and deliveries of Coca-cola. This is a significant advantage as in many developing countries the lack of a reliable credit card system is a real inhibitor of e-commerce. There are many ways that mobile phones can used to assist a business. One example is that of the Tanzanian fishermen who use mobile phones to check the price of fish in different ports before deciding where to land their boats (*Economist Editorial*, 2005; Coyle, 2005).

Many ICT projects in developing countries have focussed on rural *telecentres*, which offer Internet access, and training for local people. Telecentres also offer access to the same information about weather patterns, crop prices, and market trends that are offered by mobile phones. A 2005 Economist editorial argued that the publicly owned telecentre model was outdated, and that private ownership of mobile phones was the way to overcome the digital divide. However as the editorial was based on research carried out by Vodafone, questions have to be raised about the impartiality of the findings. What is clear is that the increasing use of mobile phones in the developing world will have an impact on the development of e-commerce.

CONCLUSION

Patterns of Internet use and e-commerce are likely to remain skewed for some time. Communication, in particular email, will continue to be the first priority of users.

Searching for information will also be important in the future. Business-to-business e-commerce will remain more significant than business-to-consumer. Growth in entertainment and online purchases will lag. Business-to-consumer e-commerce growth will be largely an urban phenomenon, and rural areas will participate at much lower rates. The gaps between young and old and males and females, which have narrowed in the developed world, will persist much longer for people in developing countries.

Infrastructural issues are bound up with politics in many developing countries. The future will see wide variation as some countries move forward and others do not. The development of e-commerce may be encouraged by government interventions such as deregulating the telecommunications sector, and promoting competition among players to bring prices down. This is likely to be successful in high population countries whose large potential markets make them attractive to private investors. In countries with lower populations the government may need to retain responsibility for telecommunications.

There is a substantial body of research demonstrating significant improvements in the economies of countries, resulting from investment in telecommunications infrastructure (Parker, 2000). The more remote the location, the greater the benefits will be. A good telecommunications infrastructure can overcome the barriers to growth caused by distance, and lack of economies of scale. These benefits can also be gained through the use of mobile computing. Research carried out by Leonard Waverman has demonstrated that investment in mobile telecommunications has a positive impact on economic growth, and that this impact is stronger in developing countries. In a typical developing country an increase of ten mobile phones per 100 people boosts GDP by 0.6% (Economist, 2005).

The barriers to the development of business-to-consumer e-commerce all have a common source in the conditions that create and sustain differences between the developed and developing world. Until these conditions change, Developing countries will continually lag the developed world in e-commerce, as they do in many, more important indicators of well-being such as health and education.

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KEY TERMS

Business-to-Business (B2B): A business selling goods and/or services online to another business.

Business-to-Consumer (B2C): A business selling goods and/or services online to private customers.

Digital Divide: The gap in ICT usage between different sections of the world population. It can be used with reference to the developed and developing world, or within one country to describe the difference in ICT take up between rural and urban areas, or between different ethnic groups.

E-Marketplace: An online marketplace where many buyers and sellers barter and conduct transactions. They are frequently owned and operated by a third party.

E-Procurement: The use of the Internet by government to procure or purchase goods and services, advertise their needs, select vendors, manage services, organize fulfilment of contracts and effect payments.

E-Readiness: A measurement of how ready a society is to benefit from recent developments in ICT. An e-readiness assessment normally takes into account education levels, infrastructure, the accessibility of ICT, and legal and regulatory issues.

Government to Citizen (G2C): Governments offering services to citizens online.

Government to Government (G2G): Online interactions between different government agencies.

Wireless Technologies: Technologies that communicate without landlines e.g. satellite, microwave, cellular radio, infrared. Common uses are pagers, cellular telephones, personal digital assistants, mobile data communications, and personal communications services.

E-Commerce in Enron

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BACKGROUND OF THE BUSINESS

Enron was formed in 1985 when a Houston natural gas company merged with InterNorth, a gas provider in Nebraska to operate an interstate natural gas pipeline that linked the Great Lakes with Texas. Kenneth Lay, a former Exxon executive, became chief executive officer (CEO) of Enron in 1986. Enron began trading gas commodities in 1989 and soon became the largest supplier in the USA. The business activities of Enron spread all around the world and included activities in countries like Argentina, Bolivia, Brazil, China India, Indonesia, Mozambique, and the Philippines (Chatterjee, 2000). Enron also diversified its product range and expanded on to the Internet trading in a wide range of products from pulp and paper to petrochemicals and plastics. It also traded in esoteric products such as airport landing rights, railroad hauling capacity, and clean air credits.

In less than two decades, Enron grew from a small gas pipe line company into the world's leading energy trading company with $100 billion in revenue, $60 billion market value and 21,000 employees in 40 countries. In 2000 the Fortune magazine named Enron as the most innovative company in the USA for the fifth year in succession. In the same year Energy Financial Group ranked Enron as the sixth largest energy company worldwide.

Enron's mergers brought the company much success, but Enron wanted more. Enron wanted growth which eventually led to its demise. This phenomenal growth was made possible by the use of new market strategies that tilted towards knowledge and innovation in place of traditional ownership of physical assets. The central strategy at Enron was to totally use the financial derivatives in the market to acquire commodities that anybody wanted to sell and dispose it at a profit to anyone who required it. This started with oil and natural gas and then just expanded into electric power generation and pipeline capacity, broadband communication, and freight capacity of modular containers. All these were the factors that were responsible for Enron's growth and corporate greed led to its downfall (Ekbia, 2004).

DESCRIPTION OF THE BUSINESS

Prior to the Internet, the tools of trade were regular phones and fax machines. Computers were used but the Internet was still an untapped resource. With the new technology, information that took days to spread by newsletter and fax became available instantly. E-mail and instant messaging then made online trading the logical next step. Charles Moore, president of PetroVantage, said, "Rather than a threat to market stability, online services have made the industry more efficient by allowing companies to quickly analyze an offer and instantly run the decision tools to make a profitable transaction" (Jones, 2001, p. 3).

Meteoric Rise and Sudden Fall

Enron was a product of the information age. The basic premise behind Enron's strategy was to create markets for goods and services that were traditionally transacted through legacy distribution channels. Enron played three different roles at the same time as a broker, a trader, and a market maker. E-commerce provides numerous opportunities in increasing networking efforts, increasing efficiency, hence decreasing costs. Enron launched EnronOnline (EOL) in November 1999, the first ever-global Web-based online commodity trading site. EOL was a principal-based online trading system. All transactions were directly with an Enron company. Customers could view real-time prices and accept full contractual terms online, such as Argentine natural gas, Japanese weather, Dutch aluminum, Spanish electricity, and U.S.

lumber. Enron had an edge over its competitors in that there was no commission and no subscription fee charged to the customer. The key factor that separated Enron from its competition was the way it interacted with its buyers and sellers. In addition, Enron offered risk management product to these buyers and sellers to make them comfortable with this new marketing exploit by hedging their financial exposures.

The introduction of EOL facilitated gas trading and operations. Enron was a large market participant, as both a buyer and seller of spot, fixed, and futures contracts. "Its launch quickly changed not just the firm but markets around the world", EOL was acclaimed by BBC News (2001). "Two years after its launch, the platform was averaging 6,000 transactions a day worth an average $2.5 billion. Twenty-one hundred different financial products were on offer to traders, across four continents in 15 different currencies." Before the collapse of Enron the company was most certainly a success story. From 1985 to 1999 Enron's net income rose from $125 million to $893 million; its market value grew from 2 billion to $50.5 billion (Enron, 2002).

Even though Enron had an advantage being a global market, offering customers an electronic option was not easy. They had to deal with a host of regulatory issues from one country to another. Data-protection laws as well as regulations vary from one country to another. Consequently, Enron had to develop different registration forms and to some degrees take a lowest-common-denominator approach. Also its competitors, like Aquila, Duke Energy, Dynegy, and The Williams Cos. wanted a share of the commodity trading market. The main problem now, given all Enron's challenges, was making success last.

Enron launched the New Power Company (NPC), the first national energy service in May 2000 along with its new strategic investors IBM and America Online. The NPC was created to provide energy services for residential and small businesses in the U.S., where deregulations in the energy market were introduced. In early 2001, Jeff Skilling took over as Enron's CEO from Ken Lay. In October 2001, the tables were turned again and Ken Lay returned as CEO with Jeff Skilling having resigned in August. Then hints of overstated earnings began to circulate, along with nose-dived share prices—employees were terminated and their life savings emptied. Investigations into corporate crimes and accountancy fraud were initiated on Enron leading to the collapse of the Enron empire (Siylak, 2002). Enron declared bankruptcy in December 2001. Quite a few of its executives reaped large benefits by disposing their stock options for cash when the share prices were high. The employees were the losers as they put all their pension money in Enron shares and lost it all when the firm went bankrupt.

Certainly, Enron exploited new areas of business in dynamic and innovative ways. Enron has had a major impact on the Internet trading industry. A competitor of Enron—Atlanta, Georgia-based IntercontinentalExchange—began discussing an IPO after seeing a surge of new business since Enron's collapse. And Enron's model, in which the company essentially served as the medium that backed every trade with a money-back guarantee—likely will live on as well, according to Forrester Research analyst James Walker. In a report, Forrester's Walker explained the somewhat ironic reason for Enron's previous success in this way: "Enron exploded online by managing risk better than others" (Regan, 2002).

How the Company was Directed

Virtually every company, including those that plunder, has a policy with the proper lofty language about their commitment to integrity. But there is a difference between words and deeds (Wright, 2003). It is an irony that at the time these companies were engaged in wrongdoing, they were never more eager to present themselves as good citizens.

Enron's token commitment to its code of ethics was famed "RICE" (respect, integrity, communication, and excellence). However, The RICE values were neither modeled by leaders nor integrated into operations. Enron was obsessed with values relating to business success and profitability. Risk taking and "do deals" had become the dominant value in the company. Enron adopted an aggressive employee review system—a semiannual weeding out known as the "rank and yank". In the performance review committee (PRC), which became known as the harshest employee ranking system in the country, every six months 15% of employees were to be given unsatisfactory ratings that largely doomed their careers at Enron. Fierce internal competition prevailed. Paranoia flourished and contracts began to contain highly restrictive confidentiality clauses.

Hypothetically, the introduction of EOL could have increased the competitive functioning of the gas markets, or instead it could become a vehicle for increasing the concentration of market information in the hands of the Enron traders. Aided by the information available through EOL, Enron could emerge as a dominant firm exerting influence on the market to its own advantage (Murry & Zhu, 2004).

With the use of e-commerce and the acceptance of its countless benefits come responsibilities and risks if not met. Enron began diversifying its portfolio through the use of thousands of special purpose entities (SPEs) which allowed the company to embark upon less conventional ventures without necessarily reflecting their cost on its balance sheets. The pushing of boundaries was most likely encouraged throughout the company. They were pioneering business methods, of the entrepreneurial culture, of innovation and deal-making. Finally they pushed too hard; they "crossed a line and strayed into illegal behavior" (Zellner, 2003, p. 16).

For the fact that activities that eventually resulted in the collapse of Enron did not occur over night, nor conducted by one person many people are responsible for what has occurred inside of Enron. CEO Jeff Skilling and Chairman Ken Lay, also former CEO of Enron, the ex-CFO Andrew Fastow played major roles in the way Enron's future turned out. Board of Directors supported the CEO and the Chairman and they were further supported by an intelligent staff of accountants, auditors, and lawyers.

The only positive outcome of the Enron failure was the revision of accounting principles and retirement plan regulations. Legislative remedies were immediately sought, culminating in the Sarbanes-Oxley Act (SOX) of 2002. SOX included a number of provisions designed to strengthen both public and private oversight of corporate behavior, and subject violators to harsher penalties (Leeds, 2003).

Saunders (2003) emphasized that "as a result of Enron there have been the biggest changes to company rules in the U.S. since the 1929 crash. CEOs must now testify to the accuracy of the accounts and auditors are effectively banned from consulting to clients." But Stanford (2004) noticed that ethical behavior cannot be legislated: it has to come from within the individual and within an organization's culture. Research suggests that to the extent organizational structure can promote ethical behavior, a decentralized structure is best. When decisions reflect consensus, and accountability is shared, self-dealing should be curtailed if not eliminated.

The Main Reasons for the Company's Failure

It's been a tremendous success during Enron's ill-fated bull run. Even nowadays, many analysts wonder what could have been if Enron was still around. "It is impossible to know how much of its potential, real or imagined, Enron's Web effort might have achieved" (Regan, 2002). In retrospect, maybe Enron had "too much, too soon."

The collapse of Enron has been explained in a range of ways. Enron's downfall is considered by many to be a classic accounting failure characterized by the inappropriate use of generally accepted accounting principles (GAAP), off-balance-sheet schemes, and questionable independent auditor performance. It was a failure brought about by loose practices and a betrayal of trust.

Kreitner and Kinicki (2004, p. 107) blamed "the damage to the culture by the unscrupulous demands and practices of the CEO 'to make the numbers' at whatever cost necessary, which contributed significantly to the company's financial and legal problems."

The Washington Post described Enron as "a fundamentally self-destructive institution, a house of cards, where human error and a culture of ambition, secrecy, and greed made collapse inevitable" (Behr & Witt, 2002, p. A1). Zellner (2003, p. 16) mentioned "the unbridled greed, the Byzantine financial deals, and the toothless watchdogs at Arthur Andersen." In Awe's (2003, p. 63) point of view, "dubious financial maneuvers, excessive spending, and intricate and questionable accounting practices", as well as "political assistance" from the big man contributed to Enron's rise and fall.

On the other hand, the demise of Enron is not only the result of ethically challenged corporate managers but also a tale of fatal near-sightedness on the part of directors, auditors, bankers, lawyers, and analysts (Martorelli, 2004). Enron dealt in commodities and derivative structures and deal terms that were far too unusual to have an established price. The both hard pressure from the "rank and yank" and soft supervision from the non-standard measurements were Enron's unprecedented environment.

Also, Prentice (2003) argued that behavioral decision theory has substantial explanatory power in the Enron debacle. Because of subgoal pursuit, individual units of Enron tackled huge, risky projects and a number of them helping drag Enron down. The self-serving bias worked particular evil at Enron. Trades were often recorded at full value as revenue rather than according to the simple profit that was made. Energy was sometimes bought, sold, and then bought back in order to inflate revenues. Emphasis was placed on stock values almost to the exclusion of all else. Enron was an organization where money was the only yardstick and where the code of ethics was only window dressing.

LESSONS LEARNED

In accordance with Seeger and Ulmer (2003), the Enron case cost investors billions of dollars in equity, dealt a fatal blow to the accounting giant Arthur Andersen, generated a dizzying array of lawsuits, and prompted serious rethinking of SEC regulations.

Enron was not in isolation of being the only company to have conducted such illegal activities when dealing with e-commerce. Other companies include but are not limited to WorldCom, Adelphia Communications, Global Crossing, and Tyco International. Over the last five years over 700 companies have been forced to re-state their earnings in the U.S. Each and every one can be accused of contributing to the damaged credibility of today's businesses (Awe, 2003).

Why "good" people make "bad" moral choices? How can long-term social acceptance be achieved in parallel with short-term maximization of returns? Does SOX, that makes structures governing the conduct of the corporation a matter of federal law, offer a panacea? Several questions remain.

Among the embers of what remains of Enron and the people who ran it there are some fundamental lessons to be learned in order to ensure that nothing of this magnitude is allowed to happen again. Three of the most important areas for corporate reform include: (1) Independent auditors are a must, (2) Redefine duties of loyalty, (3) Shake up the boardroom (Anonymous, 2003). Duska's (2004) six simple rules that simply restate old virtues that were eroded in the single-minded pursuit of profit are: (1) Constrain self-interest, (2) Don't be greedy, (3) Keep worthwhile goals in mind, (4) Avoid hubris, (5) Don't misplace loyalty, (6) Be professional.

Recently, Maccoby (2005) assets that to make both companies and government organizations behave morally, the focus should be on organizational values and leadership. What needs to be done to raise the moral level? One key factor is whether employees feel it's safe to tell the truth, argue minority views and deliver bad news, especially when telling the truth may be essential to the well-being of others. Of course, leaders must articulate and model organizational values. If leaders are serious about raising the moral level, they need to actively engage the organization.

Common sense and research show that:

- Without solid ethical foundations any company will falter.
- If you persistently try to push boundaries and attempt to get around the rules, you will eventually break them.
- The pursuit of shareholder gain should not take place at the expense of the wider community.
- Never let the inner workings of a company become so complex that the managers don't even understand what is going on.
- Substantial amount of innovative and rapid growth, if not controlled, can become unsustainable in the long run.
- If you don't understand it, don't do it!

In many ways Enron is a quintessential example of the irrational exuberance of the dot-com bubble. The negative issues and problems that came about since the unraveling of Enron are quite obvious, but America is certainly using it, to its advantage, as a learning experience for everyone involved. As a nation we are gaining from our experiences and even though many of the new challenges probably have not come to light yet, there is no doubt that as they continue to come out we will continue to use it to learn from it and not let history repeat itself.

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KEY TERMS

Centralized Structure: In contrast with decentralization, the centralized structure is sometimes referred to as vertical, bureaucratic, mechanistic, rigid, or inflexible.

Decentralization: Also as participative or democratic management, employee involvement (EI), and team-based practices to denote governance philosophies, while the flat or horizontal organization represents the type of structural design. Other terms referring to the decentralized structure as organic or flexible (Thomas, 2004).

Ethics: A set of principles of right conduct. The rules or standards governing the conduct of a person or the members of a profession.

Generally Accepted Accounting Principles (GAAP): A widely accepted set of rules, conventions, standards, and procedures for reporting financial information, as established by the Financial Accounting Standards Board.

Integrity: The character traits of honesty, candor, and protection of confidentiality (AICPA—American Institute of Certified Public Accountants).

Mark-to-Market Accounting: Whenever companies have outstanding or other derivative contracts (either assets or liabilities) on their balance sheets at the end of a particular quarter, they must adjust them to fair market value, booking unrealized gains or losses to the income statement of the period.

Morality: It has to do with reasoning and behaving according to values that go beyond narrow self-interest.

Organizational Responsibility: It refers to obligations to operate regularly according to accepted social norms and standards. Those organizations that comply with basic standards are able to argue that their behavior is ethical and that their operations are normative and legitimate.

Special Purposes Entities (SPE): An SPE, dubbed the Raptors, is a trust, corporation, limited partnership, or other legal vehicle authorized to carry out specific activities as enumerated in its establishing legal document.

E-Commerce Services Based on Mobile Agents

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INTRODUCTION

The Internet offers a unique opportunity for e-commerce to take central stage in the rapidly growing online economy. With the advent of the Web, the first generation of business-to-consumer (B2C) applications was developed and deployed. Classical examples include virtual shops, on-demand delivery of contents, and e-travel agency. Another facet of e-commerce is represented by business-to-business (B2B), which can have even more dramatic economic implications since it far exceeds B2C in both the volume of transactions and rate of growth. Examples of B2B applications include procurement, customer relationship management (CRM), billing, accounting, human resources, supply chain, and manufacturing (Medjahed, Benatallah, Bouguettaya, Ngu, & Elmagarmid, 2003).

Although the currently available Web-based and object-oriented technologies are well-suited for developing and supporting e-commerce services, new infrastructures are needed to achieve a higher degree of intelligence and automation of e-commerce services. Such a new generation of e-commerce services can be effectively developed and provided by combining the emerging agent paradigm and technology with new Web-based standards such as ebXML (2005).

Agents have already been demonstrated to retain the potential for fully supporting the development lifecycle of large-scale software systems which require complex interactions between autonomous distributed components (Luck, McBurney, & Preist, 2004). In particular, e-commerce has been one of the traditional arenas for agent technology (Sierra & Dignum, 2001). Agent-mediated e-commerce (AMEC) is concerned with providing agent-based solutions which support different stages of the trading processes in e-commerce, including needs identification, product brokering, merchant brokering, contract negotiation and agreement, payment and delivery, and service and evaluation. In addition, the mobility characteristic of peculiar agents (a.k.a. *mobile agents*), which allows them to move across the nodes of a networked environment, can further extend the support offered by the agents by featuring advanced e-commerce solutions such as location-aware shopping, mobile and networked comparison shopping, mobile auction bidding, and mobile contract negotiation (Kowalczyk, Ulieru, & Unland, 2003; Maes, Guttman, & Moukas, 1999).

To date, several agent- and mobile agent-based e-commerce applications and systems have been developed which allow for the creation of complex e-marketplaces—that is, e-commerce environments which offer buyers and sellers new channels and business models for trading goods and services over the Internet.

However, the growing complexity of agent-based marketplaces demands for proper methodologies and tools supporting the validation, evaluation, and comparison of: (1) models, mechanisms, policies, and protocols of the agents involved in such e-marketplaces; and (2) aspects concerned with the overall complex dynamics of the e-marketplaces.

The use of such methodologies and tools can actually provide the twofold advantage of:

1. analyzing existing e-marketplaces to identify the best reusable solutions and/or identify hidden pitfalls for reverse engineering purposes; and
2. analyzing new models of e-marketplaces before their actual implementation and deployment to identify, *a priori*, the best solutions, thus saving reverse engineering efforts.

This article presents an overview of an approach to the modeling and analysis of agent-based e-marketplaces (Fortino, Garro, & Russo, 2004a, 2005). The approach centers on a Statecharts-based development process for agent-based applications and systems (Fortino, Russo, & Zimeo, 2004b) and on a discrete event simulation framework for mobile and multi-agent systems (MAS) (Fortino et al, 2004a). A case study modeling and analyzing a real consumer-driven e-commerce service system based on mobile agents within an agent-based e-marketplace on the

Internet (Bredin, Kotz, & Rus, 1998; Wang, Tan, & Ren, 2002) is also described to demonstrate the effectiveness of the proposed approach.

BACKGROUND

In a broad sense, an agent is any program that acts on behalf of a (human) user (Karnik & Triphati, 1998). An agent can just sit there and interact with its environment and with other agents through conventional means, such as local/remote procedure calls and asynchronous messaging, or through more advanced coordination infrastructures such as *tuple* spaces and *event*-based systems. Agents that do not or cannot move are called "stationary agents." Conversely, a mobile agent is a program that represents a user in a computer network and can migrate autonomously from node to node to perform some computation on behalf of the user. Thus mobility is an orthogonal property of agents—that is, not all agents are mobile. Also mobile agents can interact with their environment and, notably, with other agents through mobility-aware and mobility-unaware infrastructures (Fortino & Russo, 2005). Indeed, the emergence of mobile agents was motivated by the benefits they provide for creating distributed systems. In fact, as Lange and Oshima (1999) pointed out in their seminal paper, there are at least seven good reasons to employ mobile agents: reduction of network load, overcoming of network latency, encapsulation of protocols, asynchronous and autonomous execution ("dispatch your agents, shut off your machine"), dynamic adaptation, seamless system integration, and robustness and fault-tolerance.

An agent-based e-marketplace (AEM) is a distributed multi-agent system formed by both stationary and mobile agents which provide e-commerce services to end-users within a business context. AEMs are, as previously pointed out, distributed large-scale complex systems which require tools which are able to analyze not only the AEM at the *micro* level (i.e., behaviors and interactions of their constituting agents), but also the AEM at the *macro* level (i.e., the overall AEM dynamics).

In Griss and Letsinger (2000), an agent-based framework for e-commerce simulation games has been developed by using *Zeus*, a Java-based multi-agent system developed at the British Telecom Lab. Its goal is to evaluate the potential consequences of novel combinations of market models, business strategies, and new e-services through multi-player shopping games, in which agents represent various typologies of sellers, buyers, brokers, and services.

In Wang et al. (2002), an infrastructure for Internet e-marketplaces based on the *Aglets* mobile agents that enables real commercial activities by consumers, agents, and merchants, has been proposed. Its goal is not only to provide an advanced e-commerce service, but also to evaluate several dispatching models for mobile agents.

Bredin et al. (1998) describe a simulated environment for mobile agents which allows analyzing the market-based resource control system of the *D'Agents* mobile agent system and, in particular, the resource allocation mechanism of its resource manager using a sealed-bid, second-price auction policy.

Although useful insights about AEM micro and macro levels can be acquired by playing e-commerce simulation games and, then, analyzing the obtained results, or by evaluating real e-commerce applications, discrete event simulators are essential for evaluating how AEMs work on scales much larger than that achievable in games or in applications which involve humans. In fact, discrete event simulation is currently extensively exploited as a strategic tool in most research and application areas which are directly or indirectly related to computer science. In this context, the article proposes an approach based on discrete event simulation and shows its application to the analysis of micro-level issues of a consumer-driven AEM: validation and evaluation of services based on mobile agents for product searching and buying.

MODELING AND ANALYSIS OF MOBILE AGENT-BASED SYSTEMS

The StateCharts-Based Approach for Modeling and Analysis

The proposed approach (Fortino, Garro & Russo, 2005) consists of the following phases: high-level modeling, detailed design, and coding and simulation (see Figure 1).

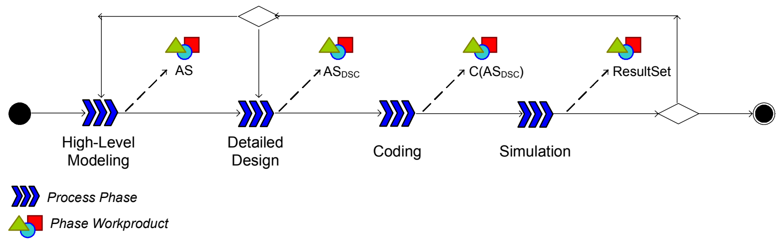
The *High-Level Modeling* of an agent-based system can be supported through well-established agent-oriented methodologies (such as the Gaia methodology; Wooldridge, Jennings, & Kinny, 2000) which cover the phases of requirements capture, analysis, and high-level design. An agent-based system (AS) can be modeled as follows:

AS = <AT, LCL, act, ser, pro>,

where:

- AT (Agent Types) is the set of types of agents embodying activity, offering services, and interacting with each other.
- LCL (Logical CommunicationLinks) is the set of logical communication channels among agent types which embody interaction protocols.

Figure 1. Phases and work products of the proposed approach



act: $AT \rightarrow$ *activity description* is the activity relation which associates one or more activities to an agent type.
ser: $AT \rightarrow$ *service description* is the service relation which associates one or more services to an agent type.
pro: $LCL \rightarrow$ *interaction description* is the protocol relation which associates an interaction protocol to a logical communication channel.

The *Detailed Design* of an AS is achieved through a Statecharts-based formalism, namely Distilled StateCharts (DSC) (Fortino et al., 2004b), which allows for the specification of the behavior of the agent types and the interaction protocols among the agent types. In fact, a Statecharts-based specification of an entity describes both internal behavior and coordination through the reception and generation of events (Harel & Gery, 1997). DSC allow for the specification of the behavior of lightweight agents which have the following features: event-driven, single-threaded, capable of transparent migration, and executing chains of atomic actions. The DSC-based specification of an AS (AS_{DSC}) can be expressed as follows:

$AS_{DSC} = \{Beh(AT_1), \ldots, Beh(AT_n)\}$,
where:
$Beh(AT_i)$ is the DSC-based specification of the behavior of the i-th agent type.
$Beh(AT_i) = <S_{Beh}(AT_i), E_{Beh}(AT_i)>$, where $S_{Beh}(AT_i)$ is a hierarchical state machine incorporating the activity and interaction handling of the i-th agent type and $E_{Beh}(AT_i)$ is the related set of events to be handled triggering state transitions in $S_{Beh}(AT_i)$.

The *Coding* of an AS_{DSC}, $C(AS_{DSC})$, is carried out through the Java-based Mobile Active Object (MAO) Framework (Fortino et al., 2004b). In particular, $Beh(AT_i)$ can be seamlessly translated into a composite object (called MAOBehavior object), which is the object-based representation of $S_{Beh}(AT_i)$, and into a set of related event objects representing $E_{Beh}(AT_i)$.

Finally, the *Simulation* phase of AS_{DSC} is supported by a Java-based discrete event simulation framework for distributed agent systems. The framework provides:

1. *Basic Simulation Objects*:
- **Agent (Ag):** Represents a stationary or a mobile agent and includes a pair of objects: <MAOId, MAOBehavior>, where MAOId is the unique agent identifier and MAOBehavior is an agent behavior object.
- **Event (Evt):** Represents the event for intra- and inter-Ags interactions.
- **AgentServer (AgS):** Represents the agent server hosting **Ag**s.
- **VirtualNetwork (VN):** Represents the logical network of hosts on which **AgS** are mapped.
- **UserAgent (UA):** Represents a user, directly connected to an **AgS**, who can create, launch, and interact with **Ag**s.

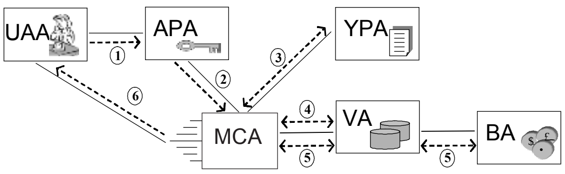
2. A *Simulation Engine* Enabling:
- execution of **Ag**s by interleaving their **Evt**s processing;
- transmission of **Evts** among **Ag**s; and
- migration of **Ag**s.

On the basis of the framework, a simulator program can be implemented and executed to obtain a ResultSet containing validation traces and performance parameter values. While the validation of agent behaviors and interactions is carried out on execution traces automatically generated, the performance evaluation relies on the specific agent-based system to be analyzed; the performance evaluation parameters are therefore set ad-hoc. The ResultSet can also be used to feed back the high-level modeling and detailed design phases.

A Consumer-Driven Agent-Based E-Marketplace

A consumer-driven e-marketplace is an e-marketplace in which the exchange of goods is driven by the consumers

Figure 2. The reference consumer-driven agent-based e-marketplace model: the types of agents, the logical communication links among them, and the sequence of agent interactions



that wish to buy a product. The modeled AEM, inspired by the systems presented in Bredin et al. (1998) and Wang et al. (2002) consists of a set of stationary and mobile agents (see Figure 2) which provides basic services for the searching, buying, selling, and payment of goods.

The identified types of agents are:

- **User Assistant Agent (UAA):** Associated with users and assists them in: (1) looking for a specific product that meets their needs; and (2) buying the product according to a specific buying policy.
- **Access Point Agent (APA):** Represents the entry point of the e-marketplace. It accepts requests for buying a product from a registered UUA.
- **Mobile Consumer Agent (MCA):** Represents an autonomous mobile agent dealing with the searching, contracting, evaluation, and payment of goods.
- **Vendor Agent (VA):** Represents the vendor of specific goods.
- **Yellow Pages Agent (YPA):** Represents the contact point of the distributed Yellow Pages Service (YPS) providing the location of agents selling a given product. The organization of the YPS can be: (1) *Centralized* (C), where each YPA stores a complete list of Vendor Agents; (2) *One Neighbor Federated* (1NF), where each YPA stores a list of VAs and keeps a reference to only another YPA; or (3) *M-Neighbors Federated* (MNF), where each YPA stores a list of VAs and keeps a list of at most M YPAs.
- **Bank Agent (BA):** Represents a reference bank supervising money transactions between MCAs and VAs

The identified types of interactions between the agent types are described below by relating them to the system workflow triggered by a user's request (see Figure 2):

1. **Request Input (UAA $\rightarrow$ APA):** The UAA sends a request to the APA containing a set of parameters selected by the user for searching and buying the desired product—that is, the product description (*Prod_Desc*), the maximum product price (P_{MAX}) the user is willing to pay, and the type of buying policy (*BP*).
2. **Service Instantiation (APA$\rightarrow$ MCA):** The APA creates a specific MCA and provides it with the set of user parameters, the type of searching policy (*SP*), and the location of the initial YPA to be contacted. Upon creation, the MCA moves to the initial YPA location.
3. **Searching (MCA$\rightarrow$YPA):** The MCA requests a list of locations of VAs selling the desired product to the YPA. The YPA replies with a list of VA locations and, possibly, with a list of linked YPA locations.
4. **Contracting & Evaluation (MCA$\rightarrow$VA):** The MCA interacts with the found VAs to request an offer (P_{offer}) for the desired product, evaluates the received offers, and selects an offer, if any, for which the price is acceptable (i.e., P_{offer}<=P_{MAX}) according to the type of *BP*.
5. **Buying (MCA $\rightarrow$ VA $\rightarrow$ BA):** The MCA moves to the location of the selected VA and pays for the desired product using a given amount of e-cash (or bills) triggering the following money transaction: (a) the MCA gives the bills to the VA; (b) the VA sends the bills to a BA; (c) the BA validates the authenticity of the bills, disables them for re-use, and, finally, issues an amount of bills equal to that previously received to the VA; and (d) the VA notifies the MCA.
6. **Result Report (MCA $\rightarrow$ UAA):** The MCA reports the buying result to the UUA.

Analysis of Mobile Agent-Based Services

A model of MCA is defined on the basis of the tuple:

<*SP*, *BP*, *TEM*>,

where:

- *SP* is a searching policy in {ALL, PA, OS}:
  (a) ALL: All YPAs are contacted.
  (b) *Partial* (PA): A subset of YPAs are contacted.

(c) *One-Shot* (OS): Only one YPA is contacted.

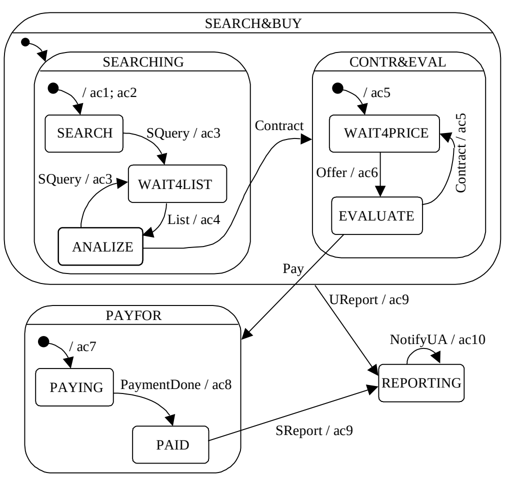
- *BP* is a buying policy in {MP, FS, FT, RT}:
  (a) *Minimum Price* (MP): The MCA first interacts with all the VAs to look for the best price of the desired product; then, it buys the product from the VA offering the best acceptable price.
  (b) *First Shot* (FS): The MCA interacts with the VAs until it obtains an offer for the product at an acceptable price; then, it buys the product.
  (c) *Fixed Trials* (FT): The MCA interacts with a given number of VAs and buys the product from the VA which offers the best acceptable price.
  (d) *Random Trials* (RT): The MCA interacts with a random number of VAs and buys the product from the VA which offers the best acceptable price.
- *TEM* is a task execution model in {ITIN, PAR}:
  (a) *Itinerary* (ITIN): The *Searching* and *Contracting & Evaluation* phases are performed by a single MCA which fulfils its task by sequentially moving from one location to another.
  (b) *Parallel* (PAR): The *Searching* and *Contracting & Evaluation* phases are performed by a set of mobile agents in a parallel mode. In particular, the MCA is able to generate a set of children (generically called workers) and to dispatch them to different locations; the workers can, in turn, spawn other workers.

Thus, each one of the defined models implements the product buying service differently. Figure 3 shows the generic DSC-based behavior of the MCA models <*,*,ITIN>. For the sake of brevity, the explanation is not given here, but readers unfamiliar with DSC-based programming can refer to Fortino et al. (2004b).

In order to analyze and compare the MCA models, the Task Completion Time (T_{TC}) parameter was defined as follows: $T_{TC} = T_{CREATION} - T_{REPORT}$ where, $T_{CREATION}$ is the creation time of the MCA and T_{REPORT} is the reception time of the MCA report. Accordingly, a simulator program was implemented which allows for computation of T_{TC} for each MCA model by varying the *Yellow Pages* organization, the number of YPAs (N_{YPA}), and the number of VAs (N_{VA}). In particular, the simulation scenario was set up as follows:

- Each stationary agent (UAA, APA, YPA, VA, BA) executes in a different agent server.
- Agent servers are mapped onto different network nodes which are completely connected through links having the same characteristics. The communication delay (δ) on a network link is modeled as a lognormally distributed random variable with a mean, μ, and a standard deviation, σ (Floyd & Paxson, 2001).
- Each UAA is connected to only one APA.
- The price of a product, which is uniformly distributed between a minimum (PP_{MIN}) and a maximum (PP_{MAX}) price, is set in each VA at initialization time and is never changed; thus the VAs adopt a fixed-pricing policy to sell products.

Figure 3. DSC-based behavior of the MCA models <,*,ITIN>*




```
ac1  :nextYP=0;
ac2  :YPATarget=(MAOId)yp.elementAt(nextYP++);
      generate(new Move(self(), YPATarget.getCurrLocation()));
      generate(new SQuery(self()));
ac3  :generate(new VAListQuery(self(), YPATarget, vaListQuery));
ac4  :List reply = (List)mevent;
      Proc proc = processYPAReply(reply);
      if (proc.continueSearching()) ac2();
      else if (proc.noVendors()) sa2();
      else { nextVA=0; sa1(); }
sa1  :VATarget=(MAOId)va.elementAt(nextVA++);
      generate(new Move(self(), VATarget.getCurrLocation()));
      generate(new Contract(self()));
sa2  :generate(new UReport(self()));
ac5  :generate(new PriceQuery (self(), VATarget, priceQuery));
ac6  :Offer offer = (Offer)mevent;
      Eval eval = evaluateVAOffer(offer);
      if (eval.buySoon()) generate(new Pay(self()));
      else if (eval.moveAndBuy()){
       generate(new MAOMove(self(), VATarget.getCurrLocation()));
       generate(new Pay(self()));
      }
      else if (eval.noBuy()) sa2();
      else sa1();
ac7  :bills = prepareBills(price);
      generate(new PayFor(self(), VATarget, bills);
ac8  :nbills = nbills - eval.price();
      generate(new SReport(self()));
ac9  :generate(new Move(self(), self().getHomeLocation()));
      generate(new NotifyUA(self()));
ac10:reportTR();
```

Figure 4. Task completion time of the MCA models in an e-marketplace with N_{YPA}=10, N_{VA}=80, and YPS=2NFBT

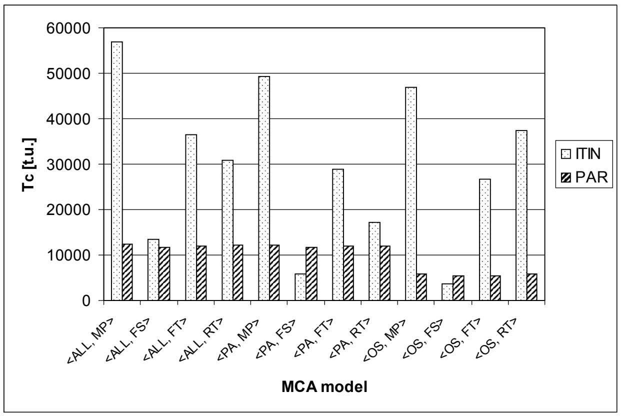
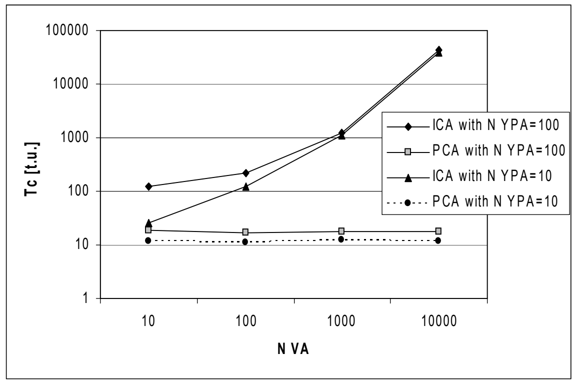


*Figure 5. Performance evaluation of the <ALL, MP, * > models for an e-marketplace with YPS=2NFBT, N_{YPA} ={10, 100}, and variable N_{VA}*



- Each YPA manages a list of locations of VAs selling available products.
- An UAA searches for a desired product, which always exists in the e-marketplace, and is willing to pay a price P_{MAX} for the desired product which can be any value uniformly distributed between PP_{MAX} and $(PP_{MAX}+PP_{MIN})/2$.

Simulations were run by varying (1) the organization of the Yellow Pages (C, 1NF and 2NF organized as a binary tree or 2NFBT), (2) the number of YPA agents in the range [10..1000], and (3) the number of VA agents in the range [10..10000]. These ranges were chosen for accommodating small as well as large e-marketplaces. The duration of the performed simulations were set so to allow for the completion of the buying task carried out by the MCA.

Figure 4 shows the T_{TC} of the <*,*,ITIN> and <*,*,PAR> models in a *medium-sized* e-marketplace with N_{YPA}=10, N_{VA}=80, and YPS=2NFBT. The lowest-performance model is the <ALL,MP,ITIN> model. The <ALL,MP,*> models are the only models guaranteeing both a successful purchase and the best purchase since they are able to find the VA offering the minimum price. The <*,*,PAR> models always outperform the <*,*,ITIN> models, but the <*,FS,*> models where the <*,FS,ITIN> models perform similarly or slightly better than the <*,FS,PAR> models. However, in the latter case, purchase of the desired product at the best price is not guaranteed.

In order to compare the performances of PCA (Parallel Consumer Agent) and ICA (Itinerary Consumer Agent) models, the results obtained for the <ALL, MP, *> MCA models adopting a YPA organization of the 2NFBT type are reported in Figure 5, where results were obtained setting N_{YPA} ={10, 100} and varying N_{VA}. In agreement with the analytical model reported in Wang et al. (2002), the PCA, due to its parallel dispatching mechanism, outperforms the ICA when N_{VA} and N_{YPA} are increased.

FUTURE TRENDS

To date, *Agents* have been employed primarily for product and merchant discovery and brokering (Sierra & Dignum, 2001). The next stage will involve moving into real trading, which will require considerable research and development efforts, including the definition, implementation, and notably, analysis of new products and services such as market-specific shells, payment and contracting methods, risk assessment and coverage, quality and performance certification, security, and trust management.

Moreover, in the very near future, a rapid growth in agent-mediated auctions is expected. Auction is a long-established and well-understood trading mechanism, and the agent technology can be used to develop and support agent-mediated auction houses (Luck et al., 2004).

In order to test these new trading and auction services within large-scale MAS, discrete-event simulation seems to be the most appropriate and reliable tool. Therefore, flexible and robust agent-oriented, discrete-event simulation frameworks must be carefully designed and developed to support analysis of MAS at different levels of granularity: from agent behaviors, protocols, and services (*micro-level*) to global MAS behavior (*macro-level*).

CONCLUSION

Using *agents* to support e-commerce (both B2C and B2B) is considered a key challenge for the agent community. This article has presented an integrated approach which effectively models and analyzes e-commerce services based on *agents*. In particular, a consumer-driven AEM was modeled, and the product searching and buying strategies carried out by the mobile consumer agents in this AEM were analyzed. The consumer-driven AEM model used here was derived from real systems using agent-based e-marketplaces on the Internet (Bredin et al., 1998; Wang et al., 2002). In line with the *future trends* which have been delineated, the proposed approach is being applied to the modeling and analysis of more complex AEMs and related services, and also enhanced by exploiting game theory and economics models.

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KEY TERMS

AEM: An agent-based e-marketplace is a distributed multi-agent system formed by stationary and mobile agents which provide e-commerce services to end-users within a business context.

Agent: In a broad sense, any program that acts on behalf of a (human) user.

AMEC: Agent-mediated e-commerce is concerned with providing agent-based solutions which support different stages of the trading processes in e-commerce, including needs identification, product brokering, merchant brokering, contract negotiation and agreement, payment and delivery, and service and evaluation.

Distilled StateCharts: A statecharts-based formalism for lightweight mobile agents.

ebXML: Electronic business XML is an XML-based language and infrastructure which aims at enabling B2B interactions among companies of any size.

E-Marketplace: An electronic marketplace is an e-commerce environment which offers new channels and business models for buyers and sellers to trade goods and services over the Internet.

Mobile Agent: A program that represents a user in a computer network and can migrate autonomously from node to node, to perform a computation on behalf of the user.

E-Commerce Use by Chinese Consumers

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INTRODUCTION

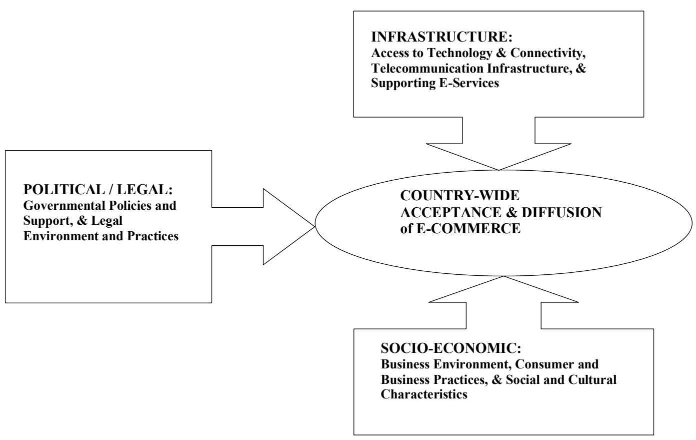
The number of Internet users around the world has steadily grown, and this growth has provided the impetus and the opportunities for global and regional e-commerce. However with the Internet, different characteristics of the local environment, both infrastructural and socioeconomic, have created a significant level of variation in the acceptance and growth of e-commerce in different regions of the world. Over time, various studies have been conducted and models have been developed to identify diffusion of e-commerce in different environments (Hasan & Ditsa, 1999; Travica, 2002; Wolcott, Press, McHenry, Goodman, & Foster, 2001; Zwass, 1999). These models have looked at "infrastructure" (e.g., connectivity hardware and software, telecommunications, product delivery and transportation systems) and "services" (e.g., e-payment systems, secure messaging, electronic markets) as the primary diffusion factors. Furthermore, Travica's (2002) study focused on Costa Rica and its culture, and Hasan and Ditsa (1999) tried to identify and present possible cultural factors that may impact broad-based adoption of information technology.

Industry-based organizations have also been interested in diffusion of e-commerce in different countries and have also identified similar factors, and have rated these countries on their readiness for e-commerce using those factors. Most widely cited of these ratings are presented by IBM and the intelligence unit of *The Economist,* which define e-readiness by measurement in six distinct categories: (a) connectivity and technology infrastructure, (b) business environment, (c) consumer and business adoption, (d) social and cultural environment, (e) legal and policy environment, and (f) supporting e-services. Based on these characteristics, *The Economist* rated China (the country that is the focus of our research) as number 51 for year 2000, number 52 (a tie with Sri Lanka) for year 2004, and number 12 out of 16 nations included in the Asia-Pacific Region. (Economist Intelligence Unit, 2004).

BACKGROUND

In addition to infrastructural and business system issues, trust (termed *transactional trust* in this article) has been identified as one of the critical issues that confront new businesses or businesses that utilize new business models like e-commerce. One of the most widely studied cultural classifications was originally proposed by Hofstede (1980). His cultural framework consists of four dimensions identified as individualism-collectivism, uncertainty avoidance, power distance, and masculinity-femininity. Even though Hofstede's framework was originally developed for national-level analyses, Oyserman, Coon, and Kemmelmeir (2002) have shown that it can also

Figure 1. Influences on diffusion of e-commerce



be applied at individual levels. Further research by Doney, Cannon, and Mullen (1998) and Jarvenpaa, Tractinsky, Saarinen, and Vitale (1999) have suggested that individualism-collectivism effects the ways people form trust and may affect the users' willingness to trust online vendors. Other studies have also tried to find correlations between trust and experience with a new system, concept, or relationships, including a correlation to frequency of e-commerce activity, and other researchers have noted that trust may be significantly influenced by culture of a given society (Lee & Turban, 2001; McKnight & Chervany, 2001; McKnight, Cummings, & Chervany, 1998). Grabner-Kraeuter (2002) observed and stated that trust is "the most significant long-term barrier for realizing the potential of e-commerce to consumers" (p. 49), and others state that trust will be a "key differentiator that will determine the success of failure of many Web companies" (Urban, Sultan, & Qualls, 2000). Other studies by Park (1993) and Keil, Tan, Wei, and Saarinen (2000) focused on the impact of uncertainty avoidance on people's willingness to accept uncertainty, which is an unavoidable foundation of e-commerce.

As my colleagues and I planned our research study, we knew from first-hand experience (I have traveled in China for extended time periods and have experienced local life, customs, culture, and have used the infrastructure) that, in spite of recently increased governmental efforts and investments, the telecommunication and e-commerce infrastructure was not as developed in China as they were in United States or Europe, and we accepted technical and infrastructural limitations to be significant current impediments for broad diffusion of e-commerce in China. We also accepted that, given the accelerated changes that are taking place in China and the continuous investments in e-commerce-related infrastructure, most of the current technical problems and issues will cease to be major impediments. Therefore, we focused on the societal issues and specifically wanted to identify and explore the influence of culture on acceptance and use e-commerce in this developing country (Bond, 1986; Chen, 1993; Moore, 1967). In the following sections, the research and its findings are presented and discussed, the changes that will be required for broader acceptance and diffusion and use of e-commerce by Chinese consumers are identified, and approaches that businesses may use to enhance this development are proposed

RESEARCH STUDY

Our objectives were to find answers to a primary research question and present some possible solutions. Furthermore, by identifying consumers with technological and financial capabilities, we wanted to minimize the impact of technological impediments on usage patterns and frequency and focus primarily on cultural and societal issues and impediments.

1. If the negative impact of technological and transactional impediments can be minimized, what are some of the prevailing attitudes and cultural issues associated with individuals' use of e-commerce in China (identify and test the influence and impact of prominent Chinese cultural characteristics on e-commerce)?
2. What can domestic and foreign businesses do to facilitate e-commerce in China (present some short- and long-run recommendations and approaches to e-commerce development in China)?

To address our research objectives, a 20-item questionnaire was created, developed in English and translated to and administered in Chinese. It contained questions designed to collect information on demographics, Internet usage, and e-commerce activities (frequency of commerce and type of purchase, means used for purchase, transaction experience, and perceptions of e-commerce in China). The questionnaire was administered on site and in groups, and the results were tabulated using the frequency of responses. The results, presented below, are based on the responses received from the study group (some comparative data, from other studies, is also provided and included in the discussion). Some of these responses were provided through the questionnaire and others through follow-up discussions with some members of the study group.

The study group consisted of selected 252 individuals that would be considered to be a close match to e-commerce users in developed countries and were considered to be "early adopters." Because the primary focus was on the "impact of culture." we wanted to get the opinions of actual participants and users of e-commerce and wanted to eliminate the infrastructure problems as much as possible. The study participants resided and worked in different regions and for different types of organizations and had different educational levels, professions, and genders. They held professional supervisory positions in their organizations and had much higher economic means than the average income levels for the local population.

The study participants were asked about their Internet usage to identify their familiarity with technology and their access to Internet, and their e-commerce participation to determine their ability (access to type of medium used for payment) to pay (possession of credit cards) for e-commerce and whether they purchased any goods or services using e-commerce within the previous 12-month period. The respondents (166 out of 252) who indicated

Table 1. Study demographics (n = 252)

GENDER		EDUCATION		AGE		ORGANIZATION		
Male	Female	BS Degree	Graduate	25-40 years	Over 40 years	MNC	DE*	JV
59.92%	40.08%	75.40%	13.49%	75.40%	7.54%	21.03%	63.49%	15.48%
* DOMESTIC ENTERPRISES including Private Enterprises, State Owned Enterprises (SOE), and University; MNC = Multinational Corporation; JV = Joint Venture								

Table 2. Sample population (n = 252) vs. e-commerce participants (n = 166)

	Male*	Age < 36 years*	Education (BS-GRAD)	Have Credit Card	Purchase in 12-mo	Purchase in 6-mo
Total Population (%)	59.92%	79.37%	88.89%	86.51%	64.29%	65.88%
E-Commerce Participants (%)	55.42%	88.55%	88.55%	86.75%	97.59%	100.00%

*Differences not statistically significant.

Table 3. Payment method (n = 166)

Bank Transfer	Cash/Check	COD	Credit Card
8.43%	33.13%	39.16%	19.28%

they had purchased goods or services were further asked about the frequency of their transactions during the previous 12- and 6-month time periods, the products or services they purchased, the highest total value of their single purchase, and their payment method (credit cards and other commonly used methods of payment in China) for these purchases. They were also asked to list their primary reasons for utilizing e-commerce and rate their overall satisfaction with the activity, and to provide unstructured comments on what they consider to be impediments to the development of e-commerce in China and Chinese attitudes towards use technology as a means for commerce.

The unstructured section of the questionnaire and the follow-up unstructured interviews were used to further explore and to identify perceptions on positive and negative aspects of e-commerce in China as it currently exits, the future of e-commerce in China, and any other issues that might have been neglected and not categorized and included in the questionnaire. These comments sometimes provided additional information and at other times reinforced the previous responses and strengthened the data collected through other questions.

RESEARCH FINDINGS

The 252 study participants had complete and fairly easy access to Internet enabling technology (e.g., access to a PC and telecommunication connection to an ISP) and used Internet regularly for multiple purposes or activities (e.g., e-mail, search), with 65.88% of the study group participating in e-commerce activities.

As was expected, for the research participants, ability to pay (access to credit cards) was not an impediment to e-commerce (86.51% had credit cards, with 69.84% having two or more credit cards), and there was no correlation between having increased number of credit cards and higher frequency of purchases. Respondents with four or more credit cards constituted 21.03% of total respondents and 21.69% of e-commerce participants. Other credit card ownership ranges also had similar distributions between the study participants vs. e-commerce participants.

The respondents paid for their purchases in four ways: cash or check (travel related purchases were paid at the time of use, e.g., hotel stay), COD, credit card, and bank transfer. As can be seen in Table 3, contrary to purchases made by U.S. consumers, in our study group, credit card purchases were not the most common payment method. This finding is also supported by the latest China Internet Network Information Center (CNNIC) survey, which identifies the top three payment methods as cash and carry (33.1%), online payment (30.7%), and post office transfer (30.0%; CNNIC, 2002; CNNIC, 2003).

With an estimated RMB 410 billion (U.S. $50 billion) in savings stashed away (most of it at homes), China still exhibits the characteristics of a cash society. According to Economist Intelligence Unit (2004), Global Insights and McKinsey China's saving rate for the years 1997 through 2005 is 40.3% (Pitsilis, Woetzel, Woetzel, & Wong, 2004). Our findings support this cultural characteristic. Even though 86.51% of our study group (218 respondents) had credit cards, only 19.28% of the e-commerce participants (32 out of 166 respondents) paid for their purchases using a credit card.

The overall results of our study clearly show that both the economic and infrastructural issues (which we had anticipated and assumed to exist but for which we tested, nevertheless) and culture continue to impede and constrain the development of e-commerce in China. Our findings also reinforced our initial premise that our study group participants were not negatively impacted by technical and infrastructure impediments, and they were much more concerned with and influenced by their culture, while deciding to participate in e-commerce.

Infrastructure and E-Support Impediments to E-Commerce

Even though they were not impacted by it, our study participants nevertheless identified specific infrastructure related impediments that will restrain and be obstacles to full development of e-commerce in China in the near future. Among the most repeatedly mentioned issues were a lack of credit cards (wide availability of them for the general public in China) and convenient payment means; poor distribution logistics; a lack of specialized, trustworthy online merchants of reasonable size (too many small players facing many bottlenecks and without necessary resources to set up e-commerce systems); an imperfect legal system; and a lack of large-scale telecommunication transmission capability (broadband). As users of e-commerce, the primary obstacles for our study group, in the order of importance, were (a) Internet security, (b) lack of feel-and-touch associated with online purchases, (c) problems in returning products, and (d) selection (product availability and breadth).

In spite of the aforementioned concerns, the respondents were reasonably positive about the availability of hardware or software and government and industry support for IT in China, and there is significant other data that support this optimism. The China Center of Information Industry Development (CCID) estimated that desktop PC sales in China would reach 17.4 million units in 2003 and projected an annual growth rate of 18.8% over the next 5 years. If these growth rates are realized, China will become the second largest PC market in the world, surpassing Japan by 2007 (Magee, 2002) These projections were supported by April 2002 Nielsen/NetRatings ranking China at second place with 57 million people having Web access at home, following the United States (166 million), and followed by Japan (51 million), Germany (32 million) and the United Kingdom (29 million). They further projected a 5% to 6% growth rate per month and expected 25% of the population (approximately 250 million people) to have Internet access in just 3 or 4 years (Juliussen, 2002; Rose & Rosin, 2002) Finally, CNNIC (official data collector for the Chinese government) 2003 figures show that 2.1% of China's Web users had bought online (CNNIC, 2002; CNNIC, 2003).

Sociological and Cultural Impediments to E-Commerce

Our study participants were slightly less positive when asked if the Chinese culture "supports" the propagation of IT and e-commerce. The group thought the Chinese consumer society was not quite ready for e-commerce and the conditions were not "ripe" (lack of confidence in technology and off-site transactions, online culture, and overall sophistication of the general public). They were especially concerned with issues related to "trust." The study participants were in agreement when it came to the potential for e-commerce but stated that the industry needs time to realize its potential in China.

Doney et al. (1998) argued that people in collectivist cultures (China is classified as a collectivist culture in Hofstede, 1991 are more likely to form trust based on prior experiences or opinions of their in-group members. According to Wong and Tam (2000), in societies with little history of formal legal contracts, trust-based relationships are the only way of doing business and strangers are not to be trusted. For the Chinese, a strong individual relationship and long-term association between the parties, *guanxi*, provide a sense of community and enhances social bonding. (Davies & Lsung, 1995) and this "social bonding" acts as the foundation of trust between the sellers of products and services and the consumers of such. It is very hard to develop a similar socioeconomic entity using e-commerce, which is primarily based on a business model and a process that brings anonymity and distances the vendor from the customer and depersonalizes the relationship between the sellers and the buyers of the product or service. Our research findings also show that "transactional trust" and related issues are major concerns for Chinese consumers conducting online transactions. Our respondents complained about existence of trust-worthy online merchants, and Internet security and credit card security. They were as wary of counterfeit products as western consumers are. As one Chinese gentleman put it "History and reality told us not to trust the system or the people's honor! E-commerce is a radical behavior that goes contrary to experience and culture. There is no 'western honor system' in China."

FUTURE TRENDS

The state of infrastructure and the unique cultural characteristics of a given country can and will act as major impediments to full-scale consumer participation in e-commerce in that country. In China, among the most pressing infrastructure limitations were broad access to technology (computers, connectivity, and gateway to the Internet), payment systems for enabling transfer of funds (wide availability of credit cards), and distribution systems for physical transfer of goods, and cultural impediments as attitudes towards off-site or depersonalized transaction systems, and level of trust in public institutions and commercial activity.

In my opinion, the unique social and cultural characteristics of China and the concepts associated with off-site exchange systems, as compared to infrastructure related limitations, pose a much greater challenge and act as the major impediments to diffusion and broad acceptance of e-commerce in China. Even though off-site exchange systems that are precursors to e-commerce, such as catalog and telephone sales, have existed in developed countries and have been used by the public for an extended time period, such systems are new and novel approaches in China, in many other developing countries, and may not be as suitable to its culture and way of doing business. Since the business foundation of e-commerce is based on such a methodology, some of these local cultural characteristics do pose significant challenges for the e-commerce industry in China. This study was an attempt to identify and to understand the possible influences of unique cultural characteristics of e-commerce in one developing country. The findings show that, even though a developing country government may make the necessary investments in infrastructure (as China has done to a significant degree), unless the e-commerce industry participants understand and address the cultural issues that are unique to that country and relate to off-site transactional process, the large scale diffusion and success of such endeavors will be greatly impeded.

CONCLUSION

Businesses, to overcome these infrastructure and cultural impediments, should take a more active role to bring about a broad-based consumer society, encourage the Chinese government to institute reforms that enhance the economic system (legal changes that support business contracts, discourage counterfeiting, and encourage consumer credit and servicing by the banking industry, built telecommunication and transportation infrastructure, etc.). However, they might not have much choice but to wait for more profound cultural changes to take hold (with the help of governmental actions and increasingly higher living standards) and, as they do, can utilize business processes that will enable and encourage e-commerce. Given the current stage of China's socioeconomic state and prevailing governmental processes, a combination business model (virtual and physical presence) may be the only way for businesses to participate in e-commerce in China.

A virtual storefront supported by a local distribution center will overcome the "touch-and-feel" concern and the lack of "transactional trust" (Zhao, 2004, personal communicatin). It will also help develop a physical relationship between the two parties (buyer and the virtual seller) involved in the transaction, addressing and taking advantage of another additional unique characteristic of Chinese business and transaction culture, *guanxi*, development of long-lasting business relationship. The face-to-face relationship, made possible by utilizing the local distribution center, will enable the economic enterprises to develop new or even deeper relationships between the various parties involved in the exchange.

Chinese people place a great deal of emphasis on uncertainty avoidance (Hofstede's 1991 classification) and spend a great deal of time planning in order to reduce even the smallest risk. This desire for stability also means Chinese consumers tend to prefer to deal with older, more well-established firms than newer ones. Chinese view age as valuable and (Schutte & Ciarlante, 1998) older firms and businesses tend to be viewed as having proved themselves over a period of time, and since they have survived, they have obviously delivered on their promises to customers. It is very hard for new companies or new exchange models to gain foothold and sustainability in local communities. Therefore, I suggest that the companies that never have had any local physical presence, new entrants, employ a "third party certification" or a "guarantee system supported by local government or business" to overcome the major transactional trust issue that is a profound characteristic of this culture.

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KEY TERMS

Cultural Dimensions: Identifying and classifying social foundations of a country using Hofstede's (1980) model.

Digital Economy: Economic system using Internet and technology for business transactions.

Electronic Commerce: Business-to-consumer exchange systems using virtual storefronts.

Online Shopping: Consumers using virtual storefronts and Internet to buy goods and services.

Technology Diffusion: Pervasive application and use of technology in everyday life.

Transaction Trust: Trust-based exchanges between buyers and sellers of products and services. "Relational trust" as defined by Rousseau, Sitkin, Burt, and Camerer (1998) applied to commerce.

Virtual Storefront: A commercial enterprise using Internet and web servers to sell products or services.

Category: Concepts, Trends, and Challenges

E-Customer Loyalty

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INTRODUCTION

Increasingly, businesses are beginning to understand the profit potential of loyal customers (Oliver, 1999). Marketers endowed with such consumers can expect repeat patronage to remain high until competitors can find a way to: (1) close the gap in attitude among brands, (2) increase the differentiation of their own brand, or (3) encourage spurious loyalty from consumers (Dick & Basu, 1994). Loyalty leads to higher retention. According to one study, a 5% increase in customer retention rates increases profits by 25% to 95% (Reicheld & Schefter, 2000).

It is thus heartening to note that "one of the most exciting and successful uses of [the Internet] … may be the Internet's role in building customer loyalty and maximizing sales to your existing customers" (Griffin, 1996, p. 50). Given its relative importance in cyberspace, it is surprising that relatively little has been done in conceptualizing and validating e-loyalty models (Luarn & Lin, 2003).

Parasuraman and Grewal (2000) argue for more research pertaining to the influence of technology on customer responses, such as perceived value and customer loyalty. Besides customer trust, our study also incorporates two constructs—corporate image and perceived value—that have been poorly explored in online environments despite their recognized importance in off-line contexts.

Consequently, a primary objective of this article is to discuss the impact of three constructs (i.e., customer trust, corporate image, and perceived value) on e-loyalty in a business-to-consumer (B2C) e-commerce context. In doing so, our model is expected to offer useful suggestions on how to manage customer trust, corporate image, and perceived value as online loyalty management tools.

This article is generally divided into three sections. The first section will discuss the constructs of interest and clarify what they mean. In the second section, we will propose hypotheses explaining these relationships. And in the final section, we introduce actionable strategies for online loyalty management based on the proposed framework.

BACKGROUND

Customer Loyalty

In research conducted in the 1960s and 1970s, customer loyalty was interpreted as a form of customer behavior (i.e., repeat purchasing) directed toward a particular brand over time. However, Day (1969) criticizes behavioral conceptualizations and argues that loyalty has an attitudinal component.

More recently, Morgan and Hunt (1994) defined loyalty as an ongoing relationship with another that is so important as to warrant maximum efforts at maintaining it which implies strong affective and behavioral commitment to the company. In this chapter, consistent with Oliver (1999), e-loyalty herein is defined as a deeply held intention to repurchase a preferred product/service consistently from a particular e-vendor in the future, despite the presence of factors or circumstances that may induce switching behavior.

Customer Trust

Online markets are different from the traditional brick-and-mortar marketplaces, owing to the lack of face-to-face personal contact and the opportunity for buyers to see products physically. There are inherent risks in trading online because of information asymmetry. All these factors make trust crucial to e-commerce because it lowers transactions risks. As a result, it puts pressure on online marketers to nurture stronger feelings of trust than is required in off-line environments (Keen, 1997).

In this study, we adopted a parsimonious definition, in tandem with Gefen, Karahanna, and Straub (2003). E-trust is defined herein as a set of specific beliefs dealing primarily with integrity (trustee and honesty and promise keeping), benevolence (trustee caring and motivation to act in the truster's interest), competence (ability of trustee to do what truster needs), and predictability (trustee's behavioral consistency of a particular e-vendor).

Corporate Image

A growing number of companies have tried to position themselves through the communication channel with the objective of building strong corporate images in order to create relative attractiveness (Andreassen & Lindestad, 1998). A favorable image is a powerful tool not only for encouraging customers to choose the company's products and services, but also for improving their attitudes and levels of satisfaction toward the company (Aaker, 1992, p. 16).

A review of the literature, however, reveals scant research on the concept of corporate image in online environments. Much of the traditional research, however, focuses on products (e.g., Darden & Schwinghammer, 1985) or services (Gronroos, 1990) in off-line environments. There is an urgent need for more of such research that explores this concept better as it applies to online environments. Customers are often overwhelmed with a variety of offerings on the Internet; as a result they base their decision on global judgments, such as store image and reputation (Teas & Agarwal, 2000).

In consonance with definitions by Barich and Kotler (1991), corporate e-image is defined in this article as an overall impression held of an e-vendor by its customers at a particular point in time. This, in turn, is the net result of consumers' experiences with an organization, both online and off-line, and from the processing of information on the attributes that constitute functional indicators of image.

Customer Value

The inclusion of the value construct in our model is important for several reasons. First, recent research revealed that more that 70% of customers feel they gain nothing by being loyal to a company (Gillespie, 1999) and, therefore, would move if perceived benefits were greater elsewhere. This makes understanding what buyers value within a given offering, creating value for them, and then managing it over time, essential elements of every market-oriented firm's core business strategy (Slater & Narver, 1998).

Second, Helm and Sinha (2001) argue for the importance of delivering customer value in electronic B2C operations. However, there has been little empirical research to develop an in-depth understanding of the concept (Sweeney & Soutar, 2001). Fewer studies still (e.g., Chen & Dubinsky, 2003) have examined this construct in the context of online environments. Finally, to the best of our knowledge, there seems to be no research that has captured the relationships between corporate image, customer trust, and perceived value in a single integrative framework.

Based on a synthesis of previous definitions (Chen & Dubinsky, 2003; Woodruff, 1997), perceived customer value is defined here as a consumer's perception of the benefits gained in exchange for the costs incurred to attain his/her goals at a particular point in time.

A PROPOSED MODEL FOR BUSINESS-TO-CONSUMER E-COMMERCE

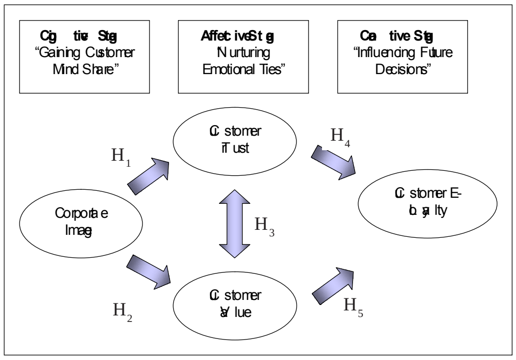
Consumers rely heavily on the online vendor's image as a proxy for trustworthiness (Lee & Turban, 2001). This is because of the lack of intrinsic product cues that are generally used to evaluate quality. Indeed, Yoon (2002) found that Web site trust is significantly related to corporate awareness and image. We thus posit that: *Corporate image leads to customer trust (H_1).*

Chen and Dubinsky (2003) reported that online retailer image is a forward indicator of value in the online context. This is corroborated by Strader and Shaw (1999) who found that in e-marketing, unless a seller's price is significantly lower than prices of a trusted seller, switching costs will inhibit the consumer from buying from the unknown e-seller. Thus, we argue that: *Corporate image leads to perceived value (H_2).*

Meanwhile, Sirdeshmukh, Singh, and Sabol (2002) suggested that perceived value is an important partial mediator of the trust-loyalty relationship. Customer relationship value may only develop when the customer has "confidence in an exchange partner's reliability and integrity" (Morgan & Hunt, 1994, p. 23). Safety, credibility, and security are important to reduce the sacrifice for the customer in a relationship and therefore lead to higher e-relationship value. Hence, we postulate that: *Customer trust leads to perceived value (H_3).*

Finally, Hoffman and Novak (1996) argued that the likelihood of Internet product purchase is influenced by the amount of consumer trust regarding the delivery of goods and use of personal information. Trust influences loyalty by affecting the consumer's perception of congruence in values with the good/service provider (Gwinner, Gremler, & Bitner, 1998). Also, when there is perceived similarity in values between the firm and the consumer, the consumer is more entrenched in a relationship. This is also evidenced in research by Gefen (2000) which showed that customer trust has a positive effect on e-adoption intention. We thus propose that: *Customer trust leads to e-customer loyalty (H_4)* and *Perceived value leads to e-customer loyalty (H_5).*

Figure 1. An integrative framework for understanding e-customer loyalty



These relationships are captured in a conceptual model in Figure 1.

REALIZING E-CUSTOMER LOYALTY: RECOMMENDATIONS

This next section suggests three strategies to attain the "Tao of Loyalty" through effective management of each of the three constructs of interest:

1. Build Trust
2. Realize Corporate Image Equity
3. Provide Customer Value

Build Trust

We argue that efforts to build trust should focus on three areas—transactional security trust, information privacy trust, and exchange trust—each with its own function in motivating consumer participation in exchange.

Transactional security trust refers to: (1) the customers' belief about the e-tailer's expertise in providing a secure shopping environment, and (2) the consumer's expectation about an e-tailer's ability to protect his/her information from unauthorized access by third parties (i.e., hackers). To assuage customers on this aspect, firms should put in place reliable control systems that can be easily understood by customers. Expedia.com, an online travel agency, explains to its customers that when personal information is sent over the Internet, their data is protected by Secure Socket Layer (SSL) technology to ensure safe transmission.

Like transactional security trust, *information privacy trust* is conceptualized in terms of two dimensions—unauthorized tracking and unauthorized information dissemination—that refer to an e-tailer's privacy protection responsibilities. Research has shown that fairness of a company's Web site with respect to information privacy is a significant factor in building trust and in ensuring the continuation of the relationship with the e-retailer (Culnan & Armstrong, 1999). For example, Expedia has an extensive privacy policy that is audited by an external audit firm, PricewaterhouseCoopers LLP.

Exchange trust is defined in terms of competence and benevolence as they apply to an e-tailer's promise fulfillment function (Sirdeshmukh et al., 2002). Specifically, exchange trust is customer confidence that the e-tailer: (a) will fulfill its transaction-specific obligations consistent with the terms of the purchase agreement or other internally held reference standards developed as a result of interaction with other e-tailers or non-store retailers (competence), and (b) will not engage in opportunistic behavior at any time in the process of product or service delivery (benevolence). A type of services, online virtual community is emerging to mitigate exchange risks. One of the better-known ones, eBay's Feedback Forum, provides information on sellers' reputations, based on feedback from previous trades. Traders having high reputation may enjoy price premiums in online market competitions.

Realize Corporate Image Equity

Having a Web site is important for brand building and creating a favorable corporate image (Farr, 1999). However, that alone is not sufficient.

First, firms should strive to create a strong Internet identity through a distinctive personality, recognizing that a company's name identifies it to outside observers (Aaker, 1992). For example, Tiffany, the well-known jewelry retailer, invested substantially in digital imaging technology to ensure that all images of jewelry on its Web site are presented using high-quality graphics. The overall impact of the Web site reinforces Tiffany's reputation as a prestigious, high-quality retailer.

Second, firms should ensure there is sustained buzz about the firm's presence. Many online firms use banner advertisements, pop-up windows, and mass e-mails to promote their products. Advertising directly confers brand and product information to consumers, and it serves to increase consumers' awareness and knowledge of a particular brand (Vakratsas & Ambler, 1999). High levels of advertising expenditures send a strong signal about a firm's commitment to quality (Shapiro, 1983). For example, Amazon.com invests more than 23% of its revenues in advertising, thus making it one of the most well-known companies in the online book retail business. However, marketers should be careful that the buzz does not degenerate into advertising clutter (i.e., excessive advertising) which erodes the overall effectiveness of advertising.

Finally, firms should strive to earn a reputation for being innovative. Generally, research has found that early movers enjoy initial and sustain continuous market share advantages. For example, Robinson and Fornell (1985) suggested that being a pioneer or product leader gives consumers a favorable image and higher familiarity on the firm's products. Examples of online firms that attain such leadership include Priceline.com, which pioneered the "name your own price" practice in its travel booking service, and eBay, which introduced the proxy bidding technology and feedback mechanism in its Internet auction business.

Create Value Experiences Online

In this section, actionable strategies relating to two important areas—target marketing and enriching the customers' online experience—will be discussed.

Target Marketing

A thorough understanding of one's target audience is critical. With a better understanding of the target market, businesses will be able to better design their Web sites to match preferences of their target groups. Two crucial areas need to be addressed: (1) How do customers make purchasing decisions?, and (2) "What information do they need in making that decision?" Wine.com, a leading purveyor of wine and gourmet products, originally believed that its core customers were wine connoisseurs. A careful assessment of online data revealed that its best customers were wine novices. With this knowledge, Wine.com significantly modified its Web site to deliver the features these less-experienced consumers wanted—recommendations and educational content.

Enriching the Customers' Online Experience

The natural question, once marketing managers know who their best customers are, is how to enrich these customers' overall experience. One suggestion marketing managers may want to focus their efforts on is customization. Customization increases the probability that customers will find something that they wish to buy, creates the perception of increased choice by enabling a quick focus on what the customer really wants (Shostak, 1987), signals high quality (Ostrom & Iacobucci, 1995), and drives customers to use simplistic decision rules to narrow down the alternatives (Kahn, 1998). In this respect, customization has often been regarded as one of the essential determinants of customer loyalty (Reynolds & Beatty, 1999).

FUTURE TRENDS

To enable more compelling value propositions to be crafted, future research could examine the moderating effects of consumer attributes like involvement and affect on the model. For example, depending on the level of involvement, consumers may be passive or active when receiving advertising communication, which in turn could moderate their perceptions of value and trust levels. Empirical comparison between different cultures could also be collated for greater generalizations of the proposed model.

CONCLUSION

Marketers are perpetually seeking to increase customer loyalty, which perhaps is the only source of sustainable competitive advantage in the coming decade for many a firm. This article suggests strategies for firms to develop an e-customer relationship orientation and improve e-customer loyalty. In this aspect, corporate image, customer trust, and customer value were found to be important drivers of e-customer loyalty. It is hoped that the accompanying suggested strategies would enable marketing managers to craft even more compelling value propositions and effective marketing-mix strategies.

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KEY TERMS

Corporate E-Image: An overall impression held of an e-vendor by its customers at a particular point in time. This, in turn, is the net result of consumers' experiences with an organization, both online and off-line, and from the processing of information on the attributes that constitute functional indicators of image.

E-Loyalty: A deeply held intention to repurchase a preferred product/service consistently from a particular e-vendor in the future, despite the presence of factors or circumstances that may induce switching behavior.

E-Trust: A set of specific beliefs dealing primarily with integrity (trustee and honesty and promise keeping), benevolence (trustee caring and motivation to act in the truster's interest), competence (ability of trustee to do what truster needs), and predictability (trustee's behavioral consistency of a particular e-vendor).

Exchange Trust: Customer confidence that the e-tailer: (a) will fulfill its transaction-specific obligations consistent with the terms of the purchase agreement or other internally held reference standards developed as a result of interaction with other e-tailers or non-store retailers (competence), and (b) will not engage in opportunistic behavior at any time in the process of product or service delivery (benevolence).

Information Privacy Trust: Unauthorized tracking and unauthorized information dissemination—that refer to an e-tailer's privacy protection responsibilities.

Perceived Customer Value: A consumer's perception of the benefits gained in exchange for the costs incurred to attain his/her goals at a particular point in time.

Transactional Security Trust: The customers' belief about the e-tailer's expertise in providing a secure shopping environment; also, the consumer's expectation about an e-tailer's ability to protect his/her information from unauthorized access by third parties (i.e., hackers).

Category: Concepts, Trends, and Challenges

Effective Collaborative Commerce Adoption

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INTRODUCTION

Technology increasingly pervades the business world and society generally. According to Walters (2004, p. 219) "markets have globalized, technology has become all embracing, and relationships with suppliers, customers, and competitors are undergoing constant change." These developments potentially raise considerable opportunities for small and medium enterprises (SMEs)[1] to enter into the global marketplace and form "partnerships" including alliances, networks, and collaborative commerce (c-commerce) (Jarrett, 1998). Though exemplars of c-commerce exist in Australia, it has not been widely adopted by SME's.

Generally, Australian SMEs have been slow to adopt any form of electronic commerce. The primary reason given for lack of adoption amongst many small businesses is that they see no real benefit in having a Web presence, that is they perceive their businesses to be too small, or they had not factored in the on going maintenance of Web pages (ABS, 2003; van Beveren & Thomson, 2002). Fear of the unknown and lack of skills have also been suggested as reasons why the uptake of technology is less for small businesses (Barry & Milner, 2002; Darch & Lucas, 2002).

If firms have been slow to embrace e-commerce, then it could explain the slow uptake of c-commerce. This article looks beyond e-commerce and suggests framework to explain c-commerce adoption.

BACKGROUND

C-commerce consists of all of an organization's information technologies (IT) bases, knowledge management, and business interactions with its customers, suppliers, and partners in the business communities in which it interacts (McCarthy, 1999; GartnerGroup, 1999; Burdick, 1999) and can be horizontal competitive cooperation or co-opetition (Levy, Loebbecke, & Powell, 2003), as well as vertical collaboration along a supply chain. Essentially this means that firms, including competitors, come together to exploit an opportunity that arises, as and when appropriate.

C-commerce signifies an organizational shift in focus from transactions and exchange, characteristic of e-commerce, to one of relationships between firms (Sheth, 1996). As global competition intensifies many organizations are forming partnerships as an expeditious way to keep up or to access unique or "pioneering" resources (Ring & Van de Ven, 1992, 1994).

Benefits of C-Commerce for SMEs

C-commerce is concerned with obtaining sustainable competitive advantage from the maximization of value adding benefits obtained by working collaboratively with others via IT. The adoption of IT has been identified as a possible source of strategic competitive advantage for SMEs (Yetton, Johnston, & Craig, 1994), collaboration using IT can generated innovation resulting in further competitive advantage (Ryssel, Ritter, & Germunden, 2004).

SMEs are better able to compete in an increasingly dynamic marketplace via the exploitation of the advantages of the Web (Grover, Teng, & Fiedler, 2002). C-commerce enables small firms to "grow" their assets, which is important for Australian SMEs due to their size and access markets not previously possible (Holsapple & Singh, 2000; Ring & Van der Ven, 1994; Tetteh, 1999;). C-commerce also facilitates innovation and information, knowledge, and systems sharing and exchange (Holsapple & Singh, 2000). Internal efficiencies can be generated by the sharing of information via IT within interorganizational relationships (IORs) (Ryssel, et al., (2004). Bitici, Martinez, Albores, & Parung (2004, p. 266) concluded that collaborative enterprises or networks "create new and unique value propositions by complementing, integrating, and leveraging each other's capabilities and competencies."

To enable SMEs to make the most of the opportunities afforded by c-commerce, SMEs need to "adopt an entirely different approach to strategic planning and management which can enable them to deploy an extensive infrastructure network based on shared resources with other firms" (Tetteh & Burn 2001, p. 171). This requires strategic thinking, trust, and a realization of the importance of co-opting rather than competition which typically exists amongst individual firms. Therefore, c-commerce requires firms to develop a strategy, both short and long term, adopt appropriate business models, develop and sustain appropriate collaborative cultures engendering trust, invest in ICT to facilitate information and knowledge sharing, and set in place appropriate organizational structures to enable collaboration (Kalakota & Robinson, 1999).

Interorganizational systems (IOS), which include c-commerce, represent one use of IT and allow the transfer of information across organization boundaries. SMEs in Australia have tended not to adopt these systems due to the previously mentioned barriers. In the past electronic data interchange (EDI) and electronic funds transfer (EFT) have been the technologies to enter into IOS. The standards required for EDI and the high set up costs have tended to act as a barrier for SMEs to enter into IOS. This is potentially overcome by the Internet which facilitates participation by SMEs in c-commerce.

It can be argued that c-commerce is the next step following adoption of the full functionality of e-commerce and e-business. Whether there is a linear progression from e- to c-commerce is debatable given the differing antecedents. A number of models have been developed that depict a progression of the application of e-commerce such as the DTI Model (Martin & Matlay, 2001).

Adoption of e-commerce or e-business cannot be said to be a direct precursor to c-commerce. However the "technology" required in these preceding stages needs to be in place for c-commerce to occur. The technology required to enter into c-commerce is more complex and involves other hardware and software in addition to the internet, as well as other factors.

THREE DIMENSIONS FOR THE ADOPTION OF C-COMMERCE

The literature reveals that three major areas are important to c-commerce adoption by SME's. The factors identified are IORs, resources, and the degree of IT integration within business strategy and will be discussed.

Depth of Interorganizational Relationships (IORs)

Global competition is increasingly occurring between networks of firms (Morgan & Hunt, 1994), and so partnerships, including c-commerce, are being established. This requires firms to choose appropriate partners and determine and agree upon the management of relationships (Ring & Van der Ven, 1992; 1994; Ritter, Wilkinson, & Johnston, 2002).

In the context of this article, IORs refers to cooperative IOR's that include strategic alliances, partnerships, coalitions, joint ventures, franchises, and network organizations. This article has adopted the framework developed by Holmlund and Tornroos (1997) that describes a number of dimensions of IOR's; Structural (the resource links, connections with other organizations through the IOR, and the institutional bonds such as contractual agreements); Economic (financial investment made in the relationship and expected economic returns form the relationship); and Social (relational concepts including characteristics such as trust, commitment, attractions, atmosphere, and social bonds).

The authors have added the dimension of "Organizational" to encompass characteristics that relate to how the organization interacts with others. Table 1 builds on these dimensions and summarizes factors deemed to be critical, to collaborative IORs and so c-commerce. The extent to which these factors explain the adoption of c-commerce or antecedents to its adoption need to be considered in subsequent research.

A coming together around IT is secondary to the formation and existence of relationships between firms since they underpin collaborative relationships (O'Keefe, 2001). Without the cultivation of relationships, firms are not able to capture the full value of technology (O'Keefe, 2001). Such a coming together will only occur if the shared benefits are acknowledged and are deemed to be worth-

Table 1. Four dimensions/factors critical to IORs (Grieger, 2004; Holmlund & Strandvik, 1999; Holmlund & Tornroos, 1997; Humphreys, Shiu, & Chan, 2001; Kauser & Shaw, 2003; Lawton, Smith, & Dickson, 2003; Marshall, 2004; Pearce, 2001; Ritter, Wilkinson, & Johnston 2002; Ryssel, Ritter, & Gemunden, 2004; Sherer, 2003; Vyas, Shelburn, & Rogers, 1995; Walter & Ritter, 2003)

Dimensions	Category
Structural/Infrastructure	Information Technology
	Institutional Bonds
	Infrastructure
Economic/Financial	Investment in the Relationship
	Value
	Reduced Productions Costs
Organisational	Compatibility
	Flexibility
	Intellectual Capital
	Organisational Interactions
	Communication
	Organisational Interconnectedness
	Relationship Management
Social	Commitment to the Relationship
	Trust
	Organisational Culture
	Individual Interaction

while. Perceptions of these benefits and a willingness to engage in c-commerce are influenced by attitudes to and experience of IT as well as the availability of resources able to be dedicated to c-commerce.

Degree of Integration of IT within Organizational Strategy

Gaddea, Huemerb, and Hakansson (2003) define strategy as an organization's direction, purpose, strategic leadership, and organizational and competitive performance. IT potentially plays a significant role in enabling a firm to achieve its strategic objectives. Levy, Powell, and Yetton (2001) argue that as well as being a major driver of strategic change, IT facilitates the exploitation of information by firms to achieve value added benefits.

In contrast, SMEs tend to adopt IT to reduce costs (Hagmann & McCahon, 1993) rather than as a way to add value. Previous research indicates that there is a limited use of management information systems (IS) amongst SMEs (Premkumar & Roberts, 1999). Consequently few benefits have flowed to SMEs from IS (Cragg & King, 1992), which reflects SMEs limited knowledge of IS which precludes them from taking advantage of the strategic information available from IT systems (Levy et al., 2001).

SMEs that make strategic IT investments often fail to obtain strategic benefits unless the IS is integral to the overall strategy of the firm (King, Cragg, & Hussein, 2000; Lesjak & Lynn, 2000). Firms that are driven by cost and efficiency are less likely to take a strategic view of IS (Lesjak & Lynn, 2000). Organizations involved in c-commerce are concerned with maximizing the benefits from value adding through IT having taken a strategic view of investment in IT.

In addition to interorganizational relationships and organizational strategy, c-commerce requires dedicated resources directed to the outcomes of partnerships.

Organizational Resources

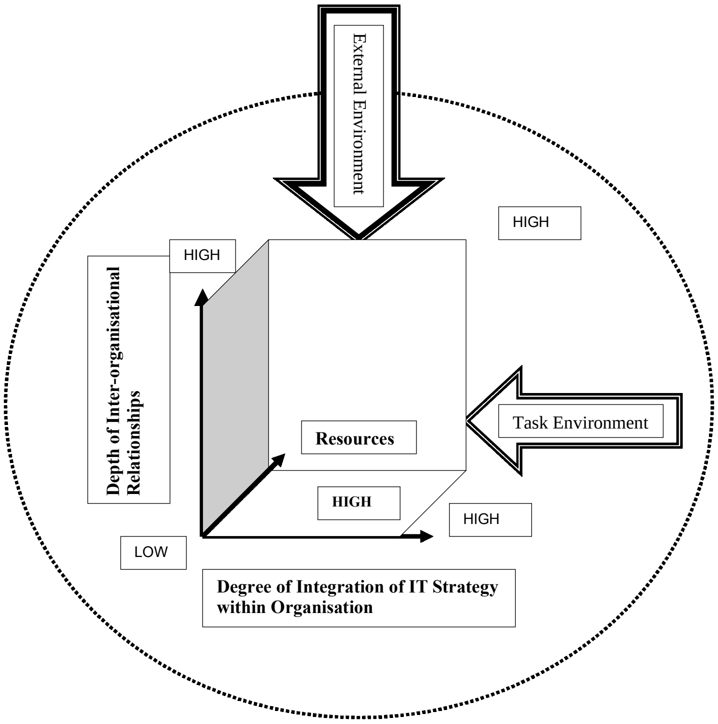
One way of looking at IT adoption and implementation amongst small business is via the resource-based theory (RBT) of the firm (Caldeira & Ward, 2003, Feeny & Willcocks, 1998). Firms are characterized by a set of competencies or skills and capabilities that are important to enable it to achieve a sustainable competitive advantage. IT expertise is part of this resource set with synergies to other resources.

Size is important as it has a bearing on resources available to the firm. SMEs tend to be resource poor—time, financial, and expertise, such as IT expertise, which limits their ability to be involved in other than day to day operations (Thong, 2001). In part, this is a function of the size of the business and often results in limited IT capabilities of the firm. This resource poverty has implications for growth and planning for the future, including investment in IT, and poses a critical difficulty for small business. On the other hand, c-commerce is one avenue for SME's to overcome resource limitations.

Resources necessary for c-commerce adoption are also relational. C-commerce requires that partners are flexible, able to provide a strategic advantage to collaborators, and have interoperable platforms that facilitate information and knowledge sharing. This presupposes a willingness to share and the existence of trust amongst "partners". Robbins (2003) argued that the key to success is to develop a knowledge sharing culture. Trust, which requires a collaborative organizational culture, is critical to encouraging the sharing of information (Ring & Van de Ven, 1992, 1994; Morgan & Hunt, 1994) using the internet, and within organizations, the intranet.

The sharing of resources and information among firms (Lee & Lau, 1999) is critical to the success of emerging business partnerships. Information needs to be communicated efficiently and effectively both within the organization and between partners in a collaborative arrangement. This is made possible via IT and requires integration of systems within the organization (Enterprise Application Integration), as well as between organizations. This necessitates interoperable platforms and systems that participants put in place (Holsapple & Singh, 2000; Badii & Shariff, 2003) which require re-

Figure 1. Framework depicting factors influential to the adoption of c-commerce



sources and potentially adaptation of systems to achieve interoperability.

FUTURE TRENDS

New business patterns are characterized by inter alia, diminishing geographical and time boundaries, globalization of the labor market, increased connectivity, and extended or virtual companies. Successful businesses are forming alliances and partnerships to enable them to more effectively compete given markets are globalized. C-commerce is the coming together of firms, including competitors, to exploit opportunities that arise and one example of this response and is seen by some as the next stage in e-business.

C-commerce is an example of collaborative networks which arise as knowledge management becomes more widespread. With the concept of knowledge networks, we enter a new era in that firms looking to be involved in collaborative networks need to "develop a new knowledge management process" (European Community, 2000, p. 3) and new business models, such as c-commerce.

Collaborative networks, including c-commerce, demand a new approach by firms incorporating new relationships, new assumptions, trust, and a shift in culture that values partnerships. Without adopting these factors it is not likely that SMEs will consider these options.

From the foregoing discussion, a proposed framework is put forward. It argues that organizations must possess certain characteristics for effective c-commerce adoption. The lack of these characteristics and low level of awareness of the benefits of c-commerce is believed to partly explain the low rate of adoption by SMEs in Australia.

The three dimensions set out in Figure 1 over plot the nature and quality of the relationships between collaborators, the extent of resources available to support the relationship, and the extent to which IT is part of the strategy, vision, and direction of the organization. Aside from the three dimensions which are internal to the organization and collaboration, Storey (1994) argues other external factors may influence c-commerce adoption. The immediate task environment such as the industry sector as well as the broader external environment may impact the organization and so are included in the proposed framework. The proposed framework acknowledges the part these factors play with regard to c-commerce adoption.

This framework enables the position of individual SMEs to be plotted in relation to these three variables should they be validated. By applying this framework to SMEs and plotting their position against the three axis, areas in which they are deficient can be readily identified. This will assist them to become c-commerce ready, should this be an appropriate strategy.

CONCLUSION

Firms engaged in c-commerce do so because they recognize the strategic benefits, however c-commerce demands significant investments in IOS. A commitment to the relationship requiring investment in IT from a long term perspective then is critical. Efficiency no longer is the sole motivation for IT adoption (Levy et al., 2002).

Yet to be identified is the relationship between the three dimensions and their relative importance to c-commerce adoption. Research is required to "test" whether these factors are critical antecedents to c-commerce adoption, as well as the interdependence between these and/or other factors identified by subsequent research. The proposed model indicates a positive relationship between these dimensions, however this requires validation. Since the development of a checklist depicting c-commerce readiness is an expected outcome of the research, the point at which an organization is "ready" to consider c-commerce needs to be mapped.

Investigation of the external and task environments are also important especially comparing the Australian context with environments where c-commerce is more entrenched in order to identify significant differences. Given that the majority of research regarding collaborative IOR's and c-commerce has taken place in Europe, the impact of the cultural and institutional settings needs to be acknowledged.

In conclusion, c-commerce is an emerging phenomenon in Australia. This article seeks to identify the antecedents required to facilitate c-commerce adoption for SMEs operating in the Australian environment. The model proposed in this article will require "testing" in different national and industry contexts so that validation or refinement can occur.

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KEY TERMS

Collaborative Commerce: The processes, technologies, and the supporting standards that allow continuous and automated exchange of information between trading partners and can be horizontal competitive cooperation or co-opetition as well as vertical collaboration along a supply chain.

Electronic Commerce: Business to business electronic commerce includes supply chain management, virtual alliances, virtual trading partners, disintermediation, and reintermediation. It is the use of IT, particularly the Internet, to facilitate trading between two or more firms.

External Environment: The conditions, trends, and forces essentially those outside the control of organizational members.

Interorganizational Relationships: Cooperative IOR's that include strategic alliances, partnerships, coalitions, joint ventures, franchises, and network organizations.

Interorganizational Systems (IOS): Are defined as "a computer and communication infrastructure that permits the sharing of an application" across organizational boundaries. The aim of an IOS is to create and exploit interorganizational efficiencies.

Organizational Resources: Include financial, physical, human, and organizational assets used to produce goods and services. Also included are competencies or skills and capabilities which are the firm's ability to put its resources to use to achieve a desired end.

Organizational Strategy: Is an organization's direction, purpose, strategic leadership, organizational, and competitive performance.

Small and Medium Enterprises: In Australia there are several size definitions for SMEs—micro-businesses employ less than five employees; small businesses employ less than 20; and medium less than 200 employees. Definitions of what constitutes an SME by the Australian Bureau of Statistics exclude agriculture since the number of employees tend to be small, however turnover may be significant. Variation in definitions needs to be borne in mind when reviewing literature from around the world given the different size classifications.

Task Environment: Includes those sectors that have a direct working relationship with the organisation. It includes customers, competitors, suppliers, and the labor market. Effectively it is the industry in which the firm operates, which is a subset of the wider environment.

ENDNOTE

1 The way in which SME's are defined varies according to country however the definitions used in this paper are the standard Australian Bureau of Statistics classifications, which are micro business being 0-4 persons, small business being 5-19 persons and medium being 20-200 persons (ABS, 2002).

E-Government and the Construction Industry

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INTRODUCTION

Recent trends indicate drives by various governments to adopt electronic means to handle their affairs and also provide value to their citizens irrespective of time and space via so-called electronic governments (see, e.g., Mathews, 2001; Tillett, 2000). Although the construction industry is part of the clientele which e-government seeks to serve, traditionally many governments are often the major clients for the supplied services of the industry. This scenario appears to re-shape the traditional customer-supplier relations into that of evolving roles, as for example in the digital environment both parties may find themselves in the roles of supplier or customers at varied times. This article seeks to explore the nature of the exchange interactions which may evolve between e-governments and the construction industry in the digital environment in value delivery. First, perspectives on the key concepts in this article are offered, then relevant literature on the subject is examined, before conceptual models to explain potential evolving roles of the two entities in the delivery of value in the digital/virtual realms is given. An outlook on future trends on the topic is then proposed before the conclusions.

BACKGROUND

Perspective on Key Concepts

Prior to the review of other relevant literature this section first examines three major concepts: electronic government, customer-supplier relationship, and digital value delivery.

Electronic Government

Electronic government also referred to as e-government, digital government or e-gov, government online, etc., made its debut in 1998 in the U.S. (Bose, 2004; Mathews, 2001). There are indications to however suggest that conditions which led to this phenomenon were at least identified about 30 years ago (see, e.g., Relyea, 2001). There appears not to be any consistent definition for the electronic government concept (see, e.g., Fang, 2002; Relyea, 2001; Seifert, 2003). As a dynamic concept it has evolved through varied perceptions. Initial perceptions of this concept concerned the use and application of information technology (IT) by government bodies, and later perceptions relate it to the ambiguous symbolic perceived use of IT to the operations of government, as well as the attainment of the goals of performance efficiency and economy (Relyea, 2001).

Three stakeholders which appear to be commonly identified within electronic government relationships are the government, citizens and business (Fang, 2002; Nikolopoulos, Patrikakis, & Lin, 2004; Seifert, 2003; The World Bank Group, n.d.). This may provide three clusters of operational interest as follows: government to government (G2G), government to citizens (G2C); government to business (G2B) (see, e.g., Fang, 2002; Nikolopoulos, Patrikakis, & Lin, 2004; Seifert, 2003; The World Bank Group, n.d.). These broad areas may also be subject to variations relative to one's intentions. For example within the G2G cluster one could refer to inter or intra government operations, and in the latter case one may for example identify government to employee (G2E) (see, e.g., Bose, 2004; Liu & Lai, 2004). The interest of this article is in the G2B cluster with specific reference to the exchange interactions (customer-supplier relations) between e-government and the construction industry. This interaction may concern the delivery of services, goods and allied items which may provide business efficacy. The next section discusses customer-supplier link in value delivery.

Customer-Supplier Exchange Relationship

Potential procurers (customers) of goods and services may directly or indirectly require exchange interactions with potential suppliers to fulfill (to a relative degree) their needs or wants. This appears to make the customer-supplier link important in fulfilling requirements. The term customer-supplier has been directly or indirectly used across varied disciplines (see, e.g., Ellegaard, Johansen, & Drejer, 2003). In marketing for example, the concept of "exchange" between potential customers and suppliers has been a recognized central model for many decades (Blois, 2004). The customer-supplier link is stressed in marketing exchange concept via emphasizing (among others) what both potential customers and suppliers have to offer and benefit from an exchange (Blois, 2004). One other prominent area in literature (of relevance to this article) which has heralded the importance of the customer-supplier link has been that of quality and its related fields. Most of these literature emphasize (among others) the need to: involve customers in value delivery processes so as to understand their requirements well in order to fulfill or exceed their expectations; continuously improve the suppliers' transformation processes and other value delivery systems (see, e.g., Huang & Lin, 2002; Ousthuizen, Koster, & Rey, 1998). The seemingly increased attention to include the customer in recent times contrast previous management orientation where transformation processes for example tended to focus on the suppliers' internal activities and were indifferent to the customer (see, e.g., Ousthuizen, Koster, & Rey, 1998). Thus arguably a shift to a relatively much broader and beneficial way in dealing with exchange interactions between customers and suppliers in delivering value. The next section discusses digital value delivery.

Digital Value Delivery

One of the aims in customer-supplier interactions concerns that of the delivery of value. One influential work on value delivery (in the business sector) was the work of Porter (1985). He defined value as the amount buyers are willing to pay for what a firm delivers to them. This work perceives value delivery via the analogy of a chain, whereby the processes for delivering value are seen as linked value adding processes. Although this work has been criticized as linear, and other conceptions like value constellations, nets, etc., proposed (see, e.g., Kippenberger, 1997a, 1997b; Parolini, 1999) it made significant impact on the conception of value delivery in the business sector (see, e.g., Kippenberger, 1997a). As value delivery within the digital environment evolved, Rayport and Sviokla (1999) also offered another seminal conception of value delivery within the digital environment, which they called virtual value chain. In their article they argued that although the processes for delivering value in the physical and virtual worlds are mutually dependent they are however not the same. They asserted that unlike the traditional value chain model which perceives information as a supporting element, the digital environment enables the use of information as a primary source of value creation (Rayport & Sviokla, 1999). They defined the virtual value chain to involve the processes of creating visibility, mirroring, and establishing new customer relationships. Visibility involves the ability of companies to use information to see their physical operations more effectively; mirroring involves the substitution of physical activities with virtual activities; then new customer relations can be created via the use of information (Rayport & Sviokla, 1999).

Although value delivery may require consideration of many other relevant things (e.g., dynamic turbulent business environment, etc.), the seminal models explained above, as well as those based on the supplier-customer delivery perspective could provide meaningful reference point, and hence basis for more complex and varied conceptions.

Trends in E-Government and Construction Industry and the Importance of a Focused Structured Link Between the Two Entities

Since the debut of e-government, various research has been done to assist in the comprehension, improvement or impact of e-government concept (see, e.g., Buckley, 2003; Fang, 2002; Hazlett & Hill, 2003; Mathews, 2001; Nikolopoulos, Patrikakis, & Lin, 2004; Teicher, Hughes, & Dow, 2002). A sample of the research findings however provide mixed results of either spectacular failure in some cases (see, e.g., Hazlett & Hill, 2003); modest or disproportionate impact (see e.g., Teicher, Hughes, & Dow, 2002); or success and a positive correlation between e-government adoption and economic competitiveness (see, e.g., Deloitte Touche Tohmatsu, 2003). Other researchers have also highlighted some of the potential opportunities for e-government leverage via enhanced forecasting, information provision, transactions, etc. (see, e.g., Nikolopoulos, Patrikakis, & Lin, 2004); whilst others have cautioned on the need to perceive e-government as both an opportunity (e.g., improvements in government services) as well as challenge (e.g., Internet security, privacy, etc. (see, e.g., Seifert, 2003).

Although the theme of most of this research is on improvements and related issues, little focus has been accorded the link between e-government and a specific sector like the construction industry. Certain governments however commissioned studies which were aimed at improving traditional construction delivery (see, e.g., CIRC, 2001). The focused study of the interaction between e-government and the construction industry could aid improve or transform: the traditional relationship between the two which often involves huge monetary exchange transactions; the role of the industry (just like other sectors) in contributing to employment, taxes, etc. For example, e-government initiatives on building permits approvals accrued 100 million dollars savings to the construction industry in the State of Oregon, USA (see e.g., Deloitte Touche Tohmatsu, 2003) This savings may also aid improve on reciprocal tax receipts to government, etc. E-governments could also offer many other things to the construction industry through say providing better: information on existing infrastructure via geographic information systems (GIS); customer input on proposed product definition and development at the construction conception/development phases via improved 3D or 4D digital visualization. Such intangible things could all have substantial impact on the success of the final delivered product.

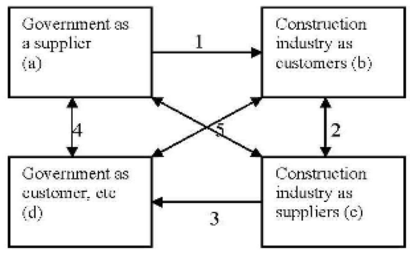
However, in spite of the potential mutual direct and indirect benefits which could be gained from the structured focused link between e-government and the construction industry, there appears to be a general lack of studies in fitting structure on the leverage of e-commerce in construction (see e.g., Ruikar, Anumba, & Carrillo, 2003). Focused structural emphasis like e-government link to construction industry could offer potential to aid study improvements, opportunities, and challenges from both macro and micro perspectives. The parties' core value delivery issues could be aligned across both entities in a linked manner to mutually satisfy their core needs at varied operational levels and capabilities. Thus, this will provide the advantage of studying the phenomena from inter-relationships rather than standalone entities. The next section presents models to highlight the evolving roles of e-government and the construction industry from a customer-supplier perspective for mutual benefit. It also builds on Rayport and Sviokla's (1999) work on virtual value delivery to support the proposed macro-perspective of construction product value delivery exchange. In addition to the explained use of the models (in the text in this subsection), other potential uses may be for the focused studies in other sectors of the economy at the macro or micro levels.

CONCEPTUAL MODELS ON THE EXCHANGE INTERACTIONS BETWEEN GOVERNMENTS AND THE CONSTRUCTION INDUSTRY

E-government and the construction industry may be usefully perceived from the evolving roles of customer-supplier relationship in a reciprocal exchange interaction. The shifting roles between government and the industry's services provision from a macro perspective is shown in Figure 1.

The role of government (a) in relationship 1 is that of a supplier of service to the construction industry through for example the approval of building permits. This role changes in relationship 3, where the government becomes the customer for the services of the construction industry. The shifting roles of both parties are shown in relation-

Figure 1. Shifting customer-supplier roles of e-governments and construction service provision



ships 2 and 4, while interactions 5 a-c and 5 b-d relates to supplier-supplier and customer-customer iterations respectively. Relationship 5 a-c could be used to study what, how, where and when e-government service delivery (e.g., time for permit delivery) impacts on the supply of services by the construction industry (e.g., delays, costs, etc.). Iteration 5c-a relates for instance to what feedback information could be collated from the construction industry to aid the e-governments deliver better services continuously. For example benchmark metrics (i.e., intra-government, comparative international, etc.) and collective strategies evolved between industry and e-government relationships to monitor this on say year on year basis. Varied routes within the model could also be leveraged and explored for studies. Latent in the model may (for example) be indirect losses in taxes from the construction industry to government as a result of consequential losses resulting from poor service delivery (e.g., due to e-government inaction, etc.) to the construction industry. Figure 2 expands this value exchange model shown in Figure 1. This may indicate a product perspective of what must be delivered via the virtual means.

Figure 2. Macro-perspective of e-government—construction industry service/product value delivery exchange

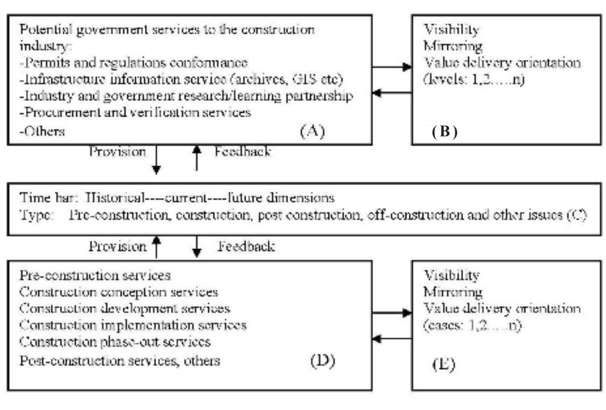


Figure 3. Cross-sectional service delivery perspective of e-government

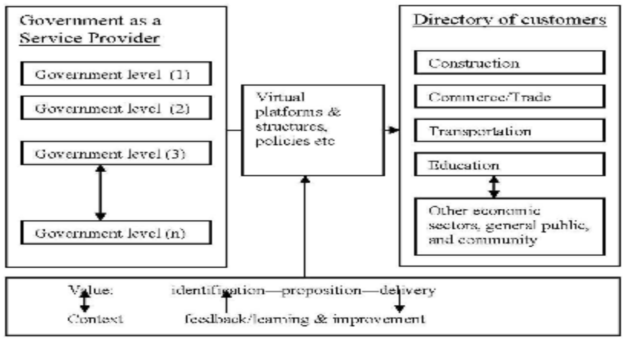
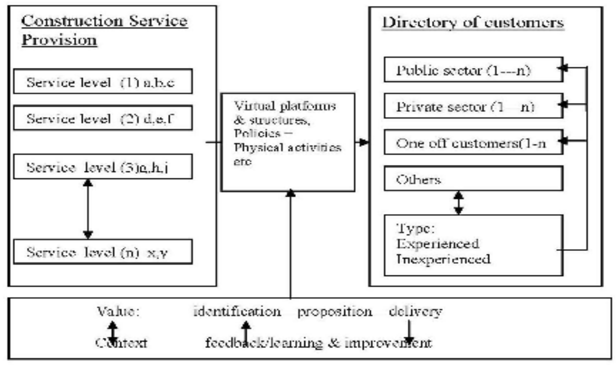


Figure 4. Cross-sectional perspective of value delivery from the construction industry



Certain categories of services from both e-government and construction industry are indicated in items A and D respectively, whilst items B and E show the packaged delivery from e-government by levels and construction service delivery by cases. Items A and D feed and receive feedback from item C, which offers time-based perspectives on the different lifecycle phases of construction. Item C also acts as the link between items A,B (via e-government) and D,E (construction industry) for linked collaborative learning, improvements, etc. The time-based perspective of the types of service delivery (i.e., pre-construction, construction, etc) in item C could be seen (relative to any strategically defined periods) from historical, current and future perspective. Feedback information from item C could be used to aid say: collaborative historical analysis for planning, current monitoring and control, and future improvement or fundamental innovation per each given context. Service delivery (see items B and E) may be packaged via decomposition into the elements of visibility, mirroring and new customer relations (see, e.g., Rayport & Sviokla, 1999). Visibility could be created for all intended processes and their delivery; mirroring may involve importing physical activities into the digital environment with say the aim of transforming existing processes in the physical realms; relations with the customer could be transformed via value delivery orientation which offers customer-centered approach and intimacy to deliver varied offerings relative to need (and this may also be supported by feedback metrics and communication mechanisms). The model in Figure 2 may also be used for improvement studies at the micro-level between specific e-government and construction project micro-cases relative to a given context.

Figures 3 and 4 provide the cross-sectional value delivery perspectives form both the e-government and the construction industry as service providers to the indicated respective categories of customers. Value delivery in each case (i.e., Figures 3 and 4) may involve tailoring delivery to each specific context relative to evolving roles as client or supplier of services, and this may involve the processes of value identification, proposition, delivery and feedback for say improvement. Tailoring in say the case of e-government (see Figure 3) may be to each specific context and customer directory orientation, as for example the needs for transportation sector may differ from the construction industry. The levels of government say levels 1 and 2, etc., may refer to the central and local government, etc. which are linked in a given context to the virtual platforms, structures, policies, etc.

Relative to the construction service delivery (see Figure 4), levels 1, 2, etc. may indicate the various levels of service in the industry, which may be categorized via types like heavy engineering, maintenance and repairs, etc. At each level (i.e., 1, 2, etc.) there may be many providers. For example at level 1 there may be providers a, b, c, etc. for any corresponding customer (which may also vary relative the nature of customers). Delivery to say the public sector may for example include customers (1, 2, 3, etc.) which may refer to specific central, local government, etc. The virtual platforms, structures and policies may aid as a collaborative framework in delivering any mutually defined value.

FUTURE TRENDS

Studies have shown that even the most mature e-governments have attained less than 20% of their full potential (see, e.g., The World Bank Group, n.d.). The feasibility of use of the models in Figures 1, 2 and 3 in this article could also be linked to e-government value delivery maturity progression levels (see e.g., The World Bank Group, n.d.) as template to study the context for further improvement and progression, to provide linked value delivery for specific industries (like construction, commerce, etc). Such an approach could provide the benefit of a focused link between e-government progression which also takes account of a value delivery orientation tailored to the specific needs of particular industries like construction, commerce, transportation, etc via linked value delivery exchange interactions for their mutual benefits.

CONCLUSION

This article explored the exchange interactions which may evolve between the construction industry and e-governments in delivering mutually beneficial value. The adoption of e-government by many governments have much implications for the construction industry, and also offers new perspective in the traditional customer-supplier relations, as both entities may play different evolving roles as customers or suppliers in the digital environment. This article offered models which structurally link the customer-supplier evolving roles of both entities to aid study relational improvements/transformations for mutual benefits. These may assist in focusing attention for the improvement or transformation of the interaction between e-government and the construction industry and other sectors of the economy.

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KEY TERMS

Construction Project Life-Cycle: This is analogous to comparing construction projects to real life. Thus projects may be assumed to evolve through the life phases of conception; development; implementation and phase-out. Post delivery involves the facilities operation/maintenance phase till asset disposal.

Customer: Refers to the entity which procures goods and services.

Customer-Supplier Perspective: Refers to the linked interrelation between the requirements (needs, wants, etc.) of the customer to the provision of these by the supplier to their mutual benefit.

Exchange Interaction: Involves the interactive relationship between e-government and the construction industry for potential mutual gains.

Supplier: refers to the entity which provides wanted or needed goods and services.

Value Delivery: This term (although variable) may generally refer to the delivery of tangible or intangible things of worth or importance. In a product transformation process this term may refer to efficient processes, and the effectiveness in attaining the right inputs, results, impacts, goals, etc. and in managing any relative context.

Value Delivery Orientation: Refers to positioning to deliver value to fit or exceed expectations of any relatively defined value. This positioning may entail both cognitive and behavioral aspects.

Virtual Value: Is the value created via the virtual media, thus with the use of information (see Rayport & Sviokla,1999). This may be extended to include value created via the integrated leverage of the physical activities and ICT based information.

E-Government and the Digital Divide

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INTRODUCTION

Many governments world wide are attempting to increase accountability, transparency, and the quality of services by adopting information and communications technologies (ICTs) to modernize and change the way their administrations work. Meanwhile e-government is becoming a significant decision-making and service tool at local, regional and national government levels. The vast majority of users of these government online services see significant benefits from being able to access services online.

The rapid pace of technological development has created increasingly more powerful ICTs that are capable of radically transforming public institutions and private organizations alike. These technologies have proven to be extraordinarily useful instruments in enabling governments to enhance the quality, speed of delivery and reliability of services to citizens and to business (VanderMeer & VanWinden, 2003).

However, just because the technology is available does not mean it is accessible to all. The term digital divide has been used since the 1990s to describe patterns of unequal access to ICTs—primarily computers and the Internet—based on income, ethnicity, geography, age, and other factors. Over time it has evolved to more broadly define disparities in technology usage, resulting from a lack of access, skills, or interest in using technology.

This article provides an overview of recent literature on e-government and the digital divide, and includes a discussion on the potential of e-government in addressing the digital divide.

BACKGROUND

The adoption of highly intensive and complex systems of ICT networks to establish e-government are radically changing how national, state, and local administrations deliver services, collect, integrate, and share information, and communicate with one another and citizens. A growing number of professionals see the Internet as a transformative technology, and they regard e-government as part of a new vision of government for the 21st century (Jones & Crowe 2001; Kearns, Bend, & Stern, 2002; OECD 2001; Pardo 2000; Socitim & Idea, 2002). The use of ICTs to support public participatory decision-making via e-government triggers information technology to make government operate more efficiently (Griffiths, 2002; Lenihan, 2002; Lenk & Traunmuller, 2002; Macintosh, Malina, & Whyte, 2002). E-government focuses on the actions and innovations enabled by ICTs combined with higher levels of speed, scalability, and accuracy.

For the past two decades, the debate about the ways technology can aid democratic governance has been continuing especially in the developed (Arterton, 1987; Mclean, 1989) and has continued to accelerate with the proliferation of the Internet as an information and communication medium (Karakaya, 2003). The interactive nature of Internet in e-government allows contributions from the user instead of broadcasting data from one centre to many users (Hewitt, 2000; Yigitcanlar, 2003). For example in the local governance context, citizens can obtain information about their council through the council's Web site, can contact their representatives easily via e-mail and state their own views through online consultations and discussion forums.

ICT is not a solution to all concerns about e-government, but it can start to close the gap between what governments do and people's everyday lives. For that reason e-government means more than just a Web site, it has the power to transform citizens' lives. Socitim and Idea (2002) state that the overwhelming majority—up to 80%—of citizen-government transactions takes place at the local level. In this way the applications of e-government are affecting people's daily lives. That is to say applications of e-government are actually affecting—easing—people's daily lives. However without giving equal opportunity and accessibility to the public, e-government is nothing more that an elitist tool. Therefore, as e-government is becoming wide spread all around the world, governments have realized the importance of developing policies and programs to address the inequalities that are becoming evident in access to ICTs and the usage of these technologies.

E-GOVERNMENT AND THE DIGITAL DIVIDE

In e-government discussions, the term digital divide has quickly become popular. It is used to explain any and every disparity within the online community. At its basic level the digital divide is about the difference between those with access and those without access to ICTs. It is also used as a term to indicate social exclusion in the online world as we move to the knowledge economy, or the knowledge society (Graham, 2002; Stimson, 2002; Woodbury & Thompson, 1999). Most of the available literature suggests that socioeconomic status and demographic characteristics determine the frequency of use of ICTs (Hoffman & Novak, 2000; NITA, 1999). In particular, issues of income and education are often seen as being important, while age and ethnic background may also be an issue (NOIE, 2002; VanderMeer & VanWinden, 2003). There may also be a geographic component.

The concept of the digital divide is generally understood as a multidimensional phenomenon encompassing three distinct aspects. The "global divide" refers to the divergence of Internet access between industrialized and developing societies. The "social divide" concerns the gap between information rich and poor in each nation. And lastly within the online community, the "democratic divide" signifies the difference between those who do, and do not, use the panoply of digital resources to engage, mobilize and participate in public life (Norris, 2001).

It is clear that technology will continue to evolve rapidly, along with its social uses. Yet despite the need for considerable caution in weighing the available evidence, if we can establish the main drivers behind the diffusion of the Internet, and if these prove similar to the reasons behind the adoption of older forms of information technologies, then we are in a much better position to understand and predict the probable pattern of future developments, the potential consequences of the rise of the Internet age, and also the policy initiatives most likely to overcome the digital—global, social and democratic—divide.

Research into global internet trends by Neilsen Netratings (2001) suggested that at the beginning of the current decade there were an estimated 429 million people online globally. Neilsen Netratings (2003) reports that at the end of 2002 with a 35% increase Internet was being used by 580 million people. However the global divide still remained the same. For example, of those 580 million, 29% were in the U.S., while 23% of the online population lived in Europe, 13% of the online population logged on from Asia Pacific, and only 2% of the world's online population was in South America.

The digital divide is becoming more of a recognized reality as technology makes phenomenal progress and e-government applications become widespread in the new information age. The United Nations Human Development Report demonstrates that high income OECD countries, with only 14% of the world's population, were home to 79% of all Internet users, and only 0.4% of people in South Asia were online although the region is home to one-fifth of the world's population (UNDP, 2001). More than ever, unequal adoption of technology is excluding many people from reaping the fruits of the e-government and global economy.

> *... Even in advanced industrial nations with rapid maturing Internet markets, whole sections of the urban population fail to benefit from the skills, education, equipment, infrastructure, capital, finance and support necessary to go and remain 'online'. This is so at precisely the time when being online is becoming ever-more critical to access key resources, information, public services and employment opportunities.* (Graham, 2002, p. 37)

The digital divide is a complex issue with no singular cause or effect. Unfortunately, new technologies alone will not suffice to close the digital divide, since they are heavily dependent on physical capital (for infrastructure, hardware and software), human capital (for installation, maintenance, updates and efficient usage of the computers) and the general economic policy environment (for functioning payment systems, stability) (DDN, 2003). Whilst e-government provides many opportunities for local authorities to serve citizens more effectively, it also runs the risk of widening existing inequalities and making non-IT users second-class citizens.

The Digital Divide Network (2003) underlines that addressing the digital divide requires a multi-faceted approach involving: (a) affordable access to information tools for the elderly, the poor, the disabled, and those living in rural areas; (b) economic development of communities developing an infrastructure of telecommunications facilities and cultivating a well-trained workforce so that communities can remain competitive in attracting and retaining businesses; (c) Internet content that is relevant to and produced by communities addressing the availability of community-relevant information, overcoming language and literacy barriers, and promoting the diversity of cultural voices; and (d) a society devoted to lifelong learning developing the learning skills which will enable all generations to adapt to constantly changing times.

The OECD (2001) stresses apart from general approaches in reducing the digital divide like extending the infrastructure, skills, and information, it will be especially important to offer low costs access. With computers and Internet available at public institutions like libraries, post offices, local and regional government facilities, schools, etc., individuals can build up familiarity with the information technology and develop important relevant skills. The provision of low-cost and subsidized access in schools for example will help to establish sound fundament for computer literacy of the future workforce and will improve the diffusion of decisive knowledge for the new economy. This diffusion of knowledge is an important aspect of developing successful e-government programs.

E-DEMOCRACY AND THE DIGITAL DIVIDE

Griffiths (2002) characterize e-democracy as referring to relations of two-way and horizontal power—using technologies to enhance democratic practice. She also identifies e-government as referring to relations of top/down power—governing populations through use of online information services, and it is often thought to be a political or more "uninvolved" than e-democracy. E-democracy focuses more on the use of ICTs in support of citizen-centered democratic processes and uses them to make elected officials more accountable to the public (Snider, 2001). It involves a shift from a more closed to a more open e-government system. Conventional e-government is, relatively speaking, a one way system where by information flow and decision-making are hierarchically controlled and community involvement is limited. By contrast, e-democracy seems likely to produce a wide range of new connections to support two-way communication and collaboration that will involve government officials in relationships with organizations and individuals (Lenihan, 2002).

E-democracy provides ways to educate and empower communities. In an e-democracy project education is one of the most important issues to address the digital divide. Education in remote areas could be supported by a number of technology-enabled applications, including a mobile teaching assistant to provide teachers with curriculum information, as well as class materials. Virtual universities and education portals could also be supported with the proper application of ICTs. Another key issue is empowerment. Empowerment and participation in government could be enabled by such applications as an m-government assistant, a mobile terminal that a rural government employee could use to provide government information and services in remote areas.

At present e-democracy and e-participation hold great promise for enhancing citizen involvement in the political process. That includes finding ways to narrow the digital divide. International experience and major international programs—to identify ways of ensuring that the digital revolution will benefit the population of the whole world—have demonstrated that e-government and e-democracy can make an invaluable contribution to helping to create digital opportunities for all by enhancing citizen involvement (i.e., Singapore and Minnesota e-government services).

Atlanta, Cleveland, Durham, and Seattle are among the U.S. cities that developed e-government initiatives to bridge the digital divide to make e-government accessible to all. European Union's e-Europe project can also be mentioned as a good practice. This e-government project includes numerous "social inclusion" initiatives. Another good practice is the Australian Capital Territory's Community IT Access Plan. It sets out the strategic approach being taken to bridge the digital divide.

FUTURE TRENDS

The digital divide is one manifestation of the unequal distribution of power. The various demographic dimensions, along which the digital divide runs, represent a map of how that social power is distributed. No matter where they are located, those who have higher incomes have greater access to, and are more likely to use the Internet. Urban dwellers are usually better connected to electronic media than rural dwellers. Those with more education often have both higher incomes, and better connectivity. Trying to close the digital divide can be interpreted as one form of economic redistribution. Riley (2004, p. 18) argues narrowing the digital dived is a matter of time and states that:

... Prior programs of a Keynesian type have successfully extended other forms of infrastructure (electricity distribution, sewage treatment, public education, telephone service, etc.) from the upper classes to the entire population. Are there some significant differences between Internet connectivity and these prior forms of infrastructure extension that precludes the digital divide from being treated in the same way as the provision of roads or sewers?

Similarly NIC (2000, p. 32) points out that "…wide range of ICT developments is leading to the rapid diffusion of Internet… by 2015, information technology will make major inroads in remote rural areas as well as urban areas around the globe."

In many countries, governments, and NGOs are already developing various initiatives to close the digital divide including: (a) providing public ICT access through libraries and community centers; (b) offering ICT training programs; (c) providing ICT access and training to disadvantaged target groups including people with a disability and their caretakers; (d) distributing a free computer training resource through libraries, shop fronts and community centers; and (e) establishing a PC Reuse Scheme to provide affordable refurbished computers to people on a low income and not-for-profit community groups. In the near future, the continuum of these policies will help in narrowing the divide, and increasing the accessibility of e-government services.

As Loader and Keeble (2004:43) note future research agenda needs to focus on the following issues: (a) economic, social and cultural characteristics of the public; (b) sustainable strategies for challenging the digital divide; (c) community intermediaries to stimulate computer literacy; and (d) economically and socially sustaining the digital divide initiatives.

CONCLUSION

The first step in handling the widening digital gap is, understanding the breadth and depth of any cultural, racial, education, knowledge or literary divide that exists in any given jurisdiction. It is incumbent on governments to bridge these divides and ensure that there are no inequities between those who have the capacity to engage in online transactions with governments and those who do not have access or do not wish to participate in the online world. Many federal, state and local governments are seeking to find solutions. This is the next challenge in ensuring successful e-government and the delivery of e-services (Riley, 2004).

E-government is an exciting frontier, but technology (e.g., bigger and faster servers, more powerful search engines) alone is not going to get governments there. What it is going to take to move to the kind of government that uses technology as a tool to provide greater accountability, transparency and collective decision making through better and more meaningful public access to government information (Hewitt, 2000). Therefore online services and activities should not be focused solely on technology but be supported by it.

International practices have shown that there are many citizens who currently can not participate in the information society, and as e-government becomes more pervasive they will increasingly be left behind and become disenfranchised. Consequently, for any e-government project to be successful there needs to be some degree of e-participation and community development. Only by understanding and addressing the digital divide, and the needs of the citizens will local governments be able to realize the vision of true e-government.

The real success of e-government comes from developing policies and programs for: (a) understanding the differences among citizens; (b) taking various public opinions and needs into consideration; (c) adding them into decision making processes; and (d) fine tuning e-government for a wider individual and community participation. In conclusion, many authors (Mossberger, Tolbert, & Stansbury, 2003; Norris, 2001; Servon, 2002; Warschauer, 2003) acknowledge that e-government is not a panacea to solve the whole digital divide problem, but when used correctly it has the potential to bridge the divide.

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KEY TERMS

Digital Divide: Is the gap in opportunities experienced by those with limited accessibility to technology especially, computers and the Internet.

E-Democracy: Refers to relations of two-way and horizontal power—using technologies to enhance democratic practice.

E-Government: Refers to relations of top/down power—governing populations through use of online information and services.

E-Participation: Is the engagement of an individual or a group in specific decision-making and action by using ICT means. It aims to encourage of those not normally involved in a particular process or decision-making system to be involved.

Information and Communication Technology: Is a term created to refer to the amalgam of computing and telecommunications technologies, including the Internet, which are the matrix within which information and digital media are created, distributed and accessed.

Local E-Government: Refers to information, services or transactions that local governments provide online to citizens using the Internet and Web sites.

M-Government: Is a subset of e-government and it utilizes mobile and wireless technologies like mobile phones, and laptops and PDAs (personal digital assistants) connected to wireless local area networks. It makes public information and government services available "anytime, anywhere" to citizens and officials.

E-Government Development and Implementation

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INTRODUCTION

This article intends to review important research issues in e-government and aims to shed light on future studies on e-government in a global setting. Specifically, this article: (1) reviews the background and development of e-government in developed and developing countries; and (2) identifies and discusses key issues and future trends/ challenges in e-government research, which provides some insights and directions for future studies in e-government.

BACKGROUND

E-government is a cost-effective solution that improves communication between government agencies and their constituents by providing access to information and services online. *The Economist* magazine estimates that the potential savings of implementing e-government could be as much as $110 billion and £144 billion in the U.S. and Europe, respectively (Symonds, 2000). Narrowly defined, e-government is the production and delivery of government services through IT applications, used to simplify and improve transactions between governments and citizens (G2C), businesses (G2B), and other government agencies (G2G) (Sprecher, 2000). Unlike the traditional bureaucratic model where information flows only vertically and rarely between departments, e-government links new technology with legacy systems internally and in turn links government information infrastructures externally with everything digital (Tapscott, 1995). Table 1 summarizes the characteristic differences between the traditional government and e-government organizations.

Though a new subject, e-government has attracted more and more research interest and focus from industries, national governments, and universities, such as IBM's Institute for Electronic Government and various "e-government task forces" in different countries around the world (Huang, D'Ambra, & Bhalla, 2002). E-government implementation has become a very important global issue faced by many countries of the world. So far, most, if not all, published IS papers discuss e-government implementation issues and problems based on the experience of developed countries, not on developing coun-

Table 1. Main differences between traditional and e-government organizations

Traditional Government	E-Government
Bureaucratic controls, clear authority hierarchy	Client service and community empowerment, leveled/blurred hierarchy
Process centricity	Customer centricity
Isolated administrative functions and data collection	Integrated resource service and knowledge focus
Functional specialization of units or geographic bias	Breakdown of unit barrier, government integration
Decision based on uniform rules and awkward reporting approvals	Decision based on negotiation and implicit controls and approvals
Isolated administrative functions	Integrated resource services
Disjointed information technologies	Integrated network solutions
Time-consuming process	Rapid streamlined responses

Table 2. Main differences between developed and developing countries

	Developed Countries	Developing Countries
History and Culture	• Government and economy developed early, immediately after independence • Economy growing at a constant rate, productivity increasing, high standard of living	• Government usually not specifically defined; economy not increasing in productivity • Economy not growing or increasing productivity; low standard of living
Technical Staff (Ledford, 2002)	• Has a current staff, needs to increase technical abilities and hire younger professionals • Has outsourcing abilities and financial resources to outsource; current staff would be able to define requirements for development	• Does not have a staff, or has very limited in-house staff • Does not have local outsourcing abilities and rarely has the financial ability to outsource; current staff may be unable to define specific requirements
Infrastructure (Dooley, 2002)	• Good current infrastructure • High Internet access for employees and citizens	• Bad current infrastructure • Low Internet access for employees and citizens
Citizens (ICeGD, 2002)	• High Internet access and computer literacy; still has digital divide and privacy issues	• Low Internet access and citizens are reluctant to trust online services; few citizens know how to operate computers
Government Officers	• Decent computer literacy and dedication of resources; many do not place e-government at a high priority	• Low computer literacy and dedication of resources; many do not place e-government at a high priority due to lack of knowledge on the issue

tries (Huang, Siau, & Wei, 2004). Can successful experience of e-government implementation in developed countries be directly applicable to developing countries? If not, why not? How can a country learn from other countries' experiences in e-government implementation? What are key issues and future trends of e-government development and implementation from a global perspective? These important questions have not had satisfactory answers yet.

Research literature shows that although e-government has become a hot research topic and there have been many prior studies on e-government, most of them are published based on experience of developed country's e-government development and implementation, such as in Britain (Irani, Love, Elliman, Jones, & Themistocleous, 2005), Australia (Huang et al., 2002), the European Union as a whole (Heinderyckx, 2002; Lassnig & Markus, 2003; Lowe, 2003; Schweighofer, 2003), Finland (Kampen, Snijkers, & Bouckaert, 2005), France (Benamou, Busson, & Keravel, 2004), Spain (Latre, 2003; Pasic, Sassen, & Garcia, 2004; Sabucedo & Anido, 2004), Italy (Ferro, Cantanmessa, & Paolucci, 2004), The Netherlands (Arendsen & van Engers, 2004), Germany (Bartels & Steimke, 2004), Switzerland (Chappelet, 2004), Belgium (Rotthier, 2004), Japan (Omura, 2000; Thompson, 2002), Canada (Marche & McNiven, 2003), and the United States (Ni & Ho, 2005; Reddick, 2005).

Although e-government technologies have a potential to improve the lives of the 80% of the world's population that lives in developing countries, so far developed countries such as the United States, Canada, Britain, and Australia are leaders in e-government (Accenture, 2002), reaping the vast majority of initial gains of e-government implementation. More than 75% of Australians file income taxes online, while the mayor of Minnesota receives about 13,000 e-mails from the public each week (Palmer, 2002). The gap between developed and developing countries in Internet technological infrastructures, practices, and usage has been wider rather than narrower over recent years. Besides the lack of sufficient capital to build up expensive national information infrastructure (NII) on which e-government is based, developing countries also lack sufficient knowledge and skills to develop suitable and effective strategies for establishing and promoting e-government.

Prior study provides some empirical evidence to show that e-government development and implementation differ in different countries in terms of income level, development status (developed vs. developing countries), and geographical regions. To examine those underlying reasons resulting in different e-government development strategies and outcomes between developing and developed countries, it is important to examine the main differences between developing and developed countries in terms of governments' characteristics. Drawn upon literature search and research, Table 2 summarizes differences between developed and developing countries in various aspects of government.

KEY ISSUES

Various stages of e-government development reflect the degree of technical sophistication and interaction with users (Hiller & Belanger, 2001), as shown in Table 3.

With the world economy going towards more and more regional and global, e-government research and implementation from a global perspective has become more and more important. Some key issues, future development trends and/or challenges that are important to both developed and developing countries are summarized as follows.

- **Accessibility issue for individuals with disabilities when accessing e-government Web sites**. For example, there are more than 54 million individuals with disabilities in the United States (Jaeger, 2004), and other countries (either developed or developing countries) have significant numbers of citizens with disabilities as well. In many developed countries, governments have invested a lot to improve hardware facilities specifically for those with disabilities. However, so far, to our knowledge, there is no single e-government Web site specifically designed for those with disabilities. What are the accessibility requirements of these people that are different from normal citizens when they are accessing and using e-government services? How can we design e-government Web sites specifically for those with disabilities? These are very important research issues, even though little empirical research has been done in the research literature.
- **Interoperability Issue** (Benamou et al., 2004; Cava & Guijarro, 2003; Guijarro, 2004). E-government includes G2C, G2G, and G2B, which requires restructuring working processes of governmental agencies as well as better coordination among citizens, businesses, and governmental agencies. To this end, e-government systems must be interoperable at different levels (federal, state, and local governments), considering different dimensions (political, organizational, human, and technical).
  To deal with this important issue, one has to deal with the existing problems that current legislatures miss components that specifically encourage and promote coordination among governmental agencies for e-government implementation (Strejcek & Theil, 2003). Further, an increasing number of governments worldwide recognize the role of establishing a metadata standard as an integral ingredient of their interoperability framework towards realizing their e-government strategy. Metadata are "data about data" or "information about information." In the public sector, metadata may be used among others for the discovery and retrieval of governmental information (Tambouris & Tarabanis, 2004).
- **Security Issue** (Kalloniatis, Kavakli, & Gritzalis, 2004). The need for keeping information secure is increasingly important in modern e-government environments. This holds because personally identifiable information can be electronically transmitted and disseminated over insecure open networks and the Internet. Some key issues include: how to develop quality requirements engineering (RE) framework for eliciting and managing security requirements (SRs), and then how to develop an effective security system for e-government services? What are key restrictions and difficulties while building up a secure e-government system (Hof & Reichstadter, 2004)?
- **Anti-Corruption Information Systems and E-Government Development** (Costake, 2003)**.** Corruption exists in almost every country, both in developed and developing countries, but it seems to be more important for developing countries than developed countries. While e-government development and implementation require restructuring of cur-

Table 3. Five stages of e-government implementation

Stage 1	The most basic form of e-government; uses IT for disseminating information by posting data on the Web sites that are viewable
Stage 2	Two-way communication between government and constituents; e-mail systems are incorporated as well as data-transfer technologies
Stage 3	Web-based self-services where online service and financial transactions are available
Stage 4	Various government services are connected internally and externally for enhanced efficiency, user friendliness, and effectiveness
Stage 5	The promotion of Web-based political participation, including online voting; highlights Web-based political activities by citizens

rent working processes and ways of doing things in governments, they provide a good chance to reexamine the issue of how to use e-government development and implementation as a catalyst to identify and formulate general informational requirements to support anti-corruption actions, which can form part of the infrastructure of e-government.

- **Cross-Cultural Issues in Global E-Government Development and Implementation** (Denman-Maier & Parycek, 2003). As shown in the proposed framework presented in this article, large differences exist between developed and developing countries in terms of national cultures. Even developed countries where most e-government initiatives are being launched tend to be far from culturally homogeneous political entities. Most of them have large minorities that may not only speak different languages, but also have different religions, use different scripts, and differ in their cultural values, traditions, and attitudes. How do these factors influence those peoples' understanding of information distributed by public authorities, and their cognitive approach to knowledge representation, so that they can also use e-government services more effectively in a more satisfactory way?
- **Best Practice in E-Government** (Makolm, 2002; Millard, 2002). How do we examine the best of e-government experience across developed and developing countries in relation to technology, organizational change, and meeting the needs of the user (citizens and business)? How do we address different needs and requirements when building up best practice solutions in the fields of G2C, G2B, and G2G?

Table 4 summarizes other key issues and trends faced by e-government development and implementation in the near future.

Table 4. Key issues and trends of e-government development and implementation

No.	Key Issues and Trends	References
1	Although there is a growing body of eGovernment literature, relatively little of it is empirical. More empirical investigation on eGovernment development and implementation will be needed in the future.	(Norris and Moon, 2005)
2	More research on privacy issue in eGovernment. The Central Intelligence Agency came under public criticism when it was discovered that their Web site used persistent "cookies" to track Web visits in violation of federal privacy policy.	(Stratford, 2004)
3	eGovernment adoption and diffusion in public sector, especially in local governments. Prior study in US shows that eGovernment has been penetrating state government much more rapidly than local government. Future research should study effects of factors such as proper marketing, privacy issues, equity, and financing on full penetration of eGovernment in public sector.	(Edmiston, 2003)
4	Information technology provides some powerful supporting tools for eGovernment, which may empower government to provide additional and/or new services to the public, which otherwise may not be possible to do so. Future study can look into the research issue on how to provide new and value-added services through integrated eGovernment.	(Pfaff and Simon, 2002)
5	Very little has been known about eGovernment usability issue for old citizens who don't have skills in computer usage.	(Becker, 2005)
6	Future research should study the relationship between eGovernment and eGovernance, and how one issue influences another in eGovernment development and implementation.	(Marche and McNiven, 2003)
7	eGovernment and accountability. Will eGovernment lead to a more transparent, interactive, open and hence, accountable, government? If not, what should we do to make it happen in developing eGovernment strategies?	(Wong and Welch, 2004)
8	Qualification issue and training issue in eGovernment. While eGovernment has a potential to substantially change the current way public section is operating and functioning, new qualification requirements arise for users, managers, decision makers in public administration. As a result, effective training programs should be worked out to meet this potentially big demand from public sector. However, little research has been done in this area.	(Kaiser, 2004)
9	Risk issue in eGovernment. Electronic government transaction services may offer a potential of increased efficiency and quality with the minim cost in the way the public administration deals with its customers. Recent reports show that this is far from reality, as eGovernment projects seem to be failing to deliver. Future study should look into this important issue on identifying key risk factors and how those risk factors influence the success or failure of eGovernment project.	(Evangelidis, Macintosh and Davenport, 2004)

FUTURE TRENDS

Due to the substantial differences discussed in Table 2, developing countries cannot and should not directly adopt developed countries' successful e-government implementation strategies. Developing countries should consider their own positions and learn from other countries' successful e-government implementation experience, and then work out their e-government implementation strategies that fit with their countries' characteristics and conditions.

A useful conceptual framework was proposed recently, which incorporates critical success factors (CSFs) influencing e-government development and implementation (Huang, Chen, & Ching, 2005). The framework includes the national e-government infrastructure (NeI) factors such as network access, networked learning, networked economy, and network policy, as well as other critical success factors such as society factors like national history and citizens (Huang et al., 2002); government staff and governance (Wimmer, Traunmuller, & Lenk, 2001); organizational structure (Baligh, 1994); and cultural factors like national culture (Hoftstede, 1980, 1991), organizational culture (Hoftstede, 1980; Schein, 1993), and social norms (Ajzen, 1988). Using a comprehensive framework, one can compare e-government development and implementation experience in different cultures and countries, understand the specific conditions and contextual factors that are related to the success of e-government development and implementation in developed or developing countries, and thus better learn from the success and/or failure of other countries' experience.

Moreover, with some emerging technologies, future studies can look into some important research issues in e-government implementation, such as how mobile technologies can be used in supporting and enhancing e-government functions and development. While e-government technologies give developing countries a chance for "leap frog" development, how do developing countries use Internet technologies to establish e-government services that may never have existed in their countries before? Further, it would be interesting and important to examine whether the five stages of e-government development are linear or discontinuous based on the experience of developed and developing countries.

CONCLUSION

Due to the considerable differences between developed and developing countries, successful e-government development and implementation experience from developed countries may not be directly applied to developing countries. On the other hand, little research has been done on exploring why and how different countries, such as developed and developing counties, adopted different e-government development and implementation strategies in the research literature. Further, less has been known about e-government development and implementation in developing countries (Huang et al., 2004).

The current study intends to do some initial work to bridge the gap by comparing specific conditions and contextual factors that are related to the success of e-government development and implementation in developed or developing countries. In addition, this article compares strategic issues and implementations of e-government between developed and developing countries. It identifies and discusses key future trends and/or challenges of e-government development in both developed and developing countries, and provides some insights for future research and practice in global e-government development and implementation.

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KEY TERMS

E-Government: The production and delivery of government services through IT applications; used to simplify and improve transactions between governments and citizens (G2C), businesses (G2B), and other government agencies (G2G) (Sprecher, 2000).

Metadata: "Data about data" or "information about information." In the public sector, metadata may be used among others for the discovery and retrieval of governmental information (Tambouris & Tarabanis, 2004).

National E-Government Infrastructure (NeI): Refers to the basic foundation, in both hardware and software, on which an e-government system can be built and developed. It generally consists of "4N factors": network access, network learning, network economy, and network policy.

Network Access: Refers to the availability, cost, and quality of information and communication technology networks, services, and equipment (Kirkman, Osorio, & Sachs, 2002).

Networked Economy: Refers to a new form of economy where businesses and governments use information and communication technologies to interact with the public and with each other to get business transactions done (Kirkman et al., 2002).

Networked Learning: Refers to an educational system that integrates information and communication technologies into its processes to improve learning? Communities of a society should have effective technical training programs that can train and prepare an ICT workforce (Kirkman et al., 2002).

Network Policy: Refers to the policy environment that promotes or hinders the growth of information and communication technology adoption and use in government agencies. Some related key issues include legislations, laws, strategies (visions and missions), and accountability (Kirkman et al., 2002).

E-Government Portals in Mexico[1]

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INTRODUCTION

Electronic government has become a powerful administrative tool for governments around the world (Dawes & Pardo, 2002; Fountain, 2001; UN & ASPA, 2002). Governments at all levels are attempting to improve services and increase their interactions with citizens using information and communication technologies (ICTs). In Mexico, state and local governments are expending large amounts of money to introduce ICTs in operational tasks, as well as in the provision of public services. Many of these governments have created Web pages, which provide information about government agencies and, in some cases, allow transactions. Unfortunately, in Mexico, there is no systematic or rigorous research program that measures and assesses the evolution and impact of e-government.

As an initial step of a broader research effort, this study focuses on the functionality of state portals, looking at technical aspects, as well as their potential to improve the quality of the services provided by states. Gant and Gant (2002) state, "A Web portal serves as the integrated gateway into the state government Web site and provides visitors with a single point of contact for online service delivery within the state." Therefore, these portals contain an interesting mixture of applications and are good examples of current e-government efforts. Accordingly, taking an evolutionary approach, this study provides an initial assessment of e-government at the state level in Mexico. This article is organized into six sections including these introductory comments. In the second section, three approaches to e-government assessment are described briefly. The third section explains our method of analysis. In the fourth section, we present some preliminary results. The fifth section includes some future trends and areas for research. Finally, section six provides some concluding remarks.

BACKGROUND: APPROACHES TO E-GOVERNMENT ASSESSMENT

There is a current debate about the concept and characteristics of electronic government (Prins, 2001; Gil-García & Luna-Reyes, 2003; Schelin, 2003). This debate can be interpreted through (1) managerial, (2) citizen-centered, and (3) evolutionary perspectives, among others. This section very briefly describes these three perspectives and attempts to highlight their advantages and limitations as approaches to e-government assessment. This article takes the evolutionary perspective to preliminary evaluate state portals in Mexico.

Managerial Perspective

According to the managerial perspective, electronic government must focus on managerial processes. Similar to the concept of e-management (Gil-García & Luna-Reyes, 2003), this perspective establishes that the main objective of e-government is to improve managerial effectiveness and efficiency. For example, Wescott (2002) states, "e-government is the use of information and communication technology (ICT) to promote more efficient and cost-effective government, facilitate more convenient government services, allow greater public access to information, and make government more accountable to citizens" (p. 1).

West (2001) and Toral (2000) also pay attention to managerial processes but in their relationships to services and citizens. West states that e-government refers to the delivery of information and services online through the Internet. Similarly, Toral says, "electronic government is the future government, which offers and performs services to the population in the way they need" (p. 6A). Finally, Holmes (2001) states, "Electronic government or e-government is the use of information technology, in particular the internet, to deliver public services in a much more convenient, customer-oriented, cost-effective, and altogether different and a better way" (p. 2).

Citizen-Centered Perspective

The citizen-centered approach to electronic government emphasizes the predominant role of citizens as drivers of e-government. This perspective also offers a critical lens to evaluate the influence of e-government initiatives on individuals and societies. Pipa Norris (2000) says that the influence of the Internet on societies, especially on the poor ones, can change their life by improving education and access to government decisions. It should be clear that the nature of e-government is different from how businesses use the Internet to interact with customers. For example, Naief Yehya (2002) mentions, "Substantially, the egov idea is radically different to the e-commerce idea" (p. 31). This technology can make life simpler for people and their real objective is to promote, protect and make strong the democratic values (p. 32).

In summary, the managerial perspective is mainly oriented to processes, methods, information, and government legitimacy, excludes any links with citizens and avoids the opportunity to make interactions the strongest part of the process. In contrast, the citizen-centered perspective focuses on people's needs and takes into consideration important transformations in government procedures to make services and information more accessible to citizens.

Evolutionary Perspective

This kind of vision maintains the assumption that electronic government is evolutionary. Some authors contend that each one of the stages is already electronic government. Others delimit from which of the phases a government can be considered electronic. After reviewing different ways to present the stages of e-government, the following model was integrated as the synthesis of previous theoretical developments (see Table 1).

Three hypotheses frame this research. First, Mexican state portals provide valuable information but few online services. Accordingly, the majority of the state portals are in the first stages of e-government (e.g., initial presence, extended presence). Second, state governments are mainly using old and less sophisticated Web technologies for their portals. With existing technologies, it is much more difficult to communicate complex information and provide transactional services. Third, there are sizable differences among state portals. Those differences may be related to economic and political factors, as well as to specific state e-government initiatives.

RESEARCH METHOD

In order to answer our hypotheses, we conducted a systematic analysis of the 32 state portals between January and February of 2005. The questionnaire includes 58

Table 1. Evolutionary approaches to e-government assessment: An overview

E-Government Stage	Additional Technological and Organizational Sophistication	References
Presence	▪ Limited government information ▪ Few Web pages developed by single agencies ▪ Static information about government structure and services	UN & ASPA, 2002
Information	▪ More dynamic information (frequent updates) ▪ Greater number of Web pages ▪ Statewide portal as the entry point with links to most of the state pages	Hiller & Bélanger, 2001; Layne & Lee, 2001; Moon, 2002; UN & ASPA, 2002; Holden, Norris & Fletcher, 2003
Interaction	▪ Forms that can be downloaded ▪ Two-way communication through electronic mail ▪ Use of search engines ▪ Use of chats, forums or other forms of interactive communication (service related) ▪ Some customization (citizen's profiles, use of passwords)	Hiller & Bélanger, 2001; Moon, 2002; UN & ASPA, 2002
Transaction	▪ Online services (secure and completely online), including accepting electronic payments (e.g., credit cards) ▪ More customization (use of passwords, citizen's profiles, etc.) ▪ Portal organized according to people's needs instead of government structures	Hiller & Bélanger, 2001; Layne & Lee, 2001; Moon, 2002; UN & ASPA, 2002; Holden, Norris & Fletcher, 2003

Integration	▪ Service portal with a single checkout point
	  ▪ Multiple agencies, *same* function, *different* levels of government
	  ▪ Multiple agencies, *different* functions, *same* level of government
	  ▪ Multiple agencies, *different* functions, *different* levels of government
		Hiller & Bélanger, 2001; Moon, 2002; UN & ASPA, 2002; Layne & Lee, 2001; Holden, Norris & Fletcher, 2003

Political Participation	▪ Political participation ▪ Online public forums/Opinion surveys ▪ Online voting	Hiller & Bélanger, 2001; Moon, 2002

Table 2. The evolution of Mexican portals (Source: Original research by the authors)

E-Government Stage	Number of Portals with Characteristics of this Stage	Percentage of Portals with Characteristics of this Stage
Presence	10	31.25
Information	15	46.88
Interaction	3	9.37
Transaction	8	25.00
Integration	5	15.62
Political Participation	5	15.62

Note: Columns 2 and 3 add up to more than 32 and 100% respectively, because some state portals have characteristics of different stages.

quantitative and qualitative items. It looks at several dimensions of portal functionality such as information provision, services provision, privacy and security aspects, accessibility, and target audiences. We will also partially assess the technological sophistication of the portal by looking at aspects such as Web development languages/programs (e.g., HTML, Dreamweaver, XML, etc.), its need of specific plug-ins (e.g., Acrobat Reader, Flash, Java, etc.), and its architectural design.

MAIN THRUST: A PRELIMINARY ASSESSMENT OF STATE PORTALS IN MEXICO

Table 3 shows results that support our first hypothesis. Forty seven percent (47%) of the Mexican state portals show characteristics associated with the information stage and many of them (31%) have characteristics of the presence stage. Therefore, our conclusion is that many of the Mexican state portals are in early stages of e-government. However, eight portals are currently providing online transactions. It is important to clarify that for this research we do not assume necessarily that there is a linear progression in the stages or that their characteristics are cumulative. For instance, Sinaloa is aligned most closely with characteristics in the presence stage, but this portal contains a link to participate politically. State portals with the highest grades are Estado de México, Sonora, and Yucatán. Generally, the more points they get, the more technically sophisticated their portals are. It is clear that Mexican state portals vary with respect to quality of services, organization, purpose and technology.

We also evaluate other variables such as openness, customization, usability, transparency, electronic services, privacy, security, broken links, search problems, design problems, readability, and the use of user fees. Twenty-five percent (25%) of the portals include the ability to review information related to taxes and government services. Twenty-one percent (21%) of the sites allowed downloading forms and other documents (mostly in PDF format). Six states (18%) have at least one complete transaction (e.g., allowing payment and delivery of the product/service online). Regarding portal organization, 34% of the Web pages have links to inside pages, mostly sites related to government. Thirty-one percent (31%) of the portals serve only as a main index. Twenty-five percent (25%) included an online catalogue of government services and procedures. Nine percent (9%) required passwords for users and registration was needed for accessing most of the portal services.

Openness can be thought of as a way to reduce corruption and was evaluated in this study. Fifty percent (50%) of the state portals do not have adequate information, but most of them include laws, regulations, and services. Important information like payment roles or directories was not available. Only seven states (22%) have a directory and five of them (15%) provide information that is more complete. Some examples of states with better information related to openness and transparency are Guanajuato, Sonora, and the Federal District. Customization is another interesting factor. Sixty-nine percent (69%) of the Mexican state Web sites do not have any way to be personalized. Only four states (12%) have the capability to select a view according to different audiences (e.g., senior citizens, business, etc.). Veracruz is the only state that provides the possibility of changing the color of the Web pages.

Regarding design, 50% of the sites are well-designed and relatively easy to use. The best example of this is the portal of Sonora. Twenty-nine percent (29%) of the sites have a very complicated, and in some cases, chaotic structure and are very hard to navigate. One example of this situation is the state portal of Oaxaca with extraordinary pictures and excellent use of Flash technology, but relatively little information and a non-systematic structure. Seventy-two percent (72%) of the portals use

Table 3. Evolutionary approaches to e-government assessment: An overview of the states in Mexico (Source: Original Research by authors [January-February 2005])

E-Government Stage	Mexican State	Comments
Presence	**High Level** Oaxaca & Yucatan (6 points) **Medium Level**: Nayarit, Zacatecas **Low Level**: Quintana Roo, San Luis Potosí y Sinaloa, Coahuila, Guerrero y Veracruz.	▪ Limited government information ▪ Few Web pages developed by single agencies ▪ Static information about government structure and services
Information	**High Level** (6 points) Baja California , Colima, Estado de México, Hidalgo, Jalisco, Michoacán, Morelos, Nuevo León, Sonora, Tabasco, Tamaulipas **Medium Level** (5p): Chiapas; Distrito Federal (DF) ; Puebla & Tlaxcala	▪ Greater number of Web pages ▪ Statewide portal as the entry point with links to most of the state pages ▪ More dynamic information (frequent updates).
Interaction	**High Level** 6 points: Sonora **Medium Level** 4 points: Chiapas & Estado de México	▪ Forms that can be downloaded ▪ Two-way communication through electronic mail ▪ Use of search engines ▪ Use of chats, forums or other forms of interactive communication (service related) ▪ Some customization (citizen's profiles, use of passwords)
Transaction	**Medium Level** (4 points) Baja California Estado de México; Nuevo León; Querétaro; Sonora; Tabasco; Tamaulipas & Yucatán	▪ On-line services (secure and completely online), including electronic payments (e.g., credit cards). ▪ More customization (use of passwords, citizen's profiles, etc.) ▪ Portal organized according to people's needs instead of government structures.
Integration	**High Level** 6 points: Estado de México. **Medium Level** 4-5 points: Chiapas, Chihuahua, Durango and Michoacan	▪ Services portal with a single point of checkout (multiple agencies, same function, and different levels of government). ▪ Services portal with a single point of checkout (multiple agencies, different functions, same level of government). ▪ Services portal with a single point of checkout (multiple agencies, different functions, different levels of government).
Political Participation	**Low Level** (1 point) Chiapas; Estado de México; Querétaro; Sinaloa; Sonora.	▪ Online opinion about new bills or laws ▪ Online Public debate with ministers ▪ Electronic vote for or against bills ▪ Electronic vote for promoting public ideas

only HTML and flash presentations. Only one state uses window server, PHP, and HTML. Three states use windows server or a combination of PHP and Apache servers. Two good examples are Sonora and Nuevo Leon. Finally, eighty-four percent (84%) are focused on the public, and 12% on government personnel.

Table 3 shows the correspondence between state portals and characteristics of different evolutionary stages. Results are divided into three categories: (1) high level, these are states that receive the highest possible score (6 points) in a category; (2) medium level, are states that received a medium score (5-4 points) in a category; and (3) low level, includes states that received 3 points or less. From this table, it is evident that characteristics of different stages can be present in a single state portal. The assumption that evolutionary stages are progressive and mutually exclusive seems not to be true empirically, at least for the case of Mexico.

Regarding the stage of political participation, no state portal received more than one point in our scale. It seems that states in Mexico are not trying to engage citizens politically through their official Web sites. Again, there is no evidence for a truly stage-oriented e-government. In fact, there are some states that combine characteristics of early and advanced stages. This is not consistent with the evolutionary stance. For the evolutionary perspective, each stage is represented by certain characteristics and these characteristics are expected to be found together. In this way, researchers can assess in which stage an e-government initiative (e.g., a state portal) currently falls. As mentioned early, this is not necessarily evident for the case of Mexican state portals.

According to the measures used in this study, the state portals that received the greatest scores (19-21 points) are Estado de México, Sonora, and Yucatán. Chiapas, Querétaro, Tabasco, Tamaulipas, and Nuevo León followed with a score between 15 and 16 points. Campeche, Colima, Hidalgo, Sinaloa, Veracruz, Coahuila, Michoacán, Puebla, Baja California, Chihuahua, Jalisco, and Tlaxcala received between 11 and 14 points. The rest of the state portals have scores below 11 points. The more points they get means that they are in a more advanced stage within the evolution of e-government. However, as mentioned before, the evolutionary approach has several limitations and should be complemented with other perspectives.

FUTURE TRENDS

There are three main trends in the Mexican government portals. First, there is a trend toward the improvement of online services. Currently, the great majority of state portals do not offer complete services and credit card transactions online, but they are increasingly adding these features. In the near future, these services will be completed entirely over the Internet and without any type of human support. The second trend is related to the first one and refers to the increasing improvement of security. Enhanced security will ensure citizens' privacy and confidentiality. One way to start improving security is the use of passwords and vertical systems to integrate one ID number for multiple transactions by the same citizen.

The third trend is to expand government openness and citizens' ability to search for a variety of information—taxes, government payroll, investments—that promotes freedom and avoids corruption inside government agencies. Openness should not be considered a fashion, but a technological and managerial need to guarantee government efficiency and effectiveness. In the end, another trend could be a highly functional e-democracy that is considered the final outcome of a democratic electronic government. In this scenario, citizens should not only be able to search information or perform transactional services, but also give opinions about public affairs, vote online, and democratically participate in government decision-making.

CONCLUSION

This article provides a useful way to assess e-government portals. This assessment is sensitive to differences in context and rich in quantitative and qualitative information. This methodology recognizes that what is considered a stage does not necessarily follow a linear progression (Moon, 2002). In addition, a state portal is not a homogeneous entity and can have characteristics of several stages. The purpose of this type of research should not only be to classify Web sites in different stages; but also to provide a better understanding of the quality and functionality of the state portals, as well as some practical suggestions about how to improve the current situation.

Mexican state portals are in the initial stages of electronic government. They provide information online but very few offer complete services. In addition, there is not enough information available for citizens. Information is mostly about government structures and services, and there is little information related to accountability. Very few state portals allow customization or have versions in other languages. The differences between states are enormous. Some are attempting to have a better presence and more current information, while others are providing several transactions or even integrating some of their services. Political, institutional, organizational, and economic factors may explain a proportion of these differences (Gil-Garcia, 2005), and future studies must build causal models to understand the relative impact of different factors.

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KEY TERMS

Citizen-Centered Approach to E-Government: A way to study e-government that emphasizes the social and political nature of the relationships between citizens and government and conceptualizes citizens as the most important stakeholder of e-government initiatives.

Customization: Fundamental characteristic of a Web site regarding personalization of information or tailoring special requirements from a specific user.

E-Government: Electronic government is the use of information technologies (IT) to improve and facilitate citizens' relationships with government through democratic procedures, cost-effective transactions, and efficient regulations, all of which enhance these relationships.

Evolutionary Approach to E-Government: A way to study e-government that identifies different stages as the right path for e-government evolution.

Managerial Approach to E-Government: A way to study e-government that emphasizes administrative processes, efficiency and effectiveness as the most important goals of e-government initiatives.

Openness: A measure of the freedom to search, collect, and exchange governmental information related to public services or to the bureaucratic structure.

State Portal: Vertical Web site where information refers mostly to the information of a national, state or local entity.

ENDNOTE

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E-Government Services Framework

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INTRODUCTION

E-government generally refers to the delivery of national or local government information and services via the Internet or other digital means (Relyea, 2002). E-government refers to the ability of government to interact electronically with citizens, businesses, and other governmental entities. The interaction may be in the form of obtaining information, filings, or making payments, and a host of other activities via the World Wide Web (Abramson & Means, 2001; Bertucci, 2003; Sharma, 2004; Sharma & Gupta, 2002).

The benefits of e-government usually include improved: quality of citizen services, internal efficiencies, law enforcement, education and information, promotion and outreach activities, safety and security, health care services and management, and involvement of citizens in the democratic process. Many believe that e-government can provide seamless services to draw agencies together, leading to more citizen-centric services (Grönlund, 2002; Gurstein, 2000; Venkatachalam, Shore, & Sharma, 2003). Many countries have decided to employ information and communication technologies (ICTs) to enhance delivery of government services to their citizens, and are thus at various stages of e-government implementation (Ho, 2002; Holliday, 2002; Layne & Lee, 2001; Netchaeva, 2002; United Nations & American Society for Public Administration, 2002; Sharma, 2004; Sharma & Gupta, 2002, 2003; Taylor, 2002). After examining studies conducted by various researchers on e-government models and frameworks, this article presents a holistic approach to create an e-government framework.

BACKGROUND

Virtually all developed and other OECD nations have launched comprehensive and challenging e-government initiatives and all levels of governments are increasingly using the Internet as another way to deliver information and services to citizens (Fletcher, 2002). E-government constitutes the way public sector institutions use technology to apply public administration principles and conduct the business of government (Riley, 2003a, 2003b; Riley & Riley, 2003). There are several models that attempt to explain the way in which e-government has evolved or is evolving. The first step into the e-government (or online government) world is a basic Web presence. Accenture (2003) describes three levels of online delivery capability before the final stage of service transformation (Ho, 2002; Sharma, 2004; Sharma & Gupta, 2003; UN, 2002; UNDESA, 2003).

Various authors have described four to six stages of e-government implementation (Layne & Lee 2001; Moon, 2002; Netchaeva, 2002; Sharma & Gupta, 2003; Silcock, 2001: United Nations & American Society for Public Administration, 2002) but all of them show the development of e-government services as an evolutionary process. For example, Silcock (2001) describes six stages which she characterizes as dynamic; these include: information publishing/dissemination, official two-way transaction, multipurpose portals, portal personalization, clustering of common services, and full integration and enterprise transformation. Netchaeva (2002) describes more or less similar stages without giving them specific terms, but she condenses them to five stages, whereas the UN (2002) categorizes five stages as: emerging, enhanced, interactive, transactional, and seamless (fully integrated). Layne and Lee (2001) proposed a four-stage growth model for e-government development: cataloguing, transaction, vertical integration, and horizontal integration. The cataloguing stage is the one in which governments establish an online presence. The Web site is usually one in which government information is made available. In the second stage, transaction, government customers are permitted to enter into transactions online, such as paying license fees and fines. The third stage, vertical integration, is one in which local, state, and federal agencies engaged in fulfilling the same customer need, or function, are linked together so as to form a seamless service. In the final stage of their model, horizontal integration is applied to break down the boundaries between functional silos within government.

Moon proposed a five-stage model, with stages named: information dissemination/cataloguing, two-way communication, service and financial transactions, vertical and horizontal integration, and political participation. Moon's stages one and two are extensions of Layne and Lee's stage one. His stage three is Layne and Lee's transaction stage. The two stages of vertical integration and horizontal integration that Layne and Lee had in their model have been concatenated into one stage by Moon. Moon has a fifth stage that recognizes the political dimension of e-government.

Sharma and Gupta's e-government framework not only includes the stages of growth model like Layne and Lee, but also contains supporting structures that are needed to achieve e-government stages and the delivery channels of e-government (Sharma & Gupta, 2003).

AN E-GOVERNMENT FRAMEWORK

Implementing a comprehensive e-government framework is a challenging task, as it requires many agencies, departments, and policy makers to coordinate their efforts, in addition to preparing the technology and support infrastructure; the soft infrastructure which includes the laws, rules, and regulations that must be changed in order to facilitate the development of both the new infrastructure and information services (Detlor & Finn, 2002; Kaaya, 2003). The previously described e-government's frameworks or models only describe the "supply side" of an e-government framework. These frameworks could be helpful to measure the presence and delivery of government service through the Internet or other digital means, however, these frameworks do not provide any indicator to measure the quality of service, the amount of citizens' engagement and participation, and use of service (West, 2001; Economic and Social Commission for Western Asia (ESCWA), 2003; European Commission/CGE&Y Study, 2002; United Nations & American Society for Public Administration, 2001). The philosophy of e-government should result in citizen-cantered and demand-oriented online service delivery (La Porte, Demchak, & de Jong, 2002; LaVigne, Simon, Dawes, Pardo, & Berlin, 2002; Zweers, & Planqué, 2001). Our proposed framework, as shown in Figure 1, is more holistic in nature and addresses both the demand and supply side of e-government implementation.

Back End Systems

Back end systems consisting of legacy data applications, ERP, workflow system, document management systems, and other data management systems. This part of the framework suggests that whatever the stage of e-government, it requires a massive integration of data that is spread across many government agencies. Many document technologies like imaging document management and workflow technologies, ERP systems, e-mail, and groupware systems are integrated to achieve structure and efficiency for data management (Dawes & Pardo, 2002; Knapp & Sanders, 2000). It also suggests that the integration of data may also result in much reengineering of various government processes (Sharma, 2004; Sharma & Gupta, 2003).

The Supply Side

The supply side stages of e-government evolution are well addressed by most of the researchers whereby the evolution is usually depicted as a four-stage process. These stages are: presence, interaction, transaction, and transformation as illustrated in Figure 1 (Sharma, 2004; Sharma & Gupta, 2003).

The Demand Side

The demand side of the framework describes customers' (including citizens, businesses, government, and employees) access to online government services through multiple channels. Including this in the framework ensures that e-government addresses the need for a critical mass of manpower, knowledge, and skills sufficient to support an e-governance strategy. Unless citizens are trained and have requisite skills to participate in e-governance, citizens' participation, and engagement would be a difficult task for evolving electronic democracy (O'Siochru & Constanza-hock, 2003; Sharma & Gupta, 2003; Surman & Reilly, 2003; Watson & Mundy, 2001).

The framework for e-government is incomplete if it is not supported with a required legal and regulatory infrastructure. The support infrastructure includes an integrated network of banks and financial institutions to serve as an automatic clearing house and a legal and regulatory structure to support payments online and protect privacy. Security must be a top priority during the creation of a support infrastructure for an e-government (Cresswell & Pardo, 2001).

FUTURE TRENDS

The contemporary literature on e-government shows that while most governments worldwide have a presence on the Web and are at least at the beginning stages of e-government development, few of them offer sophisticated online services involving interactive transactions (Gant, 2004; Garson, 2004; Sharma, 2004). E-government is rapidly moving to its full potential of e-governance and e-democracy (United Nations & American Society for Public Administration, 2002; UNPAN, 2002). E-government will ultimately lead towards direct democracy. Direct democracy means direct vote of all (interested) citizens on all important issues. Each vote should be preceded by a wide discussion and self-education of the citizens on the issue(s) to be decided. This would require unrestricted access of all citizens to information (Stowers, 2004). This form of democracy is going to be different from the present form of representative democracy. This would create a tremendous challenge to upkeep technological infrastructure, as well as to develop real time based response systems. Government needs to prepare a plan how businesses of government at every level, from parish to Parliament, will be announced in a way that makes it accessible to anyone interested (Rocheleau, 2003). Voter education and campaign information are therefore significant issues in relation to direct democracy. Presently, there is a lack of diverse and effective tools for building awareness and advocacy efforts around e-government development and specifically around the use of e-government for deepening democracy in the world (LaVigne, 2002). Government also needs to devise systems for handling privacy concerns (Hiller & Bélanger, 2001).

CONCLUSION

The current research on e-government briefly outlined above, shows that ICT and Internet technologies are increasingly moving into a civil societal domain which is multidimensional and requires new forms of research, management, and learning. Since the mid 1990s, governments around the world have made extraordinary efforts to provide services and information over the Web. E-government implementations have improved service delivery and offer greater transparency and accountability in governance systems (Fletcher, 2004).

The first wave of e-government implementation has focused primarily on the supply side. However, e-government frameworks should consider both demand and supply side to understand the requirements for total e-government implementation. Essentially, e-government implementation should simplify service delivery to citizens; eliminate layers of government management; create easier access to information and services for citizens, businesses and government employees. E-government must establish a new decision-making mechanism that involves all of the stakeholders (Holden, Norris, & Fletcher, 2003; Pavlichev & Garson, 2003).

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KEY TERMS

Digital Government: Digital government has different possible definitions, from online services to any use of ICTs in the public. In general terms, digital government refers to the use of ICTs in government for at least three purposes: providing public services, improving managerial effectiveness, and promoting democracy.

E-Democracy: E-democracy is whereby e-government is involved in the development of direct forms of political deliberation and decision-making through electronic referendums and similar devices.

E-Governance: E-governance refers to a much broader range of issues and relationships around the impact of the Internet on political life at all levels, not just the level of states and their bureaucracies. E-governance is a broader concept, which includes the use of ICT by government and civil society to promote greater participation of citizens in the governance of political institutions.

E-Government: E-government refers to any government functions or processes that are carried out in digital form over the Internet. E-government refers to the use by government agencies of information technologies (such as Wide Area Networks, the Internet, and mobile computing) that have the ability to transform relations with citizens, businesses, and other arms of government.

E-Policy: E-policy represents the policy formulation and legal function of government. E-policy does not refer only to the use of ICTs in government settings, but also to the leading role of government in promoting the information society through an adequate regulatory framework.

E-Services: E-services refer to the provision of services using ICTs, especially the Internet and the World Wide Web.

Information Privacy: Is the interest an individual has in controlling, or at least significantly influencing, the handling of data about themselves.

Privacy: Privacy is the interest that individuals have in sustaining a "personal space", free from interference by other people and organizations.

E-Health Dot-Coms' Critical Success Factors

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BACKGROUND OF THE BUSINESSES

The increasing use of the Internet by consumers gave rise to an information boom to health-care consumers. Not only could the Internet be used as a communication tool to provide information that would allow patients to make informed decisions, but it could also be used to generate revenue for investors. The dot-com boom of the late 1990s exploited this opportunity, targeting the health-care system, a $1.7 trillion market in the United States alone. Overall, the health-care system is wasteful and costly (Itagaki, Berlin, & Schatz, 2002), and as a result, health-care IT was touted as the magic pill for cutting costs. The Internet boom of the late 1990s saw the emergence of e-health: the delivery of health services and health information through the Internet and Internet-related technologies (Eysenbach, 2001). Leading the many entrepreneurs and venture capitalists who stepped in to seize a piece of the health-care industry cake were WebMD Corp., an online provider of medical information for doctors and consumers in Elmwood Park, New Jersey, and DrKoop.com, an Austin, Texas-born company that later moved to Santa Monica, California, and began doing business as Dr. Koop LifeCare Corp.

Dr. C. Everett Koop, the former U.S. surgeon general, had spent over 6 decades in the medical profession. He envisioned the Internet as an opportunity to change the health-care delivery system in order to empower individuals to take charge of their own health care (Musselwhite, 2002). With this vision and his reputation as an advocate for health-care reform, along with the help of two budding entrepreneurs, Don Hackett and John Zacarro, the trio opened a business-to-consumer Internet portal: DrKoop.com. The portal was designed to provide health information to consumers in areas such as chronic illness, food and nutrition, fitness, and medical breakthroughs. At the beginning, the Web site was an overwhelming success, receiving a million hits per month after 2 years of operation, and about 4 million unique visitors per month at its peak. The portal included a personal medical-records system that facilitated the cross-referencing of medications for interactions, as well as the storage of medical reports that could then be accessed by both patients and physicians.

DrKoop.com's public woes began in February 2000 when its auditor, PricewaterhouseCoopers, issued a "going concern qualification," an ominous warning that highlighted the precarious financial situation the Internet-based health service was in Cleary (2000). By the end of 2000, DrKoop.com was still struggling, and in the first 9 months of 2001 alone, the company's losses were nearly 3 times its revenue. According to the Securities and Exchange Commision (SEC) filings, from January 1999 until the service's liquidation in September 2001, DrKoop.com's losses stood at $193.6 million, dwarfing the $41 million revenue generated during the period. At the site's peak in July 1999, DrKoop.com's stock rose to $45.75 per share on the NASDAQ, but was worth $0.12 at the time of bankruptcy filing. In July 2002, Vitacost.com, a privately held online seller of nutritional supplements, paid a paltry $186,000 in cash for DrKoop.com's assets, which included the brand name, trademarks, domain names, the Web site, and the e-mail addresses of its registered users.

WebMD, originally called Healtheon/WebMD, was founded by Jim Clark, who also founded Silicon Graphics and Netscape. Clark's vision was to connect insurance companies, doctors, and patients over the Internet in order to lower costs and reduce paper trails. Rather than building its own products and services, Healtheon used its highly valued stock to finance acquisitions of leading companies in the industries it targeted. In 1999, it acquired WebMD.com and OnHealth, both leading health portals, giving it access to the consumer health market (Salkever, 2000). Though WebMD lost $6.5 billion on revenue of $530.2 million in the first 9 months of 2001, it still continued to expand long after DrKoop.com had dropped off the radar screen. For the fiscal year ending in December 2003, WebMD reported revenues of $964 million, an increase of 10.6% on the previous year's revenues, which totaled $871.7 million. Of the 11 health-care mergers and acquisition deals in the first 7 months of 2004, valued at $900 million, WebMD was the leading acquirer (Abrams, 2004). Two of WebMD's high-profile acquisitions in 2004 were the $160 million cash purchase of ViPS, a privately held provider in Baltimore, Maryland, of information technology to the government, Blue Cross-Blue Shield, and other health-care insurers; and the $40 million acquisition of Dakota Imaging Inc., a private company in Columbia, Maryland, that offered automated health-care claims processing technology.

As industry leaders, WebMD and DrKoop.com faced competition from both health-care information portals (such as HealthGrades.com, MDConsult, ZoeMed.com) and online pharmacies that provided consumers with one-stop shopping for medications and medical information (Walgreens.com, drugstore.com, Webvan.com). The threat from the health-care information portals, nevertheless, was minimal due to their limited brand recognition and information coverage. In the online pharmacy sector, however, Walgreens.com gained a substantial market share by combining the best of both worlds: complementing its physical stores located throughout the country by offering online customer service, convenience, and real-time access to a health library that provided comprehensive information on prescription drugs, insurance, and health issues.

DESCRIPTION OF THE BUSINESSES

Products and Services

DrKoop.com's vision for its online venture was a Web-based health-care information portal on which individuals and their doctors could have one-stop access to personal medical records, prescription history, medical exam results, and general health-care information (Itagaki et al., 2002; Musselwhite, 2002). According to Musselwhite, the venture's marketing strategy was to differentiate itself as "the premier healthcare information website," and would accomplish this via the four *C*s: content (which would be the driver), community (bringing people together to discuss issues pertaining to health), cool tools (such as Drug Checker), and commerce (enabling people to purchase drugs online from strategic e-commerce partners such as Drug Emporium) (p. 6). In order to generate revenue, DrKoop.com sold advertising rights to health-care-related companies that would pitch sales and promote their products to the portal's users and communities. Unfortunately, DrKoop.com failed to implement checks and controls on advertising, and some of the companies began making promotional claims that were not always substantiated.

WebMD's products and services, on the other hand, were more diversified with the overall objective of facilitating information exchange, communication, and transactions between consumers, physicians, and health-care institutions. Through a series of mergers and acquisitions, WebMD was able to offer a wide variety of health-related products and services, including health-care information to consumers and physicians, billing and transaction processing for physician practices and hospitals, and handheld services (Itagaki et al., 2002).

Management and Business Models

DrKoop.com was plagued with management problems from the start. None of the founders had business experience, but with less than $1 million of lifetime revenue, DrKoop.com still raised $84.4 million in its initial public offering (IPO). The company swelled from a handful of employees to 200 after the IPO, and an 80,000-square-foot office was acquired in a long-term lease. At a time when competition was fierce, advertising revenue alone could not support operational expenses, but the corporation continued its free-spending practices. Employees' in-house massages cost $9,000 per month, and free, catered Friday lunches cost $15,000 each week, contributing to a monthly burn rate of $7 million (Hawkins, 2001). The company signed a 3-year, $58 million agreement with Disney's Go Network to be the exclusive provider of health-care information on that network (Musselwhite, 2002). This was later followed by a 4-year agreement with AOL for a whopping $89 million to be featured on the AOL Web site, a sum that surpassed the IPO capitalization. Such evidence of capital mismanagement sent the wrong signals to investors, who began to question the viability of DrKoop.com. The business model envisioned by the company—a health-care information portal whose content would attract users, and in which advertisers would be attracted to the users—soon began to crack. By April of 2000, DrKoop.com was trailing its two major rivals in visitors per month and was spiraling into the dot-com abyss. In July, two class-action lawsuits were filed against management alleging the withholding of financial information for the purpose of inflating its stock price. The lawsuit was bolstered by other questionable actions by executives, including the selling of shares before the end of a 6-month holding period, which gave the impression of insider profiteering. Subsequently, two top executives, the chief operations officer and the chief financial officer, were forced to resign. In August, the stock fell below $1 a share and the downward trend never reversed. Public trust and investor goodwill on DrKoop.com were dealt a final blow with more reports of unethical practices. The company had received revenue from a pharmaceutical firm for referring patients for clinical trials, undisclosed commissions were received on health products and services sold through the Web site, and companies had paid money to be listed exclusively in some sections of the Web site, thus misleading customers (Noble, 1999).

Unlike DrKoop.com, WebMD adopted a comprehensive business model, targeting both consumers and providers across multiple industry segments. WebMD began a multibillion-dollar shopping binge from the start, acquiring several firms specializing in medical-related ventures such as electronic medical-claims processing, medical software, medical information, charge capture, physician practice management, and so forth. As the company's financial report shows (see Table 1), revenues from all areas were growing at a healthy pace. WebMD's revenues were expected to top $1 billion in 2004, and after several years of systematic cost cutting, operating earnings were expected to rise to at least $150 million (Tsao, 2004). The strength, weakness, opportunigy, threat (SWOT) analysis from Datamonitor (WebMD Corporation, 2004; see Table 2) indicates a favorable competitive environment for WebMD's continued growth. Using the value proposition framework (Crossan, Fry, & Killing, 2002), the goals, product market focus, core activities, and value propositions of both WebMD and DrKoop.com are compared in Figure 1. Compared to Dr.Koop.com, WebMD has more diversified product market focus and core activities. As a result, WebMD has been able to achieve more enhanced and sustainable value propositions.

LESSONS LEARNED

Apart from the irrational exuberance exhibited by investors, the success or failure of dot-coms can be attributed to other factors. Itagaki et al. (2002) identified four critical factors that predict the success or failure of e-health companies: a compelling value, an unambiguous revenue model, competitive barriers to entry, and the organizational structure for cost control. These factors can be matched to the traits described by Walters (2002): the "lots of money, but no vision" dilemma; the "business-as-a-website" approach; the burn rate; and the speed trap. The following sections discuss how these critical factors played out in the cases of WebMD and DrKoop.com, and the lessons that can be learned.

A Compelling Value or Vision: In the end, both WebMD and DrKoop.com succeeded in providing valuable, easy-to-understand, and useful health-care information to patients and physicians. However, DrKoop.com began to deviate from the original vision and mission, focusing on internal growth and fast-tracking to the IPO without adequate planning for the aftermath, a trap that befell many of the dot-coms that are now virtually extinct. WebMD developed a clear vision (to be a comprehensive e-health provider) and stuck to it, focusing on diversifying assets in order to augment its value. As of July 2004, WebMD Health provided the content for two of DrKoop.com's high-profile customers, the health channels for MSN and America Online, and had teamed up with the federal government to make consumer health information more widely available via the Department of Health and Human Services (HHS) channel on the WebMD Health portal (Henkel, 2004).

Table 1. Financial overview of WebMD (Source: Company Reports)

Financial Overview, WebMD
2003 vs. 2002
(in millions of $ dollars)

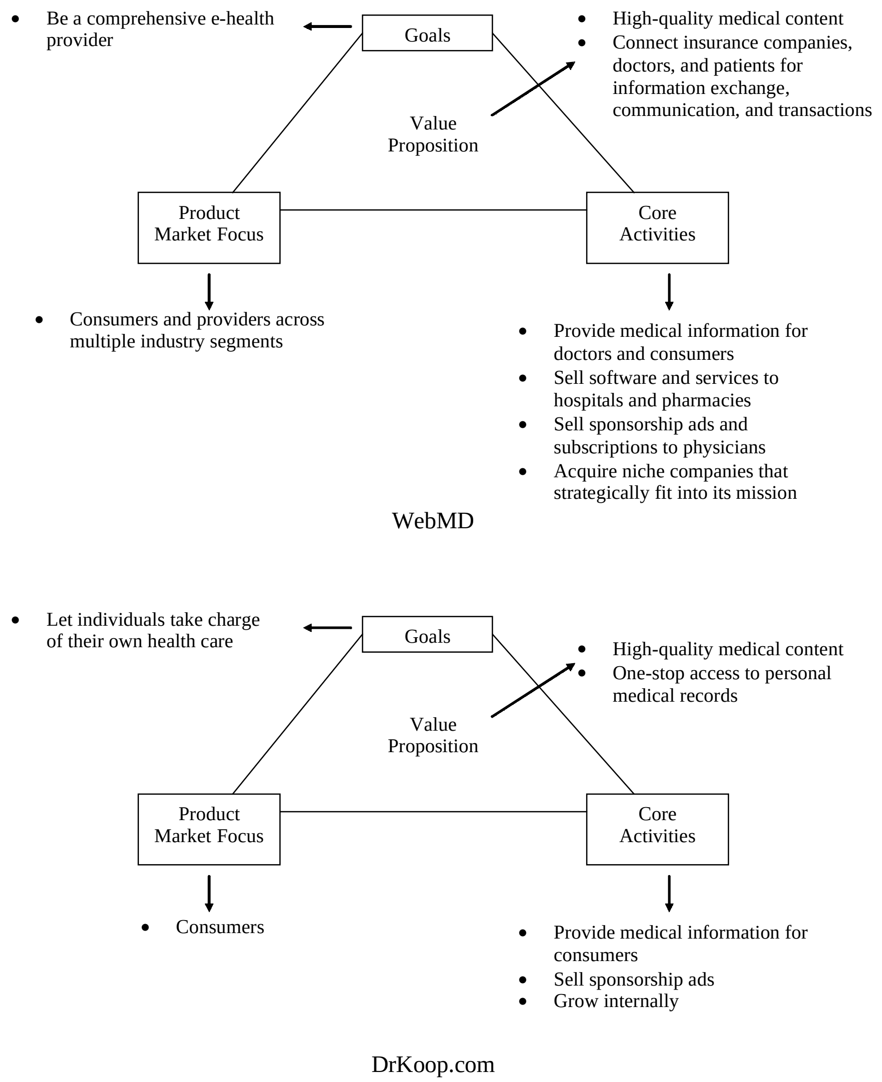
	2003	2002	Change
Transaction services	$505.7	$466.8	8.3%
Physician services	302.6	275.3	9.9%
Portal services	110.7	84.3	31.3%
Plastic Technologies	71.9	65.8	9.3%
Adjustment	-27.0	-20.5	31.5%
Revenues	$963.9	$871.7	10.6%
Net Income	$17.0	$49.7	NA

Source: Company Reports

Table 2. SWOT analysis of WebMD (Source: WebMD Corporation, 2004)

Strengths	Weaknesses
• Large footfall • Growing financial strength • Aggressive acquisition strategy	• Large restructuring charges • Acquisition-driven strategy • Investors unsure of strategy
Opportunities	**Threats**
• Shed unprofitable alliances • Drive core strength and diversify • Excess cash to pursue acquisition • Self-directed health-plan market	• Low demand from practitioners • Increasingly innovative competitors • Power shift in the market

Figure 1. Value proposition frameworks for WebMD and DrKoop.com



The lesson here is that instead of quickly rushing to the IPO, companies should first have a clear vision of where they want to be, a long-term strategy on how to get there, and the realization that agility is the key to survival in the fluid e-commerce marketplace. DrKoop.com lacked a long-term strategy and was forced to take poorly calculated risks. As a result, the stock price plummeted, massive layoffs soon followed, and in a desperate move to save the sinking ship, the company began engaging in questionable practices.

An Unambiguous Revenue Model and Avoiding the Business-as-Web-Site Approach: DrKoop.com built a technology infrastructure that relied heavily on an unproven revenue model and did not have alternative strategies for generating revenue. As a result, expenses soared and, with increased competition, Web-site traffic declined. WebMD, on the other hand, aggressively diversified its revenue sources via strategic mergers and acquisitions of firms in health-related industries. Consequently, WebMD began generating most of its revenue from the sale of software and services to hospitals and pharmacies (Bulkeley, 2003).

The lesson here is that companies should have a viable plan and alternative sources of revenue instead of putting all their eggs in one basket. WebMD's growth from a health-information portal to a comprehensive e-health site enabled the company to effectively deter the threat from substitute products and services. By expanding its offerings to both patients and physicians, and aggressively seeking business opportunities that are in sync with its corporate strategy, WebMD continues to thrive in the volatile e-commerce marketplace.

Competitive Barriers to Entry and Avoiding the Speed Trap: Both WebMD and DrKoop.com were able to create high-quality medical content, utilizing experts to ensure that the information was accurate. DrKoop.com went a step further by branding itself using the identity of a prominent physician. However, by aggressively pursuing a getting-to-market-first approach, DrKoop.com was lean on contingency planning and was thus not able to deal with the shocks that soon followed, such as the droughts of funding and declining customer demand fueled by competition. WebMD, however, was favored by economies of scale: Its large size and comprehensive services made it a dominant force and, in essence, was an entry barrier to competitors. By focusing on expansion, capturing new markets, and buying niche companies that strategically fit into its mission, the company was able to shield itself from competition and market downturns.

The lesson from this is that companies should be alert and ready to adapt to change, or perish. WebMD expanded its base by building relationships with its customers (physicians and general-health-information consumers), industry partners, and the government. Even though fast market penetration has competitive advantages, companies should also exercise patience, ensuring they have a solid and well-tested business model and contingency plan before they set sail into the expanse of the e-commerce market. Competitors who wait and take advantage of the new and improved technologies and business processes often surpass first movers in this dynamic technical and business environment. Marketing gurus emphasize the importance of capitalizing on the first-to-market advantage, but the history of e-commerce has taught us that competitive advantages created by IT were often unsustainable and could be easily duplicated by competitors (Porter, 2001).

Organizational Structure for Cost Control and Controlling the Burn Rate: Cost control was the nemesis of many dot-coms, including WebMD and DrKoop.com. The pay-per-click revenue model was fragile and unpredictable. Companies that did not have alternative revenue sources soon realized that their expenses could not be met. Within the first 6 months following the IPO, DrKoop.com spent $50 million while raising revenues of only $8 million. DrKoop.com's extravagance, with little consideration for earning a profit, further contributed to its demise. WebMD's struggle with cost control was complicated by the arduous task of harmonizing operations among the many business units it owns, but it had accumulated cash reserves that have enabled it to grow.

The lesson here is that management should not abuse its investors' trust by spending irresponsibly. Costs should be controlled and, in essence, aligned to revenues so that expenses do not spiral out of control. The surviving e-businesses spent funds wisely because they recognized that in the e-marketplace, the bargaining power of customers is very strong and demand is ever changing.

The dot-com boom was short lived, and following the bubble burst, many of the dot-coms never recovered. For a time, DrKoop.com seemed to defy the odds, but eventually it succumbed as well. WebMD managed to ride the tide and is now on its way to profitability. In this article, we have explored the factors that were critical to the failure and success of DrKoop.com and WebMD, respectively, and discussed some of the lessons learned. As can be gleaned from the demise of DrKoop.com and the continuing growth of WebMD, success in Internet commerce cannot be realized without a compelling value and vision, a clear-cut and effective revenue-generating strategy, cohesive and effective organization, and a cost-control system. Profit is not the goal but the requisite for any business, thus any dollars spent for creating and keeping customers should be measured and tracked against incremental revenue. Executives must watch the cash flow, income, and loss statements closely, and make changes where necessary to ensure that unnecessary expenses are curbed.

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KEY TERMS

Business-to-Consumer (B2C): An e-commerce business model that facilitates transactions between a company and a consumer, as opposed to a transaction between companies (called B2B) or a transaction between consumers (C2C).

E-Business: Any financial or non-financial transaction involving an electronic process using the Internet or Internet technologies e.g. creating a map with directions on Mapquest.com.

E-Commerce (electronic commerce): The buying and selling of products and services by businesses and consumers over the Internet. E-commerce involves a direct financial transaction in the electronic process using Internet technologies. E-commerce encompasses business-to-business or B2B (Cisco), business-to-consumer or B2C (Amazon.com), and consumer-to-consumer or C2C (eBay).

E-Health: The use of emerging technologies, especially the Internet, to improve or enable health and healthcare-related services. The Journal of Medical Internet Research defines e-health as "an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies" (Eysenbach, 2001).

Handheld Services: The use of hand-held devices, such as Personal Digital Assistants (PDAs) and Pocket PCs, as an extension of workstation resources through the use of client/server based software for access and synchronization in conjunction with wireless access service provider. Handheld services are used for electronic prescribing, real-time drug references, scheduling, charge capture, etc.

Pay-per-Click: A search engine advertising strategy that allows for companies to bid for a website ranking based on the price they are willing to pay per click-through (when a visitor clicks on a Web ad as a result of keywords used when performing the search, e.g. on Google.com). The client chooses the keywords to appear on his website when a search is performed.

Portal: An electronic environment that provides a secure, single point of interaction with diverse information, business processes, and people, personalized to a user's needs and responsibilities. Examples of web portals include About.com, MSN, and Yahoo.

E-Health Security and Privacy

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INTRODUCTION

The widespread and fast-developing information technologies, especially wireless communications and the Internet, have allowed for the realization of greater automation systems than ever in health-care industries: E-health has become an apparent trend, and having a clinic at home or even anywhere at anytime is no longer a dream.

E-health, including telemedicine featured by conducting health-care transactions over the Internet, has been revolutionizing the well-being of human society. Traditionally, common practices in the health-care industry place tremendous burdens on both patients and health-care providers, with heavy loads of paper-based documents and inefficient communications through mail or phone calls. The transmission of medical data is even messy for cases in which patients have to transfer between different health providers. In addition, the medical documents prepared manually are prone to errors and delays, which may lead to serious consequences. The time, energy, and resources wasted in such processes are intolerable and unimaginable in any fast-paced society. For these problems, e-health provides powerful solutions to share and exchange information over the Internet in a timely, easy, and safe manner (Balas et al., 1997).

Incorporating fast and cost-efficient Internet and wireless communication techniques has enabled the substantial development of e-health. The use of the Internet to transmit sensitive medical data, however, leaves the door open to the threats of information misuse either accidentally or maliciously. Health-care industries need be extremely cautious in handling and delivering electronic patient records using computer networks due to the high vulnerabilities of such information. To this extent, security and privacy issues become two of the biggest concerns in developing e-health infrastructures.

BACKGROUND

As early as 1987, Dr. Thomas Ferguson proposed online health care for consumers. In 1993, Dr. Ferguson, together with several other pioneers, initiated the first national conference on e-health (Nelson & Ball, 2004). The efforts laid the very foundation for the early development of e-health. However, e-health did not make a big step until the late 1990s, mainly due to the technical difficulties and high infrastructure cost. The striking development of information technology, particularly that of the computer, Internet, and wireless communications, dramatizes the reemergence of e-business and e-health (Collen, 1999). Thus, significant improvements to a new health-care infrastructure are anticipated so that health care can take place in a ubiquitous and security-assured manner.

The Internet as a fast, open, and cost-efficient way of exchanging information still faces the big challenge of protecting medical information security and privacy. The information transmitted through the Internet could be accessed, altered, deleted, or copied illegally, jeopardizing the patients' security and privacy. The security issues of e-health, in general, represented by all the precautions taken when safely accessing, collecting, and transferring the health information, must be addressed. In fact, the exchange of health information can be made more secure than in a paper-based system when carefully designed with proper security technologies. Information privacy is controlling whether and how personal data can be gathered, stored, processed, or selectively disseminated (Fischer-Hubner, 2001). Medical information may contain some of the most sensitive information about topics such as one's HIV (human immunodeficiency virus) status, emotional and psychiatric care, and abortions. Thus, the privacy of medical information needs to be especially safeguarded.

Ensuring security and privacy in e-health while preserving the fast transaction of medical data is, however, not an easy task. Security by itself is a complicated and tough task to accomplish in every sense, and there seems to be always a balance between the optimum efficiency and cost vs. maximized security (Fischer-Hubner, 2001). Security in e-business has being studied extensively, yet not a single system has been found to meet the requirements of all levels of protection. Healthcare systems need a higher level of protection because medical data are more sensitive and vulnerable to various misuses or attacks (Mac McMillan, 2002). When accessing medical data, possible errors and attacks could occur during the identification, authentication, and authorization processes. Potential threats and dangers incurred by the transmission of e-health data may come from computer viruses such as Trojan horses and droppers, and from intercepting threats such as masquerading, IP (Internet protocol) spoofing, misrouting, information modifying, and packet sniffing. General security mechanisms, which have been widely used at present, consist of the protection of individual servers and applications, firewalls, and secure data channels during transmission.

An early work conducted by the University of California, San Diego, and others in 1996, titled Patient Centered Access to Secure Systems Online (PCASSO), successfully developed a robust security architecture for Internet access (Baker & Masys, 1999). Since then, more efforts have been directed toward developing e-health security measures for virus protection, firewalls, authentication and access control, encryption, and so forth. Many businesses and research organizations have been developing and marketing their techniques and products, for example, ActiveCard Inc., MediTrust, National Health Key Corroborative, and so forth. Current technologies exploit smart cards, digital signatures, biometric devices, digital watermarking, public-key repository infrastructures, privacy-enhancing techniques, and so on (Ball, Chadwick, & Mundy, 2003; Cheng, Wang, & Tan, 2004). We believe that effective solutions to security and privacy in e-health must rely on a unified framework, with the deployment of wide-range security and privacy technologies from various vendors.

E-health security and privacy are challenging not only due to the difficulties of developing an error-free, complex framework, but also because of the complications of various moral and legal issues among all the stakeholders in the e-health industry such as the consumers, vendors, and health providers. To protect security and privacy in health care, governments around the world need to establish necessary regulatory standards. The Health Insurance Portability and Accountability Act (HIPPA) created in 1996 is a standard made by the U.S. federal government to provide the guidelines and policies that protect medical records. HIPAA presents both challenges and opportunities to improve the way in which medical data are acquired, exchanged, and distributed (Hippaadvisory, 2004). Meeting the challenges of HIPAA legislation requires a careful study of the legal infrastructure and a thorough understanding of the HIPAA evaluation process.

CONCEPTS AND REQUIREMENTS

Security in e-health is an integrated concept requiring the confidentiality, accountability, integrity, and availability of medical data. Confidentiality is ensuring that the data are inaccessible to unauthorized users. Accountability is the ability to trace back all the actions and changes made to the data, for example, through security logs used for recording log-ins, dates, accessed content, and changes. Integrity is preventing information from being modified by unauthorized users. Availability is ensuring the readiness of the information when needed. These four features are equally important and need to be satisfied simultaneously, and by working all together, they encompass the concept of security (Schneier, 2000; Stajano, 2002).

Security issues, in general, cover strategies in four different areas: (a) access security including user-authorization identification and management, (b) communication security related to the secure communication of messages, (c) content security including the protection of content such as data confidentiality, integrity, and availability, and (d) security management including security and vulnerability assessments, the implementation of policies, and guidance (Stajano, 2002; Van de Velde & Degoulet, 2003). To address the above issues, a solution to protecting the privacy and security of e-health needs to accomplish at least the following functions.

- Authentication, the process to validate the identity of the user
- Access control, the process to ensure that only authorized users see the authorized content or information
- Encryption, the process to prevent illegal access or use during data communication
- Intrusion detection and theft termination, the process to automatically detect and disable the devices if they are being accessed or attacked illegally

Privacy is the right of an individual to determine the disclosure and use of this personal data on principle at his or her discretion (Fischer-Hubner, 2001). In e-health applications over the open Internet, privacy may be seriously endangered without sufficient protection by privacy legislation and privacy-enhancing technologies

(PETs; Goldberg, Wagner, & Brewer, 1997). Besides the confidentiality and integrity of personal data considered by data security techniques, PETs need to protect user identities in terms of anonymity, pseudonymity, unlinkability, and unobservability, and also user identities in terms of the anonymity and pseudonymity of data subjects (Fischer-Hubner, 2001). PETs usually exploit encryption tools and access control, and can be enforced with security policies.

TECHNOLOGIES AND CHALLENGES

Security and privacy issues arise when accessing and communicating the health data. Basically, there are three steps for security after logging into the computerized healthcare system (Van de Velde & Degoulet, 2003).

- Identification to check who the end user is
- Authentication to check whether the information provided during the identification step is correct or not
- Authorization to check whether the user is authorized to perform certain tasks

Authentication and access control are required for security when accessing medical data through an e-health infrastructure. Many techniques have been applied for such proposes, for example, smart cards, firewalls, digital certification, biometric devices, password and PIN (personal identification number) generators, and others (Ferrara, 1998). Encryption can be incorporated into different protocols such as NCSA's Secure HTTP (hypertext transfer protocol; SHTTP) and Microsoft's Private Communications Technology (PCT; Goldman & Rawles, 2004). Theft termination is an effective and active protection strategy (Goldberg et al., 1997), and more studies are needed in developing such functionalities in e-health. In the following, we shall briefly discuss several technologies for e-health security and privacy.

Firewalls

Firewalls are a common practice set on the Internet for a business' Web site to prevent unauthorized access to confidential data. A firewall can act as an isolating layer between the inside and outside networks: All information entering the firewall is filtered or examined to determine whether the users have the rights to access the network, and whether the information entered meets the requirements of the inside network for further dissemination over the network (Gollmann, 1999).

The architecture of the firewall consists of packet filters, proxies, and internal firewalls. Packet filters are programs designed at the port level that determine access by checking the source and destination addresses of the incoming data. Proxies, also known as application-level filters or application gateways, take a step further to exam the validity of the request for the entire set of data. Proxies are also entitled the right of refusing connections based on traffic directions; for example, certain files can be uploaded but not downloaded. To prevent internal attacks from insiders, internal firewalls emerged as an access control mechanism inside the network (Stajano, 2002).

Firewalls have found widespread applications in e-health (and other industries). Some popular products include the Firewall-1 from Checkpoint, Alta Vista Firewall from Compaq, and Gauntlet from Network Associates. However, there are certain limitations to this technique. First, designing firewalls often assumes the threats or attacks are from the outside network, which is not always true in reality. Second, the firewalls cannot resist outside threats at all if we are not able to control or monitor the outside connections. Third, the packet filters cannot prevent hackers from IP spoofing, and the proxies are unable to detect many computer viruses such as Trojan horses or macro viruses. Last but not the least, there is no standard established for firewall architectures, functionalities, or interoperability (Schneier, 2000, Stajano, 2002).

Smart Card

Smart cards are actually one form of token-authentication technology, and they generate the session password that can be authenticated by the server. The whole authentication process involves one or more of the following.

1. The client software, to enter the password and communicate with the server software
2. The server software, to verify the password and record the card history
3. The application software, to integrate the token-authentication technology with other technologies (Fischer-Hubner, 2001)

In general, there are two approaches in token-authentication technology: challenge-response and time-synchronous token authentication. The former works in the following way.

- The server software generates a challenge based on the ID and password that a user entered.

- The smart card generates a response number based on the challenge number and user ID.
- The server checks the response from the smart card. The log-in session is enabled if it matches the correct one.

Time-synchronous token authentication simplifies the challenge-response authentication in that there is no server-to-client step. The user can directly enter the access code from the display of the smart card, which can be matched by the server software since every 60 seconds the smart card and the server software will generate a new access code (Goldman & Rawles, 2004). ActiveCard is an example of using smart cards in e-health services. Its one-time password method is similar to the time-synchronous token-authentication approach, while its device-PIN method incorporates digital certificates or biometric information stored on the card. Graded authentication controls different levels of access rights and needs of the confidential medical data. For example, the users are entitled different levels of rights based on their roles as physicians, clinicians, nurses, technicians, administrators, insurers, and patients. The shortcomings for using smart cards include the fact that the authentication may fail when the physical device degenerates over time, and they are easy to get lost or stolen.

Biometrics

Biometric authentication is the authentication process using the unique physiological and behavioral characteristics of a user such as fingerprints, palm prints, retinal patterns, hand geometry, facial images, voice, or others. This process requires establishing a large database for the user's biometric features as the reference during validation (Jain, Bolle, & Pankanti, 1999). Accuracy and sensitivity are important issues. Usually, a good trade-off between them needs to be achieved because accuracy depends on the ability of the equipment to detect despite small variations between biometric characteristics. Though perfect biometric devices have not yet been developed, adding biometric features to smart cards provides an improved way to achieve security and key management. Such commercial products are gradually replacing the old smart cards in e-health applications. Biometric techniques for security are an active research area, and their applications to e-health industries appear rosy.

An important challenge is how to protect privacy while exploiting biometrics. It is often possible to obtain someone's biometric sample without that person's knowledge, thus, those who desire to remain anonymous in any particular situation can be denied their privacy by biometric recognition. This covert recognition of previously enrolled people may raise privacy concerns over unintended application scopes. Besides this, unintended functional scopes also pose a privacy concern. For example, collectors may obtain or infer additional personal information from biological measurements. Such derived information could lead to discrimination against segments of the population perceived as risky. An effective way to enhance privacy while permitting all the advantages of biometric-based recognition is to decentralize the biometric system. The biometric information is stored in decentralized, encrypted databases over which the individual has complete control. To enhance privacy in using biometric information, legislation by government is necessary. The European Union has legislated against sharing biometric identifiers and personal information. Another solution to the privacy problem includes building autonomous enforcement by independent regulatory organizations like a central biometric authority.

Data Encryption of Health Data

During transmission over the Web, medical data could be intercepted and manipulated maliciously with the information confidentiality and integrity compromised. A common data-protection technique uses data encryption with either symmetric or asymmetric algorithms (Stinson, 2000). The conventional encryption algorithms include Blowfish, CAST-128, IDEA (International Data Encryption Algorithm), Data Encryption Standard (DES), and so forth. Concurrent algorithms include AES (Rijndael), Serpent, RC6, Twofish, and so on (Stinson). For symmetric encryption, the same key is used during both encryption and decryption such as DES developed by IBM. The problem for symmetric encryption lies in the difficulty of key management, where the security process will fail if the third party obtains the key.

For asymmetric encryption, a pair of keys is used including the private key that is only known to the owners, and the public key that others can process. The private key has the highest security level, which cannot be inferred from the public key though they are mathematically related. When the public key decrypts the messages encrypted with the private key, the identity of the sender can be authenticated. This technique is also known as digital signature. When the private key decrypts the messages enciphered with the corresponding public key, the identity of the receiver can be authenticated. Commonly used asymmetric algorithms include RSA (Rivest, Shamir, & Adleman, 1978), elliptic curve cryptosystems (Koblitz, 1997), and so forth. Digital signature is a common technology using asymmetric cryptography to authenticate the author of electronic transmitted documents. The biggest problem with asymmetric encryption is its high computing cost and slow process (Van de Velde & Degoulet, 2003). Thus, asymmetric cryptosystems are usually used for transmitting symmetric keys as it is inefficient for large amounts of data such as medial images.

COMPLIANCE WITH HIPPA

HIPPA has been the standard in the United States for health-care industries, with the guidelines and policies to protect the privacy and security of medical records since it was created in 1996. It includes more than 68 information security conditions in three areas that must be satisfied to ensure compliance with HIPAA. These areas include the following:

1. technical security services such as user authorization and authentication, access control, and encryption;
2. administrative procedures such as formal security planning, record maintenance, and audits; and
3. physical safeguards such as the security of buildings, and the privacy of offices and workstations that handle patient information.

The standard provides a uniform level of protection for all health information, and safeguards physical storage and maintenance, transmission, and access to individual health information. It does not require specific technologies to be used, and solutions will vary from business to business depending on the needs and technologies in place. However, all stakeholders in healthcare systems including health plans, healthcare providers, and clearinghouses are required to comply with HIPPA. Such compliance ensures the protection of patient privacy and data security through e-health, and will ultimately increase public confidence in using e-health as their preferred means for healthcare. How can the e-health strategies, technologies, services, and management be deployed to ensure HIPPA compliance? Such questions are faced by the health-care industries in promoting e-health. In sum, HIPAA has a far-reaching effect on the health-care industry, presenting health-care organizations with numerous planning, operational, technical, and financial challenges.

TRENDS

Security mechanisms are usually regarded as technical means to protect privacy. However, they can also contradict privacy. Oftentimes required is the collection of sensitive personal information from the users to better protect security. The user must trust the security system and provide such private information. The government needs to enforce the laws and keep the e-health system running healthily. Technically, one global trend in e-health is the development of privacy-protection mechanisms in e-prescription systems, patient record databases, and medical information systems. The development of security business management also represents an important trend. A healthy security system requires not only the measures to prevent current threats, risks, and attacks, but also reasonable protections against future generations of attacks and misuses. With the rapid evolvement of cyberattacks, excellent security business management skills and strategies are necessary in providing visionary preparation for future threats beforehand, and in designing and managing smart security systems. Because each security technique has its own strengths and weaknesses, an important development is to build a holistic framework, taking advantage of various techniques while compensating for their drawbacks. An industrial standard is lacking but urgently needs to integrate various security techniques so that maximum efficiency can be achieved.

CONCLUSION

E-health, a fast-developing area in healthcare industries, faces the challenges of privacy and security issues. Only with high confidence in security and privacy can both patients and health providers greatly benefit from the high efficiency and quality of service of e-health systems. We discuss relevant concepts, technologies, limitations, challenges, and trends in e-health security and privacy. Also discussed are strategies and standards such as HIPAA. We conclude our article by emphasizing that only through the collective efforts of technologies, businesses, management, and legislative regulation can the security and privacy of e-health be safeguarded.

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KEY TERMS

Cryptography: The conversion of data into secret codes for transmission over a public network to prevent unauthorized use.

Data Accountability: The ability to trace back all the actions and changes made to the information.

Data Availability: The ability to ensure the readiness of the information when needed.

Data Confidentiality: The ability to ensure the data is inaccessible to unauthorized users.

Data Encryption: The process of "scrambling" the data for transmission to ensure that it is not intercepted along the way.

Data Integrity: The ability to prevent the information from being modified by unauthorized users.

E-Health: Refers to the market, companies, and initiatives for conducting healthcare-related transactions electronically using the Internet and/or wireless communications.

Firewall: Special software used to prevent unauthorized access to a company's confidential data from the Internet through filtering all network packets entering the firewall at one or more levels of network protocols.

HIPAA (Health Insurance Portability and Accountability Act): Standard guidelines and policies enforced by the U.S. federal government to protect confidential medical records.

Privacy: The right of individuals to control or influence what information related to them can be disclosed, by whom it can be disclosed, and to whom it can be disclosed.

Security: Defined as the combination of processes, procedures, and systems used to attain the confidentiality, accountability, integrity, and availability of the needed information.

Smart Cards: Used in token-authentication systems. It can be either a hardware-based card or smart IDs the size of about a credit card with or without a numeric keypad.

Telemedicine: Refers to the delivery of health care at a distance using telecommunications or the Internet.

E-Learning Concepts and Development

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INTRODUCTION

Our society is gradually changing from information-based to knowledge-based. The Internet is transforming our workplace and the ways we work and learn. Wallace (2004) calls it a netcentric workplace, and the netcentric technologies bring a host of new tools and capabilities to workers, especially in the areas of information access, communication, and collaboration.

In recent years, we have seen an explosion of interest in e-learning, not only from the academic institutions but also from the commercial organizations. There are many activities, research, and development related to e-learning such as lifelong learning, self-directed learning, organizational learning, and virtual learning environment and virtual universities. The market for educational products and services is expanding rapidly especially in a global context.

The aim of this article is to explain the various concepts associated with e-learning: the stakeholders involved, the technology and related standards, and the products and services provided. The issues, challenges, and trends will also be explored and discussed.

BACKGROUND

The introduction of new technology changes the ways that teaching and learning can be conducted and affects the effectiveness of the process. There are four aspects related to the effectiveness of teaching and learning. They are time, place, delivery process, and the learning process.

From interactive video disc to computer-based training (CBT), the history of technology-based training is well over 30 years. With the introduction of the computer, traditional paper-based training materials became digitized. Packaged with other multimedia materials such as graphics and video, a CBT module can be produced, stored, and delivered as a CD-ROM to the desktop of the learner. However, CBT materials distributed on CD-ROMs cannot easily be updated and can quickly become out of date.

With the Internet, a new channel for delivery of content and communication is available for teaching and learning. Web-based training (WBT) starts to replace CBT. With Web-based learning materials, information can be updated on the server and made immediately available to every learner regardless of time and location (Khan, 2001). E-learning, online learning, e-content, mobile learning (m-learning), and learning management systems become popular terms.

Fallon and Brown (2003, p. 4) define e-learning as “any learning, training or education that is facilitated by the use of well-known and proven computer technologies, specifically networks based on Internet technology.” Piskurich (2003b, p. 8) defines e-learning as: “Learning that uses computer networks or webs as the delivery or mediation mechanism. By this definition neither CD-ROM-based nor satellite-based delivery would be considered as e-learning.” Rather, at the core of the e-learning evolution is the Internet.

From a technological perspective, the Internet serves two specific purposes: delivery and communication. In terms of delivery, instructional and learning materials can be packaged into learning content. Content providers such as publishers, universities, and knowledge institutes deliver the learning content to their learners via the Internet. Digital goods such as e-books and courseware can be delivered to learners regardless of time and location. Hence, just-in-time and on-demand learning are feasible. In terms of communication, instructors and learners using the Internet are able to communicate among themselves by means of e-mail, discussion forums, chat rooms, video conferences, instant messages, and so forth.

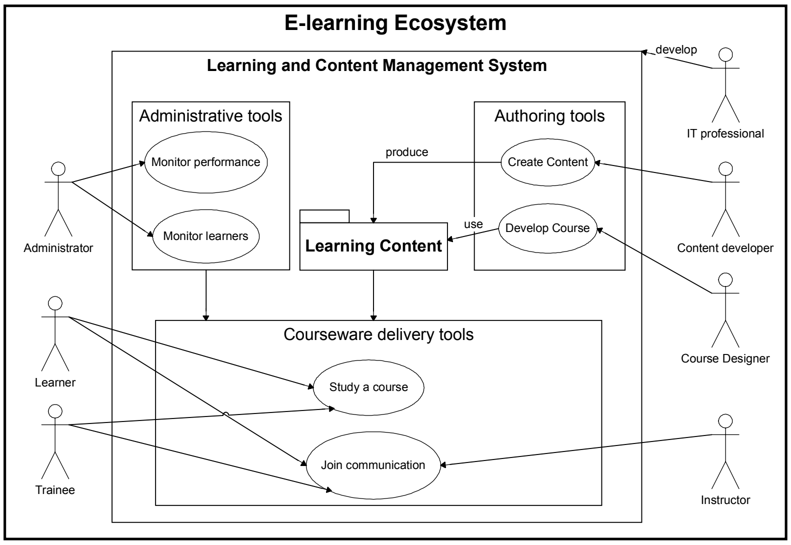
E-LEARNING CONCEPTS AND DEVELOPMENT

The E-Learning Ecosystem

E-learning is a complex field involving institutional, individual, technical, and social components. The e-learning ecosystem refers to the environment and the stakeholders involved in e-learning. Figure 1 shows an overview of the e-learning ecosystem and its components.

Within the e-learning ecosystem, there are infrastructures and platforms to support stakeholders in performing their roles required for teaching and learning such as administrator, learner, instructor, course designer, and

Figure 1. The e-learning ecosystem



content developer. There are learners and trainees who are the primary consumers. There are instructors to help and guide the learners. There are experts and content providers to create and produce contents. There are educational specialists and course designers that develop courses and learning activities. There are administrators to track enrollments and success rates, and to assess and monitor the performance of the courses and the learners. There are IT professionals to develop and create applications to support content creation, delivery, administration, and management of the courses.

The state of the e-learning ecosystem is changing dynamically. The associated technologies are evolving rapidly. The demand for quality training and learning is increasing globally both in the commercial and educational sectors. The market for more digital learning content is expanding, and hence the business of content provider or publisher is growing. At the same time, there is another market for software developers to create authoring tools for content providers, as well as administrative and management tools for administrators and managers.

The primary goal is to enhance the effectiveness of e-learning. However, different stakeholders within the e-learning ecosystem have different perspectives and definitions of e-learning which emphasize different characteristics of e-learning. Different content providers produce and store digital learning content in a different format. Different vendors are developing different applications running on different platforms. Different learners have different personal experiences and learning styles in participating e-learning courses. So, achieving effective e-learning is not a simple matter.

From a technological perspective, the main issues affecting effectiveness are reusability and interoperability of various components in different e-learning platforms. From the mangers' and administrators' perspective, the criteria for measuring effectiveness are cost, profit, enrollment, and success rate. From the learners' and educators' perspective, effective e-learning actually depends on how to achieve the desired learning goals.

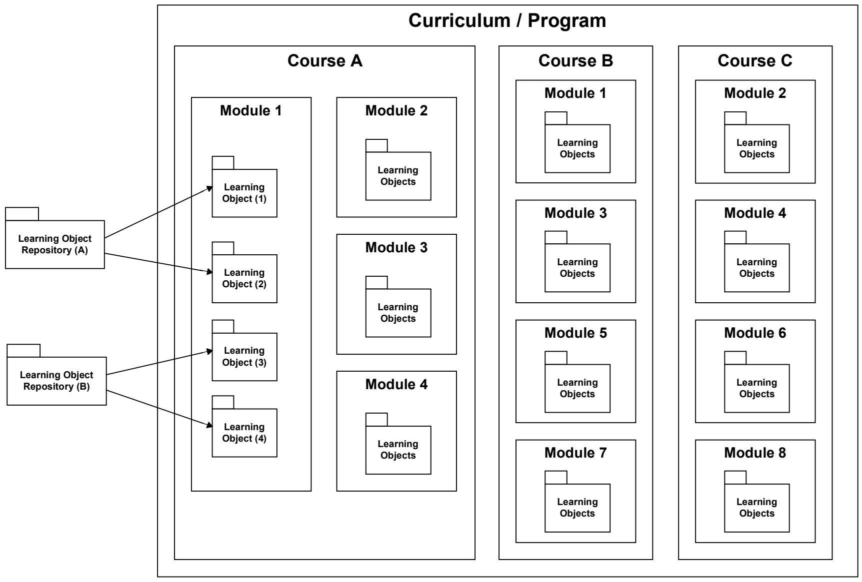
Learning Object Standards

The core of the e-learning environment is the learning content. Creating educational materials to be used in e-learning courses requires considerable investment, as they are expensive to develop. Therefore, reuse of the educational materials is necessary to gain economic benefit (Littlejohn, 2003).

In software engineering, the object-oriented approach emphasizes creating program codes that are encapsulated in objects, which are reused by different computer programs. The term "learning object" reflects the reusability feature of objects. The idea is to split educational materials into small, independent, reusable learning objects. A learning object can be used in more than one educational activity. A learning object can be aggregated from other learning objects. Reusability of learning objects is the availability of learning objects for others to use (McGreal, 2004). Learning objects created by teachers, educators, and publishers would be stored in digital repositories. A course

E

Figure 2. Aggregating learning objects into modules and courses



designer would access the learning object repositories to select, recombine, and reuse those learning objects in creating a new online course as shown in Figure 2.

The idea of reusing learning objects in different contexts implies the need for some degree of standardization. At very least, learning objects have to be categorized for easy identification and access. Combining different learning objects from different authors requires further information and functions. Learning objects are reusable but not necessarily interoperable without standardization. Standardization includes two basic standards. Interoperability standards define how lessons communicate with the administrative tools to exchange data about learners and their progress. Content-packaging standards define how learning objects should be categorized, stored, searched, accessed, packaged, and reused.

The first standard related to e-learning is the computer-managed instruction (CMI) specification developed by the Aviation Industry CBT Committee (AICC) in 1993. Another key development in e-learning standards was carried out by the Advanced Distributed Learning Initiative (ADL), which published the first version of its e-learning specification, the sharable content object reference model (SCORM), in 1999. SCORM is becoming a recognized standard in the e-learning market. E-learning application vendors are eager to meet SCORM conformance to maintain a share in the huge e-learning market. SCORM is still evolving and is revised on a regular basis to add new specifications. Many learning management systems (LMSs) and learning content management systems (LCMSs) on the market today are tested for SCORM conformance. Features of LMS vary from one system to another, but generally they include a learner interface and some administrative functions such as course setup, learner registration, course assignment, and reporting of learner's progress. Features of LCMS emphasize content creation. They usually include authoring tools for producing learning objects, a repository for storing learning objects, a framework and structure for content aggregation, and a course delivery module (Horton & Horton, 2003).

Learning Object Repositories

Reusing educational materials is a common practice in teaching and learning. As shown in Figure 2, learning object repositories are places to store digital objects or links pointing to the storage location of the objects. A key function of learning object repositories is to provide an indexing system or catalogue that enables efficient search, discovery, and sharing of learning objects. Examples of learning object repositories are: Campus Alberta Repository of Educational Objects (CAREO) at www.careo.org and Multimedia Educational Resource for Learning and Online Teaching (MERLOT) at www.merlot.org. MERLOT holds a large collection of links to learning objects, together with descriptions, peer reviews, lesson plans, or assignments.

Educators in the E-Learning Ecosystem

Reusing and combining learning objects into courseware emphasizes the approach of packaging learning materials into self-study modules. Current e-learning standards focus more on solving the technological problems related to compatibility and interoperability. However, educators care more about the quality of the learning objects, the performance of the learners, and the outcomes of the learning process—that is, the effectiveness of learning. Educators design the courses including not only the content, but also the learning activities. In the constructivist view of learning, learners use their own process to acquire and construct knowledge rather than passively receiving knowledge from external sources (Kafai & Resnik, 1996). In the view of collaborative learning, learners work in groups or communities to share and construct knowledge. Effective knowledge sharing requires the support of efficient communication services. Therefore, another important feature of learning management systems is to provide communication tools for both synchronous and asynchronous e-learning. Chat rooms, discussion forums, e-mail, video conferences, and instant messages could be incorporated into learning activities. Design of the learning activities could be stored as a template and packed together with the educational materials into learning objects. However, learning activities are usually designed for a specific context, especially in situated learning. To capture the learning activities into a learning object that can be shared and applied in another context, educators have to take an additional step to separate contextual information from learning activities, which is not common practice (Jochems, Merrienboer, & Koper, 2004).

Learners in the E-Learning Ecosystem

An important aspect of e-learning is to put the control of the learning process in the hand of the learners. It is the interaction between the learners and the e-learning environment that determines the quality and effectiveness of learning. Other factors include the prior knowledge and the learning style and attitude of the learners. If the learners are ready for e-learning, it is an efficient, effective, and economical approach. However, if the learners are not, their e-learning experience may be a failure, incomplete, and frustrated. As e-learning is based on technology, the technical readiness of the learners is critical. Technical readiness includes the technical knowledge and skills required to operate the system used to deliver e-learning courseware. Moreover, the technical attitudes and habits of the learners would help to eliminate any technical barriers or roadblocks (Piskurich, 2004). In terms of learning style, successful e-learners share the same characteristics as successful self-directed learners. Those characteristics include creativity and independence in learning, willingness to seek help, and acceptance of responsibility for one's own learning. E-learners can perform better if they understand their learning styles and preferences. Hence, the first step of an e-learning program is to assess the learners' readiness for e-learning. New e-learners or learners with lower levels of readiness might need additional support in their first encounter with the e-learning program (Piskurich, 2003a).

FUTURE TRENDS

Learning object repositories are developed to support sharing and reuse of learning objects. Copyright is an issue, as the law has not been able to keep up with the development of e-learning. New laws are emerging and new technologies are developed to make learning objects sharable and reusable while still protecting intellectual property rights. Digital rights management (DRM) technology is developed for vendors and publishers to protect their intellectual property (Barlas, Cunard & Hill, 2003). Another technological challenge for e-learning will be to develop strategies and standards for digital repositories of courseware and online course management systems, to make it easier to catalog, share, and reuse valuable content.

For the learners, there is an increasing demand for lifelong learning that is timely, personalized, and targeted. Individuals want learning tailored to their particular needs and context. They want flexibility of access and just-in-time content, for example, accessing courseware using mobile devices—that is, m-learning (Lundin & Magnusson, 2003). More learner control would be available in the next generation of e-learning. Instead of a course designed to fit all learners, each learner could select and aggregate learning objects and modules to create a customized course for achieving specific learning goals (Garrison & Anderson, 2003).

Computer-assisted assessment is an important element in e-learning. Similar to learning objects, a test and its questions can also be shared and reused. There are vendors marketing standard tests to assess people's level of skill and competence in specific areas. To facilitate effective e-learning, the purposes of assessment are:

- to verify learner's prior knowledge and skills before taking an e-learning course,
- to test the learner's understanding of the content during the course, and

- to identify knowledge gaps of the learner and to select appropriate e-learning content for the learner.

Incorporation of technology into assessment is inevitable. The challenge is to develop cost-effective systems of assessment that have both summative and formative components (Bennett, 2002). Better facilities to evaluate and provide feedback on a learner's performance, weaknesses, and strategies to improve are essential.

Research and development are carried out in the areas of intelligent software agents and computer-supported collaborative learning. Intelligent agents have been incorporated into a wide range of educational systems, from intelligent tutoring systems to computer-supported collaborative learning systems. The goal is to create a smart learning environment where intelligent agents support and enhance interaction among learners, facilitators, and active contents of the courseware. A learner's agents could also customize courses dynamically according to the learner's profile, learning style, and preferences (Lin, 2005).

CONCLUSION

E-learning is characterized by its independence of time and place, its integrated presentation and communication facilities, and its opportunities for reuse of instructional materials in the form of learning objects. It offers advantages over earlier computer-based training programs because of the way materials are developed, updated, and distributed.

In the e-learning market, learning management systems, learning content management systems, and authoring tools are available as commercial products. Digital repositories and portals of learning objects are developed in both public domain and private organizations. Online education in both academic institutes and commercial organizations is growing rapidly and globally. The value added by e-learning to organizational learning is critical to the competitive advantages of organizations.

E-learning has been driven by the advanced information and communication technologies. Infrastructures, supporting tools, and applications have been established in the e-learning ecosystem. As an ecosystem, the stakeholders involved are facing problems arising from the action and demand of other stakeholders. Demands from educators, trainers, and learners are setting new requirements for e-learning. The objective of e-learning remains the same: to support effective learning. However, the demand for effectiveness of learning is increasing. New principles and new applications are being developed to fulfill the new demands. Feedback and collaboration drives continuous improvement and development of the e-learning ecosystem.

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KEY TERMS

Computer-Based Training (CBT): Training materials and programs usually delivered on a CD-ROM or via an organization's local area network.

Digital Right Management (DRM): Technology used to control or restrict the use of digital media content on electronic devices, in order to protect intellectual property and to combat piracy.

E-Learning: An approach to facilitate and enhance learning through the use of devices based on information communication technologies and the Internet.

Learning Content Management Systems (LCMSs): Designed for the design, delivery, and management of educational materials and e-learning courses. They usually include authoring tools for producing learning objects, a repository for storing learning objects, a framework and structure for content aggregation, and a course delivery module with administrative functions.

Learning Management Systems (LMSs): Designed for the delivery and management of e-learning courses. They generally include a learner interface and some administrative functions such as course setup, learner registration, course assignment, and reporting of learner's progress.

Learning Object (LO): A reusable unit of educational materials. It is the basic building block for e-learning content. A learning object can be aggregated from other learning objects and can be used in more than one educational activity.

Sharable Content Object Reference Model (SCORM): A standard for categorizing and assembling learning objects to create e-learning courses. By specifying key information in a standardized way, SCORM makes learning objects sharable and reusable in different courses that are interoperable and compatible with different learning content management systems.

Electronic Data Interchange

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INTRODUCTION

The popular notion of e-commerce is a consumer interacting with a Web page to buy a book from Amazon or a ticket from Expedia. This is an important aspect of e-commerce, but the applications and technologies used in e-commerce are much wider than business-to-consumer e-commerce facilitated by the Internet and the World Wide Web.

E-commerce is summarized by the phrase "doing business electronically," and to that we should add the qualification that the business is conducted between the organization and some external party. E-commerce is defined by Wigland (1997, p. 5) as "…the seamless application of information and communications technology from its point of origin to its endpoint along the entire value chain of business processes conducted electronically and designed to enable the accomplishment of business goals."

This includes business-to-business transactions as well as business-to-consumer transactions, and does not presume the type of technology that is used to facilitate these transactions. There are authors that seek to define e-commerce in a way that limits the term to business transacted over the Internet, but this seems to be without merit: Did not transactions conducted using Minitel or Prodigy serve the same purpose as today's Web-based transactions, and does not the development of m-commerce still come within the more general classifications of e-commerce and e-business?

Whiteley (2000) suggests that e-commerce was facilitated by three technologies: electronic data interchange (EDI), electronic markets, and the Internet- (or e-shop) type facilities. EDI and electronic markets predate the e-shop model and, for the *Encyclopedia of E-Commerce, E-Government, and Mobile Commerce*, this article will concentrate on EDI.

What is EDI?

EDI is an e-technology that supports business-to-business transactions and is principally used by large organizations that have a large volume of standardized transactions. There are a number of definitions around, but (unlike definitions of e-commerce and e-business) they are all different ways of saying the same thing. The definition adopted by the UK National Computing Centre (Parfett, 1992, p. 7) is the "transfer of structured data, by agreed message standards, from one computer system to another, by electronic means."

The first phrase of the definition, "structured data," brings most trade exchanges within the potential scope of EDI. A simple business-to-business trade exchange consists of an order, delivery note, invoice, and payment, and these are all structured data. The utility and preciseness of the trade exchange data is enhanced by the use of codes in place of addresses and product descriptions. The Article Numbering Associations (ANA) is one set of organizations that have devised appropriate coding systems; EAN (European Article Number) and UPC (Universal Product Code) are examples of this. The scope of EDI has also been extended from basic trade documents to requirements such as customs clearance, container information, and continuous replenishment (Lauden & Traver, 2004). EDI is also used for other applications, for example, in banking (electronic funds transfer, EFT), education, medicine, and weather forecasting.

The phrase "agreed message standards" implies a message coding system that has wider application than just the two (or a small group of) organizations involved in trade exchanges. EDI standards were initially devised by industry-sector organizations and often on a national basis. Examples of early EDI standards include Tradacoms, devised by the UK ANA for general merchandise, Odette, used by automobile assemblers, and UCS, used in the grocery trade in the United States. A difficulty with the early message standards was that they were trade-sector or nationally based. As the use of electronic trade exchanges expanded to a wider range of products and across international borders, suppliers were increasingly being asked to implement more than one standard. The answer to this problem was to devise a standard that was more widely accepted and catered for a greater range of requirements. This resulted in the ANSI X12 standard in the United States, and EDIFACT (EDI for Administration, Commerce and Transport) in Europe. EDIFACT was developed under the auspices of the United Nations (UN) Economic Commission for Europe but was subsequently adopted as the international standard at a meeting of the International Organization for Standards in September 1987. Since that date, the EDIFACT standard has continued to develop and now includes in excess of 190 messages (trade documents). The full standard is available on the UN Web site (2004). The standard is vast, but that does not mean that an individual transaction has to be complex.

It is the phrase "from one computer system to another" that distinguishes the application of EDI from most other e-technologies. The concept is of an exchange that directly links the computer application of the customer to that of the supplier. This can be, for example, the stock-control or replenishment system of a supermarket chain "talking" to the order-processing system of the supplier of breakfast cereals, or the material and requirements planning system of an automobile assembler issuing just-in-time orders for the delivery of components and subassemblies by the supplier of those products. EDI is used for business-to-business transactions that are computer generated, frequently repeated, and computer processed. To gain the full benefit of EDI, there should be no requirement for manual (administrative) intervention at either end. EDI is the e-technology that most effectively automates and integrates the logistics supply chain. It facilitates the creation of an interorganization information system (IOS) integrating the business systems of customers and suppliers, and it can include other players such as shippers, customs authorities, and banks.

Finally, "by electronic means" implies the transaction takes place over a network. Traditionally, the network has been a commercial value-added data service (VADS), also known as a value-added network (VAN). These networks, marketed and managed by companies such as AT&T and GE, provide high-quality network services. A feature common to all these networks is the provision of post-and-forward facility so senders can transmit their EDI exchanges at times that suit them, and the addressees can pick them up in accordance with their own operating schedules. The VADS operator can also provide other services such as consultancy and trusted third-party services. In recent years, the Internet has been used as an alternative EDI network. The use of the Internet can be substantially cheaper than a VADS (savings of up to 90% are reported; Chaffey, 2002), but there are, or have been, concerns about reliability and security. AS2 is a recently introduced transport standard for transmitting EDI over the Internet (Adshead & Thomas, 2003)

The EDIFACT Standard

To understand EDI, it is useful to have an idea of what an EDI message would look like. As already stated, the EDIFACT standard is vast, but any specific requirement will only utilize a small subset of that standard (although agreeing on the exact subset that is to be used can be a problem). To illustrate the standard, let us consider the order shown in Figure 1.

The customer and the supplier will have already agreed on the terms of the trade. The address and product codes are standard for the trade sector, and thus names, addresses, and product descriptions are not needed in the electronic transaction. This order can then be coded into EDIFACT giving the short message shown in Figure 2. Note that the codes not in Figure 1 are qualifiers specified by EDIFACT; for instance, the DTM (date-time) data segment includes a *4*, which specifies it is the order date, and *102*, specifying the date is in century date format.

The customer and supplier will have EDI software integrated in their stock-control and order-processing application, and thus the EDIFACT message can be automatically coded and sent from the customer and will be automatically received and decoded at the supplier's end.

EDI Trading

Once the e-technology for EDI trading is installed, then the organizations involved can trade very efficiently. The impetus for EDI trading normally comes from a large customer organization that is sending out many orders on a daily or weekly basis to a large number of suppliers. A supermarket chain typically has in excess of 1,000 suppliers (and many of them will be common to several or all the major supermarket chains). The major motor manufactur-

Figure 1. Example order

```
Customer:        Johnson Wholesale
                 address code: 6261601
Supplier:        Mary's Preserves
                 address code: 3231301
Order No.:       929190
Order Date:      30 Sept 2004 (20040930)
Product 1:       Organic English Mustard
                 quantity: 200 (300 gm) pots
                 product code: 3231604
Product 2:       Yorkshire Piccalilli
                 quantity: 180 (500 gm) pots
                 product code: 3231627
```

Figure 2. Example EDIFACT order

UNH+000001+ORDERS:2:932:UN'	Interchange header
BGM+220+929190'	Order
DTM+4:20040930:102'	Header
NAD+BY+6261601::91'	
NAD+SU+3231301::91'	
UNS+D'	
LIN+1++3231604:VP'	Order
QTY+21:200'	Lines
LIN+2++3231627:VP'	
QTY+21:180'	
UNT+11+000001'	Interchange trailer

ers will typically have fewer suppliers, but for some items the orders will be more frequent. Sequenced delivery is a term that is used for components that have to be delivered at "track side" at a specific time with variants of the components loaded in the sequence. They are needed for the cars that are coming down the assembly line (thus obviating the need for storage and double handling of those items).

The large customer organization can gain greatly from the use of EDI, and it will also be appropriate for the large supplier with automated order-processing and production planning systems. EDI can be less suited to a small supplier for which the volume of transactions would not necessarily justify the investment (of time as well as money) that would be required to set up the appropriate systems.

The sending of the EDI order will typically be responded to by a delivery note when the goods are dispatched and an invoice when payment is due, and eventually the payment will be sent to settle the account. These further exchanges can also be electronic. The use of EDI for these exchanges can obviously help with the volume, but it also speeds up the matching process and cuts down on errors. The delivery note, when it is received by the customer, should be matched to the corresponding order. The invoice similarly needs to be matched against the order, and a check is made that the goods have been delivered. Finally, the payment, sent to the supplier, needs to be matched against the invoice so it can be marked as paid. The payment can be in two parts with an EFT to the supplier's bank and an EDI payment advice to the supplier.

Alternatives to EDI

EDI has been having bad press (see, for example, Deitel, Deitel, & Steinbuhler, 2001; Kay, 2000; Turban, King, Lee, Warkentin, & Chung, 2002). The criticisms of EDI include the following.

- It is expensive to set up (commercial EDI software are reasonably priced, but integrating and interfacing them to applications can be both time consuming and expensive).
- The charges for commercial VADS systems are expensive (but then, as already noted, EDI exchanges can be sent over the Internet if the parties agree).
- The standards are complex.
- The standard-forming process is both long winded and time consuming.

All of these criticisms are true, but any commercial business information system is expensive and all standards processes are time consuming (also, the EDIFACT standard is in existence, and changes to the established messages are normally relatively minor). The alternative that is proposed is the use of XML (extensible markup language) for business-to-business electronic data exchanges. The advantages claimed for XML are the following.

- The standards are simple; you can devise your own (and so can everyone else).
- XML software are readily available and in many cases they are free (although there will still be the need to integrate the XML processing software with the business application).
- EDI is old and, in comparison, XML is new, versatile, and exciting.

XML messaging has been included as an option along with EDI in many of the new Internet-enabled electronic markets such as Commerce One, Biznet, and Aribia. XML has also been used to create message standards in new areas of electronic data interchange, with the European Bioinformatics Institute (http://www.ebi.ac.uk), used by colleagues at Manchester University, being an example.

The use of XML messaging allows us to convey much the same information as we can with EDI but in a different type of coding system. Taking the order that was used in

Figure 3. Example XML order


```
<? xml version="1.0" standalone="yes" ?>
<purchase-order order-no="929190">
<order-header>
    <reference-no>929190</reference-no>
    <date>20040930</date>
</order-header>
<company>
    <company-no>6261601</company-no>
</company>
<supplier>
    <supplier-no>3232301</supplier-no>
</supplier>
<order-item>
    <item-no>3231604</item-no>
    <quantity>200</quantity>
</order-item>
<order-item>
    <item-no>3231627</item-no>
    <quantity>180</quantity>
</order-item>
</purchase-order>
```


Figure 2 to illustrate EDIFACT, we can devise an equivalent XML message (see Figure 3). The XML message can be supplemented by an XML schema, defining the rules, elements, and data types, and a style sheet that governs how the data is displayed (if that is required).

XML is now included in many EDI software packages; for example, Perwill's EDI software also processes XML messages (see, for example, the case of Arla Foods; Perwill & IBM, 2004). There is the drawback that XML standards for trade exchanges do not have the acceptance and maturity of the EDIFACT EDI standard (see, for example, Kay, 2000; UN & CEFACT, 1999 for a detailed assessment of the use of XML). Some IT industry leaders have developed their own XML interchange standards (Chaffey, 2002), and in some cases, the tags used are their own internal database definitions (UN & CEFACT). In addition, there are more general standards being developed, for instance, the EANCOM standard (the European standard for retail and manufacturing), and these tend to draw heavily on EDI experience.

There is the possible advantage that by using XML, a trading partner, that is too small to be able to afford an integrated IS infrastructure, could use an XML style sheet and free XML software to print the transaction (but that makes a rather large assumption that a small organization would have the expertise to undertake the task).

BACKGROUND OF ORGANIZATION

An example of an organization that uses EDI is Automotive Products (AP) Driveline Technology. AP is based in Leamington in the British Midlands and also has a factory in Spain. AP Driveline manufactures clutches. Their claim is, "From a family hatchback to a Ferrari and from a tractor to a static land or water based industrial plant, Automotive Products Driveline Technologies has the expertise, ability and experience to provide a total driveline solution" (http://www.apdriveline.com). The company has been based in Leamington for more than 70 years, with its driveline products originally marketed under the Borg and Beck name. The company was, until about 7 years ago, part of the AP Group, which manufactured a range of other vehicle components (including Lockheed brake systems). The company supplies original equipment (OE) to manufacturers such as Rover, Jaguar, Honda, and Aston Martin. The company also supplies the aftermarket (replacement parts).

DESCRIPTION OF E-COMMERCE

The AP Group used to have a large IT department and EDI arrangements with a number of customers. AP Driveline, when it separated from the AP Group, had to set up its own smaller, leaner IT infrastructure. The current technology is an IBM AS400 running a BPIX ERP system. BPIX includes e-commerce facilities.

Currently, AP Driveline has a single EDI link with its largest aftermarket customer and receives about 600 order lines a week. A number of other customers want AP Driveline to trade electronically, but the company has not had the resources to implement the interfaces, and these customers seem to have put their long-standing supply relationship before their normal requirement for electronic trading. For OE customers, the quantities can be quite large but the range of part numbers will be limited, making the ordering process more manageable (at least for AP Driveline). Currently, there is a project to establish EDI links with five more customers using the Odette and EDIFACT standards and probably AT&T as the VADS (seen as a more appropriate, but more expensive, solution than the current VADS supplier).

In the absence of EDI links, AP Driveline takes forecasts and orders from a variety of media. For a number of customers, including large OE customers, forecasts are downloaded from the customer's Web site and keyed into the system. Some customers will also take advice (delivery notes) electronically through their Web site. One customer was insisting on the use of Covisant (a motor-industry portal), but that requirement was dropped. Customers are also contemplating the use of XML messaging, but as yet there seems to be no clear standard and no firm requirement.

AP Driveline does not use EDI for trade with its suppliers (and the understanding is that very few organizations in the motor industry use EDI with second-tier suppliers). For most supplies, the schedules from the BPIX system are converted to a spreadsheet format and then sent by e-mail.

IMPACT OF E-COMMERCE ON THE ORGANIZATION

The restructuring of the AP Group set back the use of EDI in AP Driveline by about 10 years. AP Driveline's order-taking and trade-transaction systems are a mixed bag, and arguably they have been lucky that their customers have tolerated the situation (this would not have been the case for larger components, fitted on the assembly line, where just-in-time sequenced delivery would be required). AP Driveline would like to increase its use of EDI (and electronic trading systems—EDI is seen as a legacy technology), but it has been hard to justify the investment (particularly when the volume of lines is small and the various customers have different interpretations and subsets of the EDI standards).

CONCLUSION

EDI has, over the years, been supplemented and complemented by e-technologies such as Web-based e-shops, Internet-enabled e-markets (including Web services), and m-computing. These enable business-to-consumer and business-to-administration e-commerce and are also applicable to aspects of business-to-business e-commerce. These technologies supplement rather than replace EDI e-commerce. EDI, whether it uses a traditional EDI standard or an XML-derived convention, and whether it uses a VADS or the Internet for its network connection, is still the appropriate e-technology for high-volume, repeated business-system-to-business-system exchanges. The case study of AP Driveline shows it is still relevant, but that the picture is rather more complex and untidy than we may suppose.

EDI standards have been developed over the years and are a mature technology. There is a move to substitute XML-derived messages for their EDIFACT equivalents. The rationale for this move is unclear (and the justifications that have been put forward are, in general, readily refuted). It would be unfortunate if the standardization that has been achieved over the years in ANSI X12 and EDIFACT is discarded and replaced by a miscellaneous set of bilateral and sector-based standards—that is where EDI was 30 years ago.

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KEY TERMS

ANSI X12: The predominate American EDI messaging standard.

Business-to-Administration (B2A): Data interchange between commercial organizations and government bodies using e-technologies such as EDI or an Internet Web site. It is a component of e-government.

Business-to-Business (B2B): Commercial transactions between commercial trading partners using e-technologies such as EDI or an Internet e-shop.

Business-to-Consumer (B2C): Commercial transactions between commercial organizations and members of the public, typically using an Internet e-shop.

Consumer-to-Administration (C2A): Data interchange between citizens and government bodies, typically using an Internet Web site. It is a component of e-government.

EDIFACT: The worldwide EDI messaging standard, administered and maintained by the UN.

Electronic Data Interchange (EDI): "The transfer of structured data, by agreed message standards, from one computer system to another, by electronic means" (Parfett, 1992, p. 7).

XML (Extensible Markup Language): A markup-language standard for the Web. It can be used as an alternative to traditional EDI messaging standards for the transfer of structured data.

Electronic Voting as the Key to Ballot Reform

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BACKGROUND

The emergence of online markets and e-business was expected to revolutionize market structures, supply chains, and consumer behavior. The technological potential led to hasty forecasts that predicted extremely low costs for information. Corresponding communications advances suggested increased transparency and response speeds. Nowhere have these expectations been shown to be more flawed than in the attempted application of electronic voting in the United States. Following the controversy of voting fraud accusations, such as the narrow margin in the Florida election counts in 2000, traditional voting methods have suffered a general loss of trust in the public perception (Dill et al., 2003). These methods, which include but are not limited to optical readers and punch-card ballots, have been heavily scrutinized by critics in the wake of reports of widespread malfunctions, which suggest that the primary attributes of a successful e-vote scheme: anonymity, scalability, speed, audit, and accuracy. It also brings much criticism into the picture in regard to the reliability of direct recording electronic (DRE) voting machines.

Cranor (2001) reported that, in Florida, esoteric terms for voting mishaps (e.g., the "hanging chad") became the focus of many postelection jokes due to faulty punch-card machinery. Moreover, she reported that some local polling sites in New York with ancient voting mechanisms were missing levers. These machines had been manufactured so long ago that the necessary maintenance could no longer be performed. Such technical problems present huge obstacles for vote integrity.

Weiss (2001) provided explanations of the many ways in which votes are recorded and how effective (or ineffective) these methods have been in elections. The author provides a general overview of the possibilities for Internet voting in addition to drawing a parallel between it and ATM transactions, noting the importance of setting up an e-vote system, which takes advantage of the same kind of transaction-based technology as ATMs, which do not use the Internet per se—thus dealing with the social issues that often go hand-in-hand with a fundamentally new advance in voting procedure, such as the conveto the aforementioned faulty voting machines, there is a real concern regarding ballot design in light of "butterfly ballot" confusion made notorious during the Florida national election. Such odd designs are the result of election officials putting the function of the voting machine ahead of voter readability and understanding. Thus, even voters with 20/20 vision and great hand-eye coordination may not be able to vote properly with poor ballot layouts, contrary to the popular belief that such voting errors resulted from those voters of old age with visual handicaps. Mercuri (2002) reported on the defects of DREs brought into Florida poll sites after the election fiasco of 2000. New technologies should be studied further until real implementation can be brought into the polling sites.

If U.S. citizens look beyond their own national issues with voting failure, they find themselves behind the times when they glance at other democratic countries such as Brazil and Costa Rica (Weiss, 2001). Such systems involving secure electronic implementations force voters to consider the benefits of electronic over paper systems in terms of voter fraud, cost, accessibility, and usability.

One pertinent question becomes obvious at this point: Why are poll sites continuing to use voting equipment that does not meet the needs of its voters? If the mechanisms for voting are compromised, the very nature of our democracy is threatened. Undoubtedly, as with any information system, the success of the electronic voting process critically depends on voters' beliefs and feelings about the electronic voting process. The more voters, become aware of the system's failure and lack of credibility, there will be less trust in the efficacy of the voting procedures and in those who oversee elections.

As a response to the degeneration of traditional voting methods and spurred by technological paradigms, *e-voting* has become a new catch-phrase in ballot reform. This new term, however, is shrouded in ambiguity. On one side of the debate we have those that talk about e-voting in terms of the Internet and the ability to cast votes from a great number of different locations (Weiss, 2001). The other camp of e-voting still thinks of the process in the traditional sense of conducting elections at local polling sites, but instead polling sites would be virtually, if not entirely, paperless. Both camps, however, agree that e-voting has the potential for solving the problems of traditional voting techniques but must first be approached with cautious planning.

DESCRIPTION OF E-VOTING ISSUES AND ALTERNATIVES

Internet voting takes advantage of remote access to increase voter participation. This follows from the logic that most people are familiar with browsing the Web from their personal computers and will more readily be able to participate in an election where both physical and scheduling obstacles do not interfere. Mohen and Glidden (2001) described how the 2000 Democratic primary in the state of Arizona utilized the power of Internet voting in conjunction with mail-in and poll-site options. The voting process, run through election.com, enabled Democrats from all locations within the state to vote on their personal computers with Internet access. Voter identity and authentication were successfully dealt with in a secure operating environment. Internet voting advocates in the state claim that polling site locations were increased in those areas that had limited access. They present the Arizona Democratic primaries as a success in e-voting and a fundamental reason for encouraging states to adopt such e-vote measures and also show the decryption technologies available for use and the effectiveness of these techniques for combating hackers.

Although groups like the Voting Integrity project have taken issue with Arizona's implementation of Internet voting in regard to its exclusion of those minority voters without Internet access (Craft, 2000). In addition to the Arizona primary in 2000, the Alaskan Republican Party's presidential straw poll utilized the Internet for voting in January of the same year. In this example, geographically inaccessible polling sites and other physical limitations could only be overcome by using a quick and easy remote access method. Craft (2000) also provides an overview of some case-studies in Internet voting and the pitfalls that it might succumb in terms of security. Specifically, the voices of the California Internet Voting Initiative are heard in regard to what we would need to do in order to preserve the integrity of elections.

Following from this, we also see the benefits for U.S. citizens currently involved in overseas military action or for a number of personal reasons, as opposed to mail-in ballots. To support this move, researchers have discovered that mail-in fraud had been on the rise since states have become less strict with the procedural rules (Phillips & von Spakovsky, 2001).

Rubin (2002) asserted that the major concern of such remote voting techniques lies within the realm of security, especially when one considers the possible manipulation of votes by hackers or denial-of-service attacks on Web servers hosting these election sites. Such a large-scale implementation of Internet-based voting could seriously compromise the nature of an election by a concerted effort by malicious online entities. He delves into the concerns over security breaches to a communications infrastructure supporting an online election system. Thus, social engineering, in addition to technical hacker attacks, is a threat lurking beneath the obvious ways of manipulation. For example, pseudoelection servers could be set up on the Internet to trick those unfamiliar with e-voting into believing they have actually cast a vote when they have not. There must be secure voting in order to ensure votes are not "stolen" by malicious hackers.

E-voting advocates, however, do not always support the Internet voting method. On the other hand, some advocates say traditional polling sites should convert the mix of old voting methods (such as paper ballots, punch-card ballots, optical-reader ballots, and lever ballots) to an electronic medium. A private network, as opposed to the public Internet voting framework, provides a safer, more secure transmission of ballot choices. Such a network depends on direct recording electronic systems (DREs) to present information to each voter in a way that is easy to read and understand and capable of accurately and reliably recording voter choices to a back-end database server.

Proponents of these machines often refer back to the not-so-distant past with regard to the butterfly ballot scandal in Florida. Better prepared visual layouts are promised through the use of electronic interfaces, in which the function of the device does not determine the layout. Whether or not this actually occurs in practice within the DRE market is questioned by analysts, such as Bederson et al. (2003), who further consider how malicious coding by private e-vote companies (unregulated) can corrupt election results. This leads to the question of the design of e-voting systems, such as Diebold AccuVote, and their accessibility, including ballot layout issues and their impact on elections, in addition to the problem of training requirements for both election site officials and voters.

In both forms of e-voting there is the primary concern of being able to recount votes and analyze the paper trail for corruption. Whether this serves merely the losing candidate's political vested interests or the will of the people, however, is questionable. It is clear, however, that some alternative auditing techniques must exist for the voting system to have validity within the eyes of the voters involved in the entire process. Zetter (2004) illustrated the ineffectiveness of one e-voting company's security and of a disturbing trend in how such systems can be easily exploited by simple malicious code. It also presents an interesting critique of systems which are or can be given to a single person who has the ability to manipulate the way in which votes are counted or recorded.

As explained by Saltman (1998), voting, as it is carried out in the United States today, consists of four distinct administrative steps: (a) voter authorization: the determination of whether the prospective voter is entitled to vote at a particular place, and for what set of offices and issues; (b) secret choice: provision of the opportunity for the voter to express his or her choices without intimidation; (c) precise recording of the expression of each voter's choices in a voter-disconnected and easily countable format; and (d) accurate summarization of all voters' choices by candidate and issue alternative.

Paper Ballots

Paper ballots remain in use today in small communities and rural areas by a small percent of U.S. registered voters. Saltman (1998) described the vulnerabilities of paper ballots as subject to possible fraud and error in their distribution, in their use at polling places, and in counting.

Lever Machines

As Saltman (1998) explained, the vulnerabilities lever machines center on the fact that there is no ballot (i.e., no independent verification of each machine's recorded result). Although the lack of ballots eliminates the possibility of chain voting, counterfeit ballots, and spoiling of the opponent's ballots, there are other possibilities for fraud or error, some available because there are no ballots including vote count frauds, no audit trail of voter intent, no true recount capability, write-in difficulty, mislabeling, storage and transport.

Punch-Card Voting

Saltman (1998) asserted that punch card ballots have all of the vulnerabilities of paper ballots that are related to distribution, precinct use, and collection. Administrative controls may be implemented to prevent the typical paper ballot frauds.

Voting with a Mark-Sense Ballot

Saltman (1998) explained that, with this type of ballot, the voter makes a mark in a small rectangle or circle on a ballot to indicate a vote, and after the ballot is handed in, it is automatically read. Mark-sense technology is widely used also in standardized testing, for example for college entrance, and in statewide lotteries. Vulnerabilities include: ballot-reader and ballot requirements and treatment of reader-rejected ballots.

Direct Recording Electronic (DRE) Machines

This type of machine, the newest entry in applying computer techniques to voting, is an electronic implementation of the lever-machine concept. As with a lever machine, there is no ballot; the possible choices are visible to the voter on the front of the machine. The voter directly enters choices into electronic storage in the machine with the use of a touchscreen, or pushbuttons, or similar devices. If an alphabetic keyboard is provided with the voter-choice entry device, write-in possibilities are significantly eased. Saltman (1998) noted that the DRE machine is an electronic implementation of the lever machine concept, with significant distinctions regarding set-up and risks.

According to Zetter (2005), one of the big debates over how to handle the problem of source code manipulation in skewing election results is whether proprietary code should be made open source or not. Proprietary DRE makers are often criticized for keeping the black box closed in order to make profits for their secrecy at the expense of transparent and honest code evaluation. This is not entirely true, however, because independent testing authorities (ITAs) referenced by HAVA are allowed to view proprietary code in order to conduct evaluations of software robustness. Furthermore, following an Election Assistance Commission strategic plan announcement in June 2004, five major proprietary software vendors of DREs (Election Systems and Software, Diebold Election Systems, Sequoia Voting Systems, and Hart InterCivice) have voluntary released their source code to the federal government for safekeeping in the National Software Reference Library

IMPACT OF FIXING AMERICA'S VOTING SYSTEM

The disputed American presidential election of 2000 has made it clear that we can no longer take our election procedures for granted. This election was ultimately decided by a margin of 537 votes, an insignificant sum when one considers that as many as 6 million ballots throughout the United States either were not counted or were prevented from being cast in the first place (Selker, 2004). In order to prevent a recurrence of the voting problems Americans experienced in 2000, Congress in

2002 passed the Help America Vote Act (HAVA). Under the auspices of this act, $3.6 billion dollars was distributed to local jurisdictions in an effort to improve voting procedures. Yet despite this massive effort, many contests in the 2004 election below the presidential level continued to be plagued with problems similar to those we saw in 2000.

In 2002, U.S. Congress passed the Help America Vote Act (HAVA) which provided $3.9 billion in funding for states wishing to implement electronic voting systems. In addition, the HAVA outlined steps that states should take in order to fulfill voting requirements for election integrity. These recommended guidelines cannot strictly be enforced by states, as the right to choose and implement the voting process is not established by federal mandate but by the local municipalities holding the voting (Stewart, 2005).

This state of affairs is both puzzling and astonishing. The United States possesses the information technology capable of successfully tracking the transactions required to fuel an $11 trillion dollar economy (CIA, 2005). Billions of these transactions occur daily with few if any mistakes being made by the systems required to process them. Why then is it so difficult to conduct an election consisting of around 100 million votes occurring at only infrequent intervals? We expect a great many things from our voting system, some of which are mutually exclusive. To a great extent, fixing our voting system will involve finding the right balance of tradeoffs among undesirable factors rather perfect solutions.

CONCLUSION

What has been explored in this article is the feasibility of developing an e-voting system for national elections. The Internet (remotely) and DREs (polling sites) have been looked at in comparison to traditional mechanical voting methods in terms of usability, accuracy and audit. In light of the many advantages and disadvantages, it appears that our democracy has enough faith in e-voting, in whatever form it may take, for it to become common practice. Unanswered questions center on a social critique of e-voting from a digital divide perspective—whether wealthier homes are more likely to have Internet access and, hence, vote more easily than poorer homes.

Finally, a concern express by Selker et al. (2003) while addressing the problems of usability in new e-voting technologies. Of course, specialists must be involved in the process of designing systems that are voter-friendly. Perceptions of validity among voters are key factors in switching technologies. If there is no trust in an e-vote system, the entire experience will be altered in ways that extend beyond the real threats. The democratic system itself will be endangered.

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KEY TERMS

Direct Recording Electronic Systems: DREs, as they are commonly abbreviated, are a new technique for collecting and counting ballots. This system utilizes, in most cases, some form of touchscreen and stores the vote results in a back-end database server.

HAVA: Help America Vote Act. This act provided funding to states to encourage the adoption of new electronic voting systems. It also provided voluntary federal guidelines to be followed in implementing these systems.

ITA: Independent Testing Authority. These companies are authorized by the government to test and certify proprietary DRE software and hardware systems.

Optical-Scan Voting Systems: Optical-scan voting systems requires voters to use a pen or pencil to fill in an oval or connect dots on a paper ballot. This is the same system used to record test scores on standardized tests like the SATs.

Paper Trail: The ability to track votes through tangible means, as opposed to electronic auditing procedures.

Punch-Card Voting Systems: Punch-card voting systems are operated by punching holes in cards that lock into holder devices. Holes in the card correspond to the appropriate candidate or issue in the device holder book.

Vote Accuracy: Conformity of the output data of a vote-tallying system with logically correct and acceptably precise treatment of all input data provided to the system.

Category: Concepts, Trends, and Challenges

Electronic Word-of-Mouth

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INTRODUCTION

One of the most powerful and pervasive influences on consumer behavior is variously described as "social communication," "word-of-mouth," "opinion leadership," or "buzz." These terms all refer to the effects that consumers have on each other when they communicate. The importance of off-line social communication has long been recognized by social scientists (e.g., Lazarsfeld, Berelson, & Gaudet, 1944) and especially by marketing management (Dichter, 1966; Whyte, 1954). Good word-of-mouth (WOM), the term most often used in business, is still considered to be the most effective form of promotion, so it is highly valued by marketers (e.g., Dye, 2000; Walker, 1995). The advent of the Internet and the growth of the World Wide Web, however, have given consumers an entirely new realm in which they can communicate and thus influence each other (Negroponte & Maes, 1996). That they do so with a vengeance is evidenced by the sheer amount of social communication online, by the many forms these interactions assume, and by the grudging acknowledgment by marketers and managers that this has become a vital component of e-commerce (e.g., Kirkpatrick & Roth, 2005). This article explains some of the theoretical aspects of social influence, describes the many ways social influence operates online, and suggests methods by which marketers can manage this force to benefit their brands.

BACKGROUND

Social communication is distinguished from mass communication, the formal communications marketers and advertisers use to persuade consumers to buy their brands (see Schiffman & Kanuk, 2004). The elements of these marketer-dominated strategies consist of advertising in all its many forms, personal selling, sales promotion, public relations, and publicity, making up the Promotion component of a marketing strategy. These communications are characteristically one way or unidirectional, highly scripted, impersonal, and use media, thereby permitting few opportunities for consumers to respond. These communications take the form of "one-to-many."

In contrast, social communication (see Gladwell, 2000; Weimann, 1994) takes place when consumers talk (face to face or at a distance) or write to each other. (Some social communication is non-verbal signaling using body language or symbols ("you are what you drive") or imitation, which occurs when consumers copy other consumers' behaviors. These topics are better discussed under the rubric of "reference group theory.") Like formal marketer-dominated communications, informal, consumer-dominated communications often include two elements: information and advice. Information refers to the objective, descriptive elements of communication that are factual or presumably fact based. Information answers the questions: "who, what, why, when, where, and how?" Advice refers to the opinions of others. Advice describes a subjective evaluation part of a communication relating to whether the topic is good, bad, worthwhile, valuable, and so forth. Advice is present when one party attempts to persuade or change the mind of the other party. It is the answer to the questions: "What did you think of it?" or "Did you like it?"

Social communication stands in contrast to formal communication because it is informal, personal, unscripted, encourages feedback and exchange of information, and does not require media to take place. Social communication is usually "one to one." We distinguish two principal ways social communication takes place. It occurs first in the course of ordinary, casual conversations in which the topics of shopping, buying, owing, or consuming arise without the participants deliberately broaching them. Information thus is exchanged, and one party of the conversation might attempt to influence the other, but there is no premeditated effort to seek or give opinions.

Social scientists have not directed most of their attention to this casual form of consumption-related social communication, but instead have focused on a more deliberate, premeditated, and purposeful type of social exchange. This is usually referred to as "word-of-mouth" or "opinion leadership." In this instance, some consumers seek out others whom they view as credible (knowledgeable, trustworthy, attractive) and solicit both information and advice. Thus, social communication can be taken as the broadest descriptive term for this phenomenon, and word-of-mouth can be considered an informal, generic term for either casual conversations or opinion seeking/opinion leadership. The slang term "buzz" is currently used to refer to any type of social communication, but most often today seems to refer to these communications when they take place online (Darlin, 2003; Dye, 2000; Rosen, 2000).

Social communication is powerful because people trust others more than communications from marketers, owing to a perceived lack of vested interest. Why would someone try to persuade you to buy a product when they do not benefit; but advertisers and marketers always benefit when you buy. The aspects of attractiveness, expertise, and trustworthiness (i.e., credibility) of information sources are of prime importance in deciding whether to place credence in a message, and personal contacts frequently are perceived to be superior to impersonal marketing messages in this regard. Consequently, social communication is a powerful influence on consumer behavior. Its extension to the Web, and even to other new forms of communication such as mobile commerce, represent a challenge to marketing managers who lose their ability to influence via promotion. It also gives public policymakers new opportunities to promote social goals by enlisting the influence of consumers online to spread socially beneficial information more efficiently and effectively than limited advertising budgets ever could. Thus, it is important to understand the types and nature of eWOM.

SOCIAL COMMUNICATION ON THE INTERNET

The Internet gives consumers many opportunities to share information and to give opinions. Thus, we would expect to find consumption-related elements embedded within the context of other cyber conversations occurring in e-mail, blogs, and listservs. This is analogous to the casual, unpremeditated word-of-mouth so common offline. Because what is transmitted on the Internet can be collected and preserved, researchers can perform content analysis of these cyber conversations to determine main themes and to detect trends in consumer behavior. Moreover, the deliberate seeking and giving of information and advice featuring opinion leaders and opinion seekers online constitutes a major aspect of e-commerce, an important source of information for consumers, and an opportunity for marketers to influence consumer behavior. The ability of consumers to receive the information and advice of other consumers online is part of a general shift of marketplace power from producers to consumers (Baker & Green, 2005; Donation, 2003; Kiecker & Cowles, 2001). As markets fragment, communications media proliferate, and traditional promotion tools such as advertising lose effectiveness, marketers increasingly turn to techniques such as WOM to influence consumers.

Why do consumers give opinions online? The extensive body of research and theory on social communication provides us with several key insights. Information givers can be motivated by their interest in the product category; they enjoy talking about it with other consumers. They like to exhibit their product knowledge and expertise, thereby also gaining status and respect. Advertisements can form the stimulus and content of conversations when they are particularly memorable, entertaining, or informative. Opinion givers can be genuinely motivated by a desire to help other consumers or by the analogous desire to help a favored brand. Negative WOM is often motivated by a desire to punish firms that have offended the consumer through insensitive, incompetent, or irresponsible behaviors, strategies, or products. Revenge is sweet. Online, some additional motives for giving opinions are a desire for social interaction and for economic incentives (Hennig-Thurau, Gwinner, Wlash, & Gremler, 2004).

The motives for seeking opinions are also many and varied. As sources of information, opinion leaders are sought out because it is simpler, cheaper, and easier to consult them than it is to locate and to examine marketer-dominated advertising, promotion, and sales personnel. As noted above, personal sources of information are trusted more than impersonal sources. Other people might have more direct and specific experience with a brand than any other source of information about it. Seeking prepurchase information is an effective way to reduce the risk of buying and consuming, especially for big-ticket purchases or for “experience” products (those purchases consumers cannot evaluate prior to purchase, such as a vacation, entertainment, or restaurant) or “credence” products (purchases consumers cannot evaluate confidently even after they are consumed, such as financial products or medical/dental services). Finally, some consumers seek opinions from others because they are seeking contact with other people in addition to the information they receive, thereby satisfying some of their need for social interaction.

How do consumers share opinions online? Although it seems as if new forms of online communication continue to appear, at this point in time there are at least nine unique ways in which consumers can seek and give information and opinions online. While there is no unequivocal way to order or classify these communication modes, they are presented here roughly in order of how much they are controlled by consumers vs. how much they are controlled by marketers, recognizing that these are gray areas on the Internet and often these communication channels are integrated within each other.

The first avenue for online social communication was *e-mail*. Consumers talk about consumption online in much the same way they do via surface mail, with the added dimensions of speed and convenience that e-mail provides, becoming perhaps, "word-of-mouse". *Instant messaging* is a similar form of this social communication channel analogous to the telephone.

A related type of social communication takes place via *listservs* or *forums*. These are e-mail discussion groups with regular subscribers whose messages are forwarded to all members of the list. A listserv provides a superb way for consumers to ask about products and brands, and receive the opinions of many other consumers.

Bulletin boards or *newsgroups* are areas online where users can post messages on selected topics for others to read. Such sites yield threaded discussions that can provide detailed, authentic information if they are organized and accessed correctly. An example of a product-focused bulletin board is www.saturn.com/mysaturn, a site for Saturn owners to discuss their cars, thereby providing many opportunities for product-related social exchange. Another good example might be Rotten Tomatoes, a popular site for movie reviews submitted by ordinary consumers that are arranged and featured by the site organizers, by and for movie buffs (Grover, 2004). TripAdvisor.com also provides destination reviews by travelers.

Similar to bulletin boards are *chat rooms*. These are virtual meeting grounds where groups of regulars come to gab in real time. There are so many of these online that several sites have been created to simply list them (e.g., http://chat.yahoo.com).

Encompassing some of the above channels, but more extensive and formal, are *online communities* (also called *virtual communities*). These Web sites vary in the scope of their content, from fairly simple lists of resources to complex cyber environments offering visitors information, entertainment, and opportunities to socialize with likeminded individuals. Some of these have arisen spontaneously from the efforts of dedicated individuals, while others are sponsored or managed by companies (see Flavian & Guinaliu, 2005). Examples would be communities based on interests such as virtual vineyards, communities based on relationship communities such as The Cancer Forum (Armstrong & Hagel, 1995, 1996), or communities held together by interests in products or brands such as apple.com/usergroups.

While companies may sponsor virtual communities, or they may arise spontaneously from the efforts of individual creators, *homepages* are the property of their creators, expressing their individuality and need to communicate with other interested individuals. Many homepages contain the opinions of their owners for others to read and respond to, so that homepages can contain e-mail, chat rooms, or listservs, and will certainly contain links to virtual communities and newsgroups. Homepages may also contain *blogs*, or Web logs, online diaries where writers can publicize whatever is on their minds. Increasingly, blogs are coming to exert great influence in the marketplace as they come to be consulted by more and more consumers seeking information and advice (see Baker & Green, 2005; Kirkpatrick & Roth, 2005).

Similar to homepages are product-specific *suck sites* (also called *hate sites*). These Web pages are devoted to criticism of specific firms (e.g., *Wal*MartSucks.org*; there are lots of these!), providing consumers an opportunity to air grievances and express dissatisfaction with businesses (Crush, 2000). Site visitors will certainly read stories and learn the opinions of other consumers from these sources of interpersonal information.

Finally, many sites provide opportunities for consumers to post *product reviews* that other consumers can consult (again, rottentomatoes.com does this). For example, Amazon.com encourages consumer product reviews of the books and music sold there. Reading what another consumer thought of a book is getting their opinion, and since they have the personal experience of reading the book, they act as an opinion leader for it. Often, consumers are asked to rate a product, and these ratings are summarized in a simplified form (how many stars did the product get or what percentages of buyers liked the product), giving other consumers the collective opinions of many consumers.

Given this variety of eWOM, companies can react in many ways. Although some firms choose to ignore what consumers tell each other about their brands online, this is probably not the most prudent course of action (see Baker & Green, 2005; Crush, 2000). Kirkpatrick and Roth (2005) describe the unhappy experience of the Kryptonite lock company, one of whose products was revealed to be defective. This news spread rapidly on the Internet, and instead of admitting the problem, they denied it and waited until a crisis broke, costing the company $10M to fix and hurting their reputation. Instead of ignoring eWOM, firms try to manage it to their advantage in three ways (see Goldsmith & Litvin, 2005).

First, eWOM is a useful source of information, a type of market research. Firms can learn what consumers think about them and their brands. Managers see what consumers are saying that can alert a firm to potential problems that can be fixed promptly. They gain crucial insights about competitors. New product ideas can be suggested by consumer discussions of unmet needs and wants, and unsolved problems. Second, firms that monitor and respond to eWOM can blunt criticism and quickly solve problems, thereby creating good feelings, enhancing their reputations, and stimulating positive eWOM. Third, firms can try to encourage positive eWOM using a combination of tried-and-true techniques for managing offline WOM (Dichter, 1966; Haywood, 1989), combined with newer techniques emerging from the cyber marketplace. This approach is now commonly referred to as "buzz management" and can be very effective (e.g., Darlin, 2003). Similarly, firms can try to get customers to pass along their marketing message to other consumers online. This form of managed social communication is termed "viral marketing" (Lindgreen & Vanhamme, 2005). Rewards or incentives, connecting the marketing message to some area of concern (such as the environment), and designing the viral marketing message to be amusing or entertaining are some of the ways marketers encourage customers to spread the word about the brand.

FUTURE TRENDS

The variety of ways to communicate online are not only bidirectional, they are becoming one-to-many and many-to-many, thereby increasing the opportunities consumers have to consult with other consumers, increasing the speed and power of WOM, and increasing the importance of this force to the health of brands and companies. Work by RoperASW for the last two decades has focused attention on the *Influentials*, that 10% of the general American population that exerts disproportionate influence on their fellow citizens by virtue of being sought out for their opinions (Keller & Berry, 2003). Online, there appear to be the *e-fluentials*, the 10% of Internet users who exert disproportionate influence on other users' Internet-related behavior. Because these individuals are likely to become more influential with time, mangers are likely to want to identify these consumers and market to them in much the same way they currently market to off-line opinion leaders.

As firms adjust to new realities, eWOM will be come commonplace and part of the broader system of integrated marketing communications that many firms now design as a normal part of their overall marketing strategies. Because this phenomenon is evolving over time, companies will develop new techniques to monitor, respond, and manage eWOM. Consumers will likewise learn to use eWOM more effectively and efficiently. Thus, the point/counterpoint competition between companies and their consumers will continue. As mobile commerce becomes more commonplace, consumers will seek each other's advice using this medium as well, resulting perhaps in *mWOM* as a unique extension of the basic tendency for humans to consult with each other before making decisions or just to discuss topics of interest. The understanding of eWOM and these other manifestations will be advanced as new studies are conducted.

CONCLUSION

Consumers have always talked about shopping, buying, owning, and consuming. They have always sought and given opinions. Social communication has always been powerful. The Internet provides consumers with many new opportunities to continue these behaviors. The speed, ubiquity, and freedom of the Internet magnifies them and contributes to the general transfer of power from companies to consumers that characterizes the 21st-century marketplace. Faced with this changing informational landscape, companies cannot ignore eWOM. They must come to terms with it and develop their own creative responses that minimize its harmful effects while bringing real benefit to the firm. Marketing theorists and researchers will focus on eWOM to integrate it into the panoply of marketing doctrine and education, and study it empirically to reveal how it works and how it can be managed.

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KEY TERMS

Blog: A Web log. An online diary in which a Netizen or Cybercitizen records thoughts and opinions on a theme or topic of interest to its creator.

Buzz: A buzzword referring to word-of-mouth offline or on the Internet.

Chat Room: A Web site where many individuals can talk in real time via instant messaging.

E-Fluentials: The 10% of Internet users who manifest the greatest influence on other Internet users' online behaviors.

E-WOM: Electronic word-of-mouth, or social communication on the Internet. Web surfers either transmitting or receiving product-related information online.

Listserv: A collection of online users who have chosen to belong to an e-mail-based information exchange.

Suck Sites: Hate or revenge sites. Web sites that focus on consumer complaints and dissatisfaction with specific companies.

Viral Marketing: When individuals forward information online to each other so that it spreads exponentially like a virus or rumor.

E–Marketplace Regression of National Trucking Exchange

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BACKGROUND OF THE BUSINESS

This article discusses a business-to-business (B2B) electronic marketplace's (e-marketplace's) turnaround. National Trucking Exchange (NTX), a pseudonym, became one of the first true B2B e-marketplaces when it transferred its dial-up exchange to the Internet in 1996 (Patsuris, 2000). For 5 years, NTX struggled to conduct transactions. When the business environment changed and NTX incorporated powerful organization's preferences, its turnaround began. NTX's experience shows how using power and overcoming competition facilitates bringing a critical mass of competitive organizations together to form an information-technology initiative benefiting the entire industry. The article discusses NTX's background, describes its business, and offers lessons from NTX's turnaround.

These insights are based on a case study (Dube' & Pare', 2003; Eisenhardt, 1989) of NTX's B2B e-marketplace. The study spanned the dot-com boom, bust, and stabilization. The research included field visits with NTX, its organizational members, and a buyer and a seller that declined NTX's membership invitations. Data collection included participant observations, system demonstrations, interviews, surveys, and internal and external document reviews. We interviewed the people in each organization responsible for the organization's NTX participation.

NTX is a B2B e-marketplace for the United States transportation industry. B2B e-marketplaces bring together businesses wishing to sell and those wishing to buy goods and services. They promise trading communities increased business purchasing efficiency and economy by replacing traditional, limited seller-buyer networks with a B2B e-marketplace with many more sellers competing on cost, quality, and service. Sellers can contact more buyers more efficiently.

NTX's founder and a venture capitalist group formed NTX in 1994 to solve the transportation industry's unused-capacity problem. Unused capacity occurs when carriers deliver products along their routes and their remaining trailer capacity is empty (Patsuris, 2000). The American Trucking Association estimates that United States carriers travel 12% of their miles without a payload (Patsuris).

DESCRIPTION OF THE BUSINESS

This section describes NTX's service offerings, management, and reasons for success.

Service Offerings

NTX developed technology bringing shippers and carriers together into an open B2B e-marketplace. NTX enables shippers to post their shipping needs on a Web site. Carriers view the Web site by geographic region and accept loads meeting their specifications. The Web site includes the load's location, pick-up time, delivery time, weight, size, refrigeration needs, and shipping price. The shipping price is the amount the shipper is willing to pay for the load's transport less NTX's fee. NTX assesses a transaction fee on loads tendered over the e-marketplace. Transaction fees vary. To increase transaction volume, NTX does not assess a transaction fee on some loads. NTX membership is free.

Shippers post loads to NTX's Web site. In most cases, a carrier's central dispatch locates loads. If an existing load does not fill a truck or if the carrier does not have a load to haul back to its origination, the central dispatch can find other loads on NTX to fill the truck. Carriers accept loads using NTX's Web site. NTX immediately notifies the shipper. The shipper then prepares the load for the carrier. NTX does not disclose shipper and carrier identities. Keeping shipper names anonymous prevents carrier salespeople from soliciting the business. Carrier anonymity prevents carriers from knowing they are participating in an e-marketplace with one another. The transportation industry is competitive and carriers do not like being compared in an open e-marketplace with one another.

NTX offers shippers and carriers value for less-than-truckload freight. Less-than-truckload freight occurs when shippers hire a carrier to transport a product that does not fill the truck. Carriers must charge for the entire truck to cover the truck and the driver miles traveled. By bringing shippers and carriers together, NTX increases the chances of consolidating loads into one truck. This lowers shipping costs and increases carrier profits. Mileage and driver costs are spread over many shipments. For carriers, once loads cover costs, additional loads become profit. Shippers in our study developed spreadsheets calculating their savings from using NTX. The spreadsheets listed by load the usual shipping cost, cost using NTX, and savings. The shippers felt that NTX use had saved their company money substantially.

NTX reduces shipper and carrier search time. Over the years, large-volume shippers and carriers have developed long-term relationships facilitated by prenegotiated contracts and electronic data interchange (EDI; Premkumar, Ramamurthy, & Crum, 1997; Williams, 1994). These relationships reduce carrier and shipper search costs. However, nonroutine shipments, either occasional shipments or shipments falling outside a carrier's routine shipping area, require soliciting bids. This process involves calling carriers, providing load information, and requesting prices. Because of quote variations and carrier availability, shippers must solicit bids from several carriers. A sales representative comments, "Finding a carrier to transport a load could take all day."

Before NTX, carriers used regional brokers like dial-a-truck to fill unused truck capacity. Shippers telephone dial-a-truck with available loads. Carriers telephone dial-a-truck to find available loads. Since time passed between calling in or accepting a load, and updating dial-a-truck's load listing, errors occurred. NTX's Internet-based model is more efficient, dynamic, accurate, and timely.

By-products of NTX's core value proposition include accounting-practice simplification and report improvement. NTX simplifies shipper and carrier accounting practices. NTX reduces the number of vendors shippers have to pay. One monthly bill detailing all NTX-tendered loads replaces bills for each carrier and each load. NTX reduces the accounts carriers have to collect. Carriers receive bimonthly checks from NTX for all NTX-tendered shipments. NTX offers improved reporting. Shipper reports show the savings from NTX use. The report compares the shipper's expected price to NTX's transacted price. The tracking reports track loads to the stock-keeping-unit level.

NTX has standards. Carriers must achieve certification. Passing certification requires maintaining insurance and current inspections. Carriers and shippers must follow NTX's business rules. Carriers must pick up and deliver loads on time and in good condition. Shippers must have loads ready for pick up at the specified time. NTX imposes a $200 fine for rule violation. If a party violates the business rules three times, NTX bans further participation.

NTX is a Web site on the Internet. Anyone with an Internet connection and computer or other Internet access device can use NTX. NTX's customer-support methods includes e-mail, Internet, fax, and telephone. NTX e-mails and faxes load confirmations. Customers frequently contact customer support using the telephone. Sales and initial training occur in person or over the Internet.

Management

While private investors and venture capitalists funded NTX, NTX struggled until the e-marketplace cultivated industry relationships. Today, NTX's management team and sales representatives are from the transportation industry. A president, chief executive officer, and board chairman; a chief financial officer and treasurer; and a technology vice president comprise NTX's management team. NTX's labor force includes sales representatives and customer-support analysts. Becoming a sales representative requires transportation-industry experience, expertise, and contacts. Sales representatives solicit shipper and carrier membership, train members, maintain customer relationships, and customize marketplace solutions to customer needs. Shippers and carriers comprise NTX's customer advisory board. The board ensures NTX's cognizance of customer needs.

Success Reasons

Innovation-diffusion theory links "an innovation being better than the ideas it supersedes to its adoption" (Rogers, 2003, p. 265). The American Trucking Association estimates that unused capacity costs the transportation industry $22 billion dollars annually (Patsuris, 2000). Even though NTX could help solve this problem, it struggled achieving use. A business environment change and e-marketplace regression contributed to NTX's success.

Environment Change

The year 2000's (Y2K's) aftermath and September 11, 2001 facilitated NTX's success. In Y2K's aftermath, NTX's membership doubled. American information-technology departments had spent unprecedented amounts making systems Y2K ready. Countries that dedicated few resources to Y2K preparation experienced minimal problems. In the aftermath, many believed information-technology departments had wasted resources preparing for Y2K. Under pressure, many information-technology departments were exploring ways to deliver savings. Many organizations adopted NTX to do so.

NTX's membership further increased after September 11, 2001, when America's economy slowed. Carriers reduced fleet sizes and a freight shortage occurred. With less freight capacity available, freight rates increased. Reflecting market prices, NTX offered better rates than carriers' long-term, fixed-price contracts. Carriers broke contracts and began using NTX. Shippers struggled finding carriers. They started using NTX to find them. NTX thought excess freight was its biggest strength, but freight shortages were it's biggest.

Environmental change stimulated other B2B e-marketplaces' formation. E-marketplaces in the London insurance market (Barrett & Walsham, 1999), the Dutch flower market (Kambil & van Heck, 1998), and the United States utility industry (Koch, 2004) formed in response to industry business-environment changes. Record numbers of B2B e-marketplaces formed in response to a business environment encouraging EC. When the boom turned to bust, B2B e-marketplaces failed in record numbers (Day & Fein, 2003). This may indicate that while business-environment change can motivate e-marketplace membership and formation, when the environment changes again, the motivation may not endure.

Regression

NTX began achieving significant volume when it regressed to support preexisting freight arrangements. In the transportation industry, prenegotiated contracts cover most loads. Shippers prefer prenegotiated contracts because they routinize load tendering and ensure products are delivered on time and in good condition. Shippers perceived that the labor costs and risks of open e-marketplace use exceeded the potential cost savings from routine, open e-marketplace carrier comparison. For carriers, prenegotiated contracts routinize the load-tendering process, enable load consolidation to fill truck capacity, increase profits, and facilitate maintaining a stable labor force and adequate fleet size. Carriers believed NTX's requirement that carriers accept shipper prices would lower freight prices. Since NTX required carriers to monitor NTX's Web site to find shipper-posted loads, carriers perceived that the labor costs would increase.

Given shippers' and carriers' preference for preexisting contracts and the fact that preexisting contracts cover most loads, large-volume shippers and carriers rarely used NTX. Without large-volume shippers' and carriers' volume, the chances of a shipper-posted load being in a carrier's geographic region were unlikely.

To survive, NTX regressed to support existing relationships. Industry relationships and customer input facilitated NTX's regression. After struggling to attract members, NTX hired sales representatives with industry experience. They presented NTX to industry contacts. The contacts recognized NTX's value for loads not covered by existing freight arrangements and recognized NTX's potential for managing their existing carrier arrangements. NTX incorporated this input and regressed the e-marketplace to support existing freight arrangements. Large-volume shippers began using NTX to electronically facilitate existing freight arrangements. When a shipper's existing carriers were not available, the shipper used NTX. They first used NTX to procure freight from second-tier, company-selected carriers. When this carrier tier was unavailable, shippers posted loads to the open marketplace for any carrier. Shippers required their carriers to join NTX. This brought the carriers to NTX and made their excess capacity available on the open e-marketplace. With large-volume shippers' and carriers' routine NTX use, small-volume shippers and carriers that do not have prenegotiated contracts increased their benefits.

Surviving B2B e-marketplaces in the utility (Koch, 2004) and health-care (White & Daniel, 2004) industries also support existing relationships. Two e-marketplace failures in the convenience-store industry did not support existing relationships (Koch, 2005). The utility industry B2B e-marketplace was founded on matching buyers and suppliers, but evolved to support relationships after struggling with the open e-marketplace model. This may indicate that facilitating existing relationships is key to e-marketplace success. However, this raises the question of whether these surviving e-marketplaces are e-marketplaces.

LESSONS LEARNED

Of 1,734 B2B e-marketplaces that formed in 2000, analysts predicted 407 would remain (Meehan, 2002). NTX is one of these. This article provides insight into NTX. NTX formed in 1994 and began operating in 1995. It executed the transportation industry's first online logistics trade in 1996. NTX struggled for 5 years to attract members and tender loads. The study tracks NTX during the dot-com boom, bust, and stabilization. Contrary to many dot-com endeavors, NTX struggled through the dot-com boom and began attracting members and achieving significant volume during the aftermath of Y2K and September 11, 2001. NTX has attracted over 2,500 shippers and carriers (NTE, 2002a, 2002b), and tenders over 10,000 transactions daily.

Developing information-technology initiatives for which benefits depend on a critical mass of self-interested organizations' participation is difficult. Unlike single-organization information-technology implementations, no organization in a B2B e-marketplace has the power to force the change. Understanding power relationships and competition can help B2B e-marketplace makers develop an e-marketplace using member critical mass. NTX's turnaround offers lessons in power and competition.

Power

Lesson 1: When powerful organizations perceive that B2B e-marketplace use offers their organizations a relative advantage, they will join the e-marketplace and encourage their business partners' membership.

NTX began achieving significant volume when they modified the e-marketplace to support powerful organizations' preferences. In the transportation industry, large-volume shippers have power. Carriers depend on shippers for revenue. When NTX modified its e-marketplace to support shippers' preferences, the shippers joined and encouraged their carriers' membership. NTX could not convince large-volume carriers to join its e-marketplace. The carriers felt NTX's price-comparison model did not emphasize their strengths. Carriers joined NTX when their shippers requested their membership. The shippers interviewed in this study indicated that their primary membership motivation was maintaining their shipper contracts. The same pattern occurred with the electronic-data-interchange adoption. Carriers did not want to adopt electronic data interchange. They adopted it at their shippers' requests (Premkumar et al., 1997; Williams, 1994).

This observation shows how power facilitates e-marketplace adoption. Power theory (Emerson, 1962) and resource-dependency theory (Pfeffer & Salancik, 1978) posit that organizations depend on other organizations to the extent that an organization needs resources or performances from the other organization, and in inverse proportion to the extent that others can provide the same resources or performances. The theory explains that powerful organizations can influence the activities of organizations that depend on them.

The interorganizational information-systems literature supports our finding that offering powerful organizations a relative advantage facilitates adoption. Many firms adopt electronic data interchange to maintain powerful trading-partner relationships (Chwelos, Benbasat, & Dexter, 2001; Iacovou, Benbasat, & Dexter, 1995). B2B e-marketplaces that do not offer powerful organizations a substantial relative advantage fail (Kambil & van Heck, 1998; Koch, 2005; Lee & Clark, 1996).

Despite evidence that power facilitates e-marketplace adoption, e-marketplace makers and powerful trading partners must be aware of power's negative effects. Using coercive power to force weaker business partners' e-marketplace adoption can degrade business-partner relationships and cause coerced parties to distrust the e-marketplace (Allen, Colligan, Finnie, & Kern, 2000). A marketplace's adoption may slow if marketplace participants perceive the e-marketplace will transfer power to the other participants (Barrett & Walsham, 1999).

Competition

Lesson 2: B2B e-marketplaces may overcome competitive organizations' resistance to participate with one another in an open e-marketplace by having trading partners solicit their membership.

The trade press (Memishi, 2001) and empirical research (Koch, 2003) show that organizations with competitive histories do not want to participate in an e-marketplace with one another and do not want to collaborate to build an e-marketplace benefiting all industry participants. Given the transportation industry's competitive nature, why did carriers join the same e-marketplace as one another? Shippers drove membership, not carriers. Since shippers come from an array of industries, they are not competitive with one another. Shippers did not mind being in the same e-marketplace as one another or sharing information to improve the e-marketplace's operations. Competitive forces actually facilitated the carriers' membership. The carriers in our study explained that they joined NTX to maintain their shipper contracts and ensure their competitors did not secure their contracts. This is a pattern in the transportation industry as these same reasons motivated carrier EDI adoption (Premkumar et al., 1997; Williams, 1994).

Empirical research shows that industry competition affects e-marketplace success. B2B e-marketplaces in the United States utility (Koch, 2005) and United Kingdom health-care (White & Daniel, 2004) industries achieved success and linked their success to the industries' non-competitive nature. Two B2B e-marketplaces in the United States convenience-store industry failed partly because of the industry's competitive nature and partly because of the industry organizations' reluctance to collaborate and participate with one another (Koch, 2003). While competition can inhibit membership, if an e-marketplace takes an approach opposite of bringing competitors together to collaborate, competition can stimulate membership.

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Category: Concepts, Trends, and Challenges

Emergent Semantic Web

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INTRODUCTION

In less than a decade, the World Wide Web has become popular because of the depth of information it provides and the simplicity of its usage by simple clicks through related and interlinked pages. However, the amount of information and the numerous formats in which it is presented are simply overwhelming, and it is not uncommon to get overloaded with irrelevant or unrelated information. For example, a simple search task of finding books written by an author named David Flower would fetch hundreds of pages that merely contain the words David and/or Flower.

The Web contains information on millions of Web pages interwoven by the use of hyperlinks and presented in rich HTML (hypertext markup language) formats, such as images, graphics, audio, and video. This rich presentation capability makes the Web highly readable for humans, but adds no meaning to the information when read by computers.

The Semantic Web, which is considered to be the next evolution of the current Web, would qualify information with well-defined meaning. This added meaning to data, called metadata, would enable computers and people to work in cooperation (Hendler, Berners-Lee, & Miller, 2002). In addition to having hyperlinked pages containing media objects, the Semantic Web will also contain resources pointing to real-world objects such as people, places, organizations, and events. These objects will be linked based on their real-world relationships.

Another goal of the Semantic Web is to develop enabling standards and technologies designed to help machines understand more information on the Web so that they can support richer discovery, data integration, navigation, and automation of tasks (Berners-Lee, Hendler, & Lassila, 2001). The current Web has the potential of becoming the largest database system, but it suffers from its foundation as a presentation media. This article addresses issues involved in effectively storing and managing data on the Web and focuses on various research activities in this direction.

The Semantic Web is a vision that will extend the current Web to give well-defined meaning to information, enabling computers and people to work in better cooperation. A collaborative effort between the World Wide Web Consortium (W3C) and a large number of researchers and industrial partners is defining standards and technologies required for building the Semantic Web. This effort will enable data to be understood by machines and will be used for effective discovery, automation, integration, and reuse across applications.

BACKGROUND

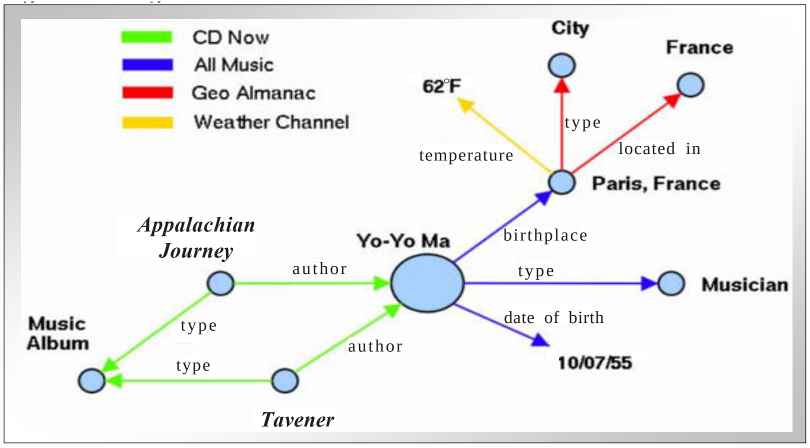
The Semantic Web is not just a web of documents; it is a web of relations between resources representing real-world objects, such as people, places, and events. It includes documents describing explicit relationships between objects and containing semantic information intended for automated processing by the machines.

Figure 1 shows a small chunk of the Semantic Web corresponding to the cellist Yo-Yo Ma (Guha, McCool, & Miller, 2003). It contains objects such as the city of Paris, the musician Yo-Yo Ma, the music album *Appalachian Journey*, and so forth. It is clear from the diagram that many different sources such as CD Now, All Music, Geo Almanac, and the Weather Channel have published different types of information about Yo-Yo Ma.

The Semantic Web extends the cumulative knowledge about any resource in a distributed fashion. This example illustrates the basic idea behind building the Semantic Web.

To transform the novel idea behind the Semantic Web into a reality, the designers of the Semantic Web are following a bottom-up approach to deal with the complexities involved in such a gigantic structure. They are building simple components for specific purposes that can be glued together in a layered structure. Figure 2 displays this layered architecture of the Semantic Web along with its various components. Some of the major components are described in the following section.

Figure 1. A segment of the Semantic Web (Source: Semantic Search)



SEMANTIC WEB ARCHITECTURE

In this section, some of important architectural components of the Semantic Web are analyzed and a proposal is derived.

Infrastructural Components

Uniform Resource Identifiers

Each item on the Web is considered a resource, and uniform resource identifiers or URIs are used to uniquely identify them (Swartz, 2002). URIs can be assigned to real-world objects like persons, places, books, and so forth. The most common form of URI is the universal resource locator (URL), which represents the address of a unique Web page on the Internet. However, the primary function of a URI is to identify a resource in lieu of providing an address of a specific file on the Web.

Resource Description Framework

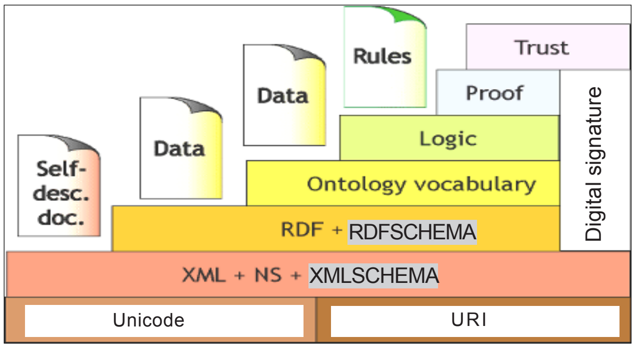
In order to automate the understanding of data by machines, metadata have to be added to describe the data contained on the Web. The resource description framework (RDF) is the standard followed by W3C to process metadata on the Semantic Web (Brickley & Guha, 2000). RDF is a framework to create statements about resources in a machine-readable format and is based on the idea of identifying things using URIs and describing resources in terms of simple properties and property values. This enables RDF to represent simple statements about resources as directed, labeled graphs of nodes and arcs representing the resources and their properties and values (Manola & Miller, 2003).

Ontologies

Ontologies are ways to describe the meaning and relationships between terms. RDF is used to create these descriptions that help computers know how to use different terms.

The ontology for a domain enumerates and gives semantic descriptions of concepts in the domain of discourse, defining domain-relevant attributes of concepts and various relationships among them. For example, an ontology that describes wines will include concepts like vintages, wine regions, wineries, and grape varieties. It will also include relations such as by whom a wine is

Figure 2: Architecture of the Semantic Web (Source: Semantic Web-XML 2000, http://www.w3.org/2000/Talks/1206-xml2k-tbl/slide10-0.html)



produced, from what it is made, its color, its year, and the body of the wine (Noy, 2003).

Logic

One of the biggest challenges in making the computers more intelligent is to enable them to apply logical principles and draw conclusions by inference. This is one of the key research areas in the field of artificial intelligence. Although it is not likely to happen in the near future, we are definitely headed in that direction.

Proof and Trust

As there is no central authority controlling the Web, it is assumed that anyone can say anything about anything. This freedom of expression is a great idea, but it can lead to misuse of this freedom and result in mistrust. If the Web has to become the single source of all information, it has to provide a mechanism of proving trustworthiness. The digital signature is the mechanism that is going to be used to provide proof that a certain person wrote (or agrees with) a document or statement. This will enable users to decide who to trust and who not to.

Inference Engines

Inference engines are one of the main components of the Semantic Web that will process the available knowledge. They will deduce new knowledge from the knowledge already specified to them. The inference engines will apply reasoning over the information that is coming in from all over the Web. They will not have control over when that information arrives, how often it is updated, or how accurate or reliable it is. The engines, therefore, will have to have built-in mechanisms for dealing with these real-time uncertainties. The standardization of the data through the markup languages should make some aspects of building these systems a little easier.

Web Services

The Web, once solely a repository for text and images, is evolving into a provider of automated services in different forms, such as flight-booking programs and a variety of e-commerce and business-to-business (B2B) applications. Web-accessible programs, databases, sensors, and a variety of other physical devices are already realizing these services (McIlraith, Son, & Zeng, 2001). A fundamental component of the Semantic Web will be the markup of Web services to make them computer interpretable, use apparent, and agent ready.

Managing Data on the Semantic Web

The Web is the largest source of data, yet is far from offering the benefits of a database-management system. Database-management systems are characterized by a structural model (the entity relationship model or the object-oriented model) as well as by efficient operations of data extraction and manipulation (the structured query language, SQL). Even though the Web uses many databases at the back end, the structure and semantics of the data is lost when it is squeezed into the Web (Marchiori, 2001). Also, the Web lacks the ability to provide a good way of querying the data. Inside a database, any piece of information has a well-defined meaning in terms of entities and relationships. Considering the example of employee and department tables in a database, the “Dept. No.” column uniquely identifies a department and also defines the relationship between the two tables. This defined relationship makes it very easy to query the employees belonging to a particular department. However, once this information is published on a Web page, both the meaning of the data and the relationship between them is lost. Only a human with the domain knowledge can infer the relationship; the computer has no way to know that the number actually represents a department and that the employees listed belong to that department.

A Proposed Model for Searching Dynamic Pages

Search engines fail to access information from dynamic pages as these pages do not contain any information as such. Their content is built dynamically based on user queries. These pages send the queries to the back-end database and retrieve the information requested by users. Even though the dynamic pages do not contain any data, they do contain the query that gets executed. In the case of relational databases, this query is written using SQL. An SQL query in its simplest form has three clauses: Select, From, and Where. The Select clause lists the data items being fetched from the database. The From clause tells which tables are the source of the information and how they are joined. The Where clause filters the information based on the user’s requirements. SQL is not limited to data-retrieval queries since it comprises a data-definition, data-manipulation, and data-control language.

The collection of dynamic Web pages, referred to as the “deep Web,” is estimated to be around 500 times the size of the “surface Web” (Bergman, 2001). As most of the existing search engines fail to index this vast portion of the Web, there arises the need for intelligent tools that can extract and integrate the results from dynamic Web pages. The key prerequisite for this kind of information integration is obtaining the schema of these Web sites. One of the recent research works in this area (Wang & Lochovsky, 2003) describes the DeLa (data extraction and label assignment) system that can capture the schema and extract data from dynamic Web pages with complex HTML search forms. This makes further manipulation and integration of the data much easier. Future research in this field is directed toward automatically locating the Web site(s) from which users want to extract data objects.

The greatest hurdle in implementing this idea is to have a global identifier for the databases. Without this identifier, it would be ambiguous to identify which database is referenced in the query. The query might be referring to a local database, but there might be many other databases with the same name. With the URI and RDF technologies used for the Semantic Web, a global identifier can be created for all databases (Laborda & Conrad, 2003).

FUTURE TRENDS

As the Semantic Web effort is gaining momentum, numerous research activities in diverse fields are bringing rapid evolution to the technologies. However, there are many challenges ahead regarding the standardization of technology and a consensus about the direction and characteristics of the Semantic Web.

Developing Ontologies

One significant area of concern in the development of ontologies is the difference between the RDF framework and the majority of existing data sources. While RDF is focused on identifying the domain structure, most of today's data sources tend to focus more on the document structure around important objects. For example, RDF would explicitly represent the relationship between a book and its author as "author writes book." However, an XML (extensible markup language) document might represent this relationship only implicitly by embedding an author object inside a book object. The Semantic Web applications need to be able to interoperate with existing data sources by mapping between different domains as well as document structures.

Many research organizations are currently working to develop systems that address the aforementioned problems. One such system, called Piazza (Halevy, Ives, Mork, & Tatarinov, 2003), provides algorithms to map the domain and document structures, as well as enabling the interoperation of XML data with RDF data. Mappings in Piazza are provided at a local scale between small sets of nodes, and its query-answering algorithm is able to chain sets of mappings together to obtain relevant data from across the Piazza network.

Constructing Thesaurus

Another area of ongoing research is the automatic construction of a thesaurus by discovering the semantic relationships between existing Web pages. A hand-coded thesaurus has been widely used in many applications, including information retrieval, natural-language processing, and question answering. Chen et al. (2003) have proposed a new technique to automatically construct a domain-specific thesaurus from the Web using link structure information. The proposed method extracts relationships between terms, and can identify new terms as the Web evolves. Their research is based on the observation that Web pages contain two types of links: navigational links for easy browsing, and semantic links for connecting related pages together.

Semantic Annotation

The vision of the Semantic Web heavily depends on metadata. Ongoing research activities are focused on two approaches to define metadata. The first approach is to create ontologies that will store metadata about entities and provide them when needed. The second approach is to annotate Web pages with semantic tags. Semantic annotation (also called semantic tagging) is the process of augmenting data to facilitate the automatic recognition of the underlying semantic structure. However, the majority of the documents on the current Web do not contain any semantic annotations. With the lack of applications for automatic annotation, it is unlikely that Web developers would add the semantic tags manually. Dill, Eiron, Gibson, Gruhl, Guha, and Jhingran (2003) have proposed an application called SemTag that performs automatic semantic tagging. They have also developed a platform called Seeker that can be shared by different tagging applications.

CONCLUSION

The Semantic Web has the potential to eliminate many of the drawbacks of the current Web by making it understandable by machines. This can be achieved by adding meaning to data by using frameworks such as URIs, RDF, and ontologies. The W3C, in collaboration with a large number of research organizations, is defining the required standards and technologies. The Semantic Web also has the potential of becoming a huge distributed database.

Various XML-based query languages are under development to effectively retrieve the data from various data sources. With the development of the right infrastructure, the inability of current search engines to retrieve dynamic Web pages can be eliminated. There is absolutely no doubt that every Web user will find more than one reason to support the grand vision of the Semantic Web. There are endless possibilities, and the journey itself is worth the effort even if all the goals are not achieved.

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KEY TERMS

Metadata: Metadata are data about data. Metadata are commonly used to identify information that describes a Web asset, most typically an HTML file. Metadata refer to the use of a structured set of elements to describe an information resource and its intellectual property rights. The elements used should assist in the identification, location, and retrieval of information resources by end users.

Ontology: A systematic arrangement of all of the important categories of objects or concepts, which exist in some field of discourse, showing the relations between them. When complete, an ontology is a categorization of all of the concepts in some field of knowledge, including the objects and all of the properties, relations, and functions needed to define the objects and specify their actions.

RDF (Resource Description Framework): A specification developed in 2000 by the World Wide Web Consortium as a foundation for processing machine-understandable metadata regarding resources on the Internet, including the World Wide Web. It uses XML.

Semantic Web: The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries. It is a collaborative effort led by W3C with participation from a large number of researchers and industrial partners. It is based on the Resource Description Framework, which integrates a variety of applications using XML for syntax and URIs for naming.

SQL (Structured Query Language): A language for sending queries to databases. SQL was developed by IBM in the mid-1970s as a way to get information into and out of relational database-management systems (RDBMSs). A fundamental difference between SQL and standard programming languages is that SQL is declarative. You specify what kind of data you want from the database, and the RDBMS is responsible for figuring out how to retrieve it.

URIs (Uniform Resource Identifiers): URIs are short strings that identify resources on the Web: documents, images, downloadable files, services, electronic mailboxes, and others. They make resources available under a variety of naming schemes and access methods such as HTTP, FTP, and Internet mail addressable in the same simple way.

XML (Extensible Markup Language): A specification developed by the World Wide Web Consortium. XML is a pared-down version of the standard generalized markup language (SGML), designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations

Category: Concepts, Trends, and Challenges

Engineering Adaptive Concept-Based Systems for the Web

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INTRODUCTION

In recent years we have witnessed a growing interest in adaptation and personalization in numerous application domains including business, education, and so forth. Applications that offer large bodies of information have in the Web era turned into systems with a significantly different nature than two decades ago. Think of the typical book catalog database from 20 years ago and the Web site of a book seller nowadays. A characteristic aspect of the restyling is the attention paid to the individual user. Technology has evolved and now allows application designers to include adaptation and personalization in the applications. This is especially important in the field of e-commerce, where users (customers) expect personalized services similar to those they receive in a conventional store.

Typical e-commerce systems employ large bodies of information. In the case of a bookstore Web site, the designer defines an appropriate structure for the collection of books with all relevant properties. Generally, the design uses structures of concepts, where the concepts represent the actual information objects. The adaptation engineering is later performed on the level of these (abstract) concepts. We refer to these applications as *concept-based systems*.

Adaptive concept-based systems are especially accepted in areas where the main goal is to tailor large amounts of information to the individual preference and knowledge state of the user. Besides electronic commerce, other examples include online museums (the visitor wandering through the collection on an individual basis) and e-learning applications (the student being involved with learning material in a way that the teacher thinks fits the student's situation).

BACKGROUND

Concept-Based Systems

Most concept-based systems use navigation in one way or another to structure the information they present. The design of navigation is not trivial, and including adaptation in it increases the complexity quickly. A nice example for adaptation and personalization in a business context (customer management) is ATG's Dynamo Personalization Server (http://www.atg.com): explicit user data from marketing databases is combined with implicit information gathered from the user's browsing behavior to provide dynamic content adaptation. Educational applications based on the adaptive hypertext architecture AHA! (De Bra et al., 2003) show how adaptation platforms are successfully used for presenting personalized learning environments.

The typical concept-based system on the Web is a data-intensive information system that contains content retrieved dynamically from a repository and uses hypermedia to present the output:

- The system is *data intensive*. There are classes of adaptive concept-based systems where handcrafting is possible, but typically the collection of information objects is so large that designers cannot do this organization by hand and have to rely on schematic designs.
- The system holds the data elements in a *repository*. Systems differ in the way they materialize this repository. Some assume a fixed set of data elements that are all individually known to the designer. In others the properties of the data elements are known and available for the designer at schema level (like

in databases). Some systems retrieve data in the way we know from search and retrieval engines, leading to yet another engineering process.

- The system uses *hypermedia* to present the output to the user. Systems differ in how they use hyperlinks to structure the output information. Note that this structuring is crucial in communicating the semantics of the output.

Development of Adaptive Concept-Based Systems

Adding adaptation and personalization to the picture influences the three issues mentioned above. Adaptation plays a major role in the hypermedia construction. For example, one might want to look at the user's platform, such that the application presents the (conceptually) same information differently for PC, personal digital assistant (PDA), phone, or other viewer, considering screen size or bandwidth. A different kind of adjustment would be based on the user's previous actions in the application. It is obvious that with the data-intensive nature of the application, including adaptation and personalization in the requirements, immediately leads to a much more complex *development and authoring process*. This presents the need to find a systematic and application-independent approach to adaptation engineering:

- Obviously, general object-oriented software engineering approaches, such as unified process (Jacobson, Booch, & Rumbaugh, 1999), lack the specific hypermedia aspect. On the other hand, specific methodologies for hypermedia like relationship management methodology (RMM) (Isakowitz, Stohr, & Balasubramanian, 1995) or object-oriented hypermedia design methodology (OOHDM) (Schwabe & Rossi, 1998) do not cover significant aspects related to adaptation (like user modeling and personalization).
- There are efforts that systematize the engineering (lifecycle) process and offer an integrated methodology, for example, the UML-based Web Engineering (UWE) approach (Koch, 2001). We observe that UML gives only a specification of the process, but not the semantics to perform the reasoning required for adaptation: semantically richer approaches are needed and current research on Semantic Web (Berners-Lee, Hendler, & Lassila, 2001) and ontologies (Sowa, 2000) offer solutions.
- The hypermedia community has defined reference models for adaptive hypermedia systems (e.g., the AHAM model (De Bra, Houben, & Wu, 1999) and the Munich model (Koch & Wirsing, 2002)). Although the number of adaptive systems grows, their development process is still rather ad-hoc, without a lot of re-use, and therefore difficult to manage.

We observe a lack of uniform methods to describe the functionality of adaptive concept-based systems for analysis and comparison. The target is a systematic, unified, and measurable approach for engineering adaptive concept-based systems, starting from the *conceptualization* of the domain through application modeling, maintenance, and upgrade (Lowe & Hall, 1998).

ADAPTATION ENGINEERING

Principles of Adaptation Engineering

Modeling the Domain

The specification of concepts and their structure is a crucial aspect of concept-based system design. Concept-based systems, whether adaptive or not, commonly employ a well-specified subject *domain model* to define the information processed in the application. Traditionally, content descriptions are expressed in terms of concept structures, such as concept maps, semantic networks, or conceptual graphs (Sowa, 1984).

Modeling the User

The user plays a fundamental role in the system and therefore in its design. The system might want to record the user's presentation preferences (e.g., for platform, layout, font size, or other presentation aspects), as well as content preferences. Typically, the systems maintain a model of the individual user as an overlay of the domain model to record the current state of the user w.r.t. his/her preferences/knowledge of domain concepts. This *user model* is the basis for adapting the content presentation.

Modeling the Adaptation

The challenge left is to combine the information domain and user model when generating the appropriate adaptive presentation. This adaptive presentation includes individualized content selection and/or individualized navigation paths/links. Phrased differently, the main adaptation design challenge is to define *content selection* and *navigation* through adaptive methods and techniques (Brusilovsky, 2001). Typically this is done in the *adaptation model*.

Adaptive Web Information Systems

A large and general class of concept-based systems is built by the *Web Information System* (WIS) (Isakowitz, Bieber, & Vitali, 1998). WIS emerged when the Web paradigm was applied to data in databases and other structured data repositories (Gaedke & Graf, 2000). Examples are Web sites about products for sale in a store, or employees working at a large corporation. Most current Web applications are WIS and constitute the "deep Web" (opposed to the "surface Web").

Hypermedia design became a crucial challenge in WIS design. While most of the mentioned approaches like Unified Process, OOHDM, and RMM try to support the hypermedia aspect, modern WIS methodologies like WebML (Ceri et al., 2002) or Hera (Vdovjak, Frasincar, Houben, & Barna, 2003) go a step further and make the design of the content presentation the focus of WIS design.

We discuss the main principles of such methods and use Hera terminology to illustrate. Typical is the model-driven nature:

- The *conceptual (domain) model* describes the conceptual structure of the application content in terms of *concepts* and their *concept relationships*. Several data modeling formalisms are used in the different approaches (e.g., Hera uses RDF(S)).
- The *application model* specifies the abstract navigational view over the content from the conceptual model. Hera identifies *slices* as meaningful units (pages) in the navigation structure. The *slice relationships* connect slices and complete the actual navigation structure with hyperlinks.
- The *adaptation model* specifies the *adaptation*. It defines how the user is modeled, and how the content presentation depends on that.
- The *user profile* captures the user's preferences, for example, device properties. It is used to support *adaptability*: the presentation is constructed following the constraints from the user profile.
- The *user model* holds the state of the user w.r.t. the presentation content. This supports *adaptivity*: the user model changes *during* the navigational use (browsing) of the presentation. Think of the user's knowledge about application concepts—for example, has the user seen (visited) a concept before?

The focus of WIS design methodologies is on the navigational structure, but a thorough definition of the content is needed first. The methodologies therefore give a major role to the *domain model*.

The notion of *user model* is implemented in WIS design methodologies less prominently. Among the notable exceptions, Hera identifies a user profile and user model, thus influencing the availability (visibility) of content and links.

The *adaptation model* extends the application model in Hera. With conditions relating to user profile and user model, it becomes possible via adjusting content/link visibility to implement different adaptive methods and techniques.

We conclude that methods for adaptive WIS are strong in supporting adaptation in relation to *data-intensive* applications. They target the creation of *hypermedia* presentations, and in terms of *adaptation* primarily aim to support different device/user situations. The designers' main challenge concerns the large quantity of content elements fitting a given structure.

Adaptive Hypermedia Systems

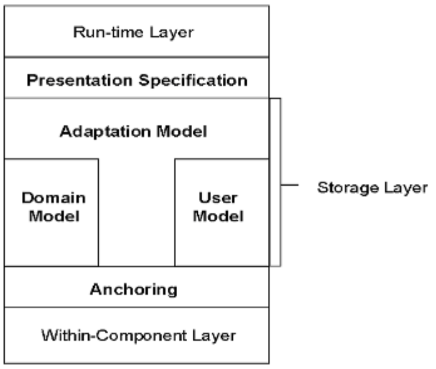
Adaptive hypermedia systems (AHS) (Brusilovsky, De Bra, & Houben, 1999; Brusilovsky, 2001) build the second class of adaptive concept-based systems.

Hypermedia designers have the difficult task of deciding on which pages to place which links. Ideally each page contains only links that are of interest for each user, independent of how the user got to the page: impossible in practice. Content and presentation of each page should fit preference, interest, and knowledge level of each user: an even harder task. *Adaptive* hypermedia offers a potential solution. It allows selecting links, content, and presentation elements that are *potentially* appropriate. Based on a *user model,* the adaptive system can decide which links and content to show, and how to present them.

The AHAM reference model (De Bra, Houben, & Wu, 1999; see Figure 1), gives the overall architecture with three main parts for adaptation in the *Storage Layer*:

- The *domain model* represents the application (subject) domain conceptually. It consists of *concepts*

Figure 1. The AHAM reference model



with *attributes* and of *concept relationships.* Concepts can represent broad topics or small concrete objects. AHAM only deals with this conceptual level, not with the actual content in the *Within-Component Layer*. A typical example of concept relationship is *prerequisite*: A is prerequisite for B, if knowledge of A is needed before the system considers B appropriate (for this user).

- The *user model* is the system's representation of the (assumed) state of mind of the user. Usually it is an *overlay model* of the domain model. In AHAM every domain model concept also appears also in the user model with an appropriate *knowledge/access* indicator.
- The *adaptation model* links the other two, using *adaptation rules*. When the user accesses a page, a rule determines how this event influences the user model. A second type of rule deduces navigation and presentation adaptation: a link to an "appropriate" page is displayed prominently while others are de-emphasized, hidden, or removed. Brusilovsky (1996, 2001) identifies possible adaptation methods and techniques.

A good illustration is the general-purpose adaptive engine AHA! (De Bra et al., 2003), which combines the *domain* and *adaptation models*. When the user accesses a page, the rules associated with the page are triggered, updating the *user model*. They also determine values for "presentation attributes" such as *suitability* and *visited*. *Suitability* influences including, hiding, or annotating links or fragments. *Visited* is similar to the blue/purple link-color change from browsers.

AHSs directly implement the domain, user, and adaptation model. Their *domain model* is a structure of concepts from the application content. Their *user model* represents the application's assumptions on the user's knowledge on these concepts. Their strongest emphasis is on the *adaptation model*, which requires *rules* for user model updates and presentation adaptation, and a rule engine.

Most adaptive hypermedia reference models like AHAM assume *handcrafting*. The author carefully selects the content, designs a hypermedia presentation out of it, and configures its adaptation. Newer approaches aim at more automated adaptation design, but require a close coupling between designers' understanding/knowledge of the content and adaptation.

Adaptive Task-Based Systems

Adaptive task-based systems are characterized by a strong task-orientation in adaptation. To efficiently implement *content selection* and *navigation,* they require domain *conceptualization*—a process of classifying subject domain knowledge and presenting it in *concept structures*. Concept-based content representations play a pivotal role not only in modeling domain content (*domain model*) and user (*user model*), but also in modeling the application-oriented problem-solving strategies (*task model*) and the employed adaptive mechanisms (*adaptation model*).

Concept structures include domain concepts and semantic relationships among them. They present a *meta-layer* over the domain, clearly separated from the content units (data), and allow dynamic linking of content units to relevant concepts. The explicit concept structure (efficiently indexing the content) supports adaptation through dynamic topical content generation.

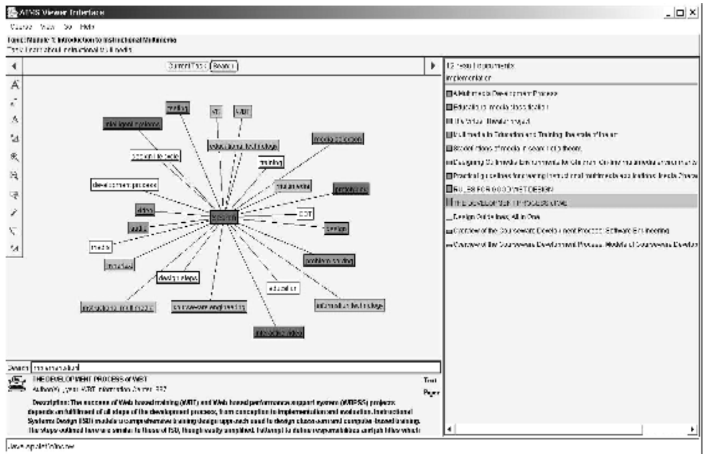
Conceptualization allows for *standardization*. The concept structure can represent a domain ontology providing a broadly agreed vocabulary for domain knowledge representation, thus making the content reusable, interchangeable, and interoperable.

As illustration we consider an *educational information support system (EISS)*—AIMS (Aroyo & Dicheva, 2001). EISS exhibits adaptation engineering in task-based systems (Magoulas, Papanikolaou, & Grigoriadou, 2003), combining ontologies with educational metadata standards to achieve openness and interoperability of intelligent instructional software. AIMS focuses on efficient information provision for *task-oriented problem solving*. The ontological structure of the subject domain acts as an index, represented graphically by a *concept map* (see Figure 2), which supports efficient search and strong visual presentation/navigation of search results.

AIMS uses four models:

- The *domain model* conceptualizes subject domain with *concept* and *link* objects. Objects have attributes to characterize behavior, used in adaptation rules to allocate the most appropriate concepts for tasks.
- The *resource library model* semantically annotates *resources* used in AIMS. Resources have metadata for educational applicability and are linked to domain concepts. Links have weights indicating the relationship strength.
- The *course tasks model* specifies course tasks and a course structure by using the domain and resource library models. Tasks have an input/output of concepts/resources and sets of pre-/post-conditions to define the start/end states of relevant user knowledge. *Adaptation rules* define navigation patterns based on user model values and concept links in the domain model. Post-conditions trigger user model updates.

Figure 2. AIMS search & browse tool



- The *user model* is a domain model overlay: domain concepts have specific *user* values indicating current user knowledge (*state* within the entire instructional cycle).

The AIMS approach separates the abstract domain concepts from the resource library items describing them. It also uses an explicit (course) tasks model to represent goals and tasks of users, and defines the adaptation on this task model. This allows designers to effectively specify paths through resources.

The authoring aspect is rather different here. The author (instructor) has a large influence on composing learning resources into personalized courses (Aroyo & Dicheva, 2003; Specht, Kravcik, Klemke, Pesin, & Huttenhain, 2002). Authoring activities include:

- **Domain-Related:** Editing and annotating the domain model concepts and links.
- **Course-Related:** Generating the course structure and sequencing course tasks, including user-related activities to define the user model and its application.
- **Resource-Related:** Defining educational resources in the library, for example, using LOM-based metadata (LOM, n.d.).

The tasks offer a significant variety in constructing adaptation through identifying tasks and subsequent content sequencing. Separating concepts from resources allows an extra adaptation dimension, as the resource-concept association can be programmed to realize personalization. Conceptual structures based on standardized metadata also allow reuse/exchange of resources.

AHA! and AIMS approach conceptual structuring differently. AHA! uses concepts to label content fragments, concept relationships to indicate dependency, and knowledge-propagation links to structure these fragments. AIMS uses conceptual structures in the more traditional ontological meaning—to represent the subject domain knowledge and allow more elaborate contextual reasoning. Whereas engineering systems like AHA! typically start from the available content and use concept structures to organize the content and its adaptation, systems like AIMS typically start from concept (ontological) structures to support more complex reasoning in the domain and only run-time associate content (resources) with the concepts.

FUTURE TRENDS

In the discussion of three large classes of adaptive concept-based systems, we have identified their strengths and weaknesses. With the current technologies these systems are primarily effective in application areas where engineering is of a more authoring nature. For an effective application in larger-scale situations, the more general WIS and the task-based systems appear more promising, since they use a more engineering approach to adaptation.

The "hottest" trend is certainly the exploitation of *ontologies* for organizing the concepts and their adaptation and facilitating interoperability. The engineering of ontologies is therefore a relevant research topic. *Interoperability* is an essential condition for success. In the world of e-commerce, nobody is waiting for isolated, unconnected solutions. While there is already some advancement in reusing and exchanging content, the reuse and exchange of adaptation mechanisms is an open problem. Application areas like education show a possible way, but also demonstrate the problems ahead for a general solution for adaptation engineering in e-commerce.

CONCLUSION

We have discussed *adaptation engineering* in the concept-based systems that play a vital role in the modern e-society. We have demonstrated how adaptive concept-based systems in general are characterized by a domain model, user model, and adaptation model. As different types of systems have different properties, we have identified three main classes of adaptive concept-based systems. We have discussed these classes on the basis of representative systems, and have identified similarities and differences.

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KEY TERMS

Adaptation Engineering: The process of constructing the automatic adjustment of an application to the user; often in adaptation engineering, models are created for the domain, the user, and the adaptation.

Adaptation Model: Representation of the way in which both the selection and presentation of content are adapted to the user.

Adaptive Hypermedia System: An adaptive concept-based system that is based on applying adaptation to a hypermedia application; characteristic is the (virtual) construction of a hyperdocument.

Adaptive Task-Based System: An adaptive concept-based system that is based on organizing the conceptual structures and the adaptation on the basis of the tasks and goals of the user; characteristic is the explicit representation of tasks.

Adaptive Web-Based Information System: An adaptive concept-based system that is based on the principle of using hypermedia to present output from a structured repository or database, and that performs the adaptation on the hypermedia presentation and the content retrieval; characteristic is the role of navigation.

Concept-Based System: An information system that uses conceptual structures to organize and present the information content; typical systems are data intensive, retrieve content dynamically from a repository, and use hypermedia to present the output.

Conceptualization: The process of constructing conceptual structures—that is, structures of concepts and their relationships that represent a subject domain.

Domain Model: Representation of the subject domain at a conceptual level, often in terms of concepts and their relationships.

Ontology: An explicit specification of a shared conceptualization of a domain of interest; an ontology is a controlled vocabulary that describes objects and the relations between them in a formal way; the vocabulary is used to make queries and assertions; ontological commitments are agreements to use the vocabulary in a consistent way for knowledge sharing.

User Model: Representation of the preferences and the state of knowledge of the user (to be used as a basis for adaptation).

Enterprise Application Service Model

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INTRODUCTION

Following the recent changes in the global business environment, many organizations are reevaluating their approach to delivering enterprise applications and are looking for more effective ways to control IT costs. There is growing evidence of reluctance to fund large-scale implementation projects, and of tighter budgets forcing more careful cost-benefit analysis to justify IT investments. It is becoming increasingly clear that the traditional model for delivering enterprise applications that involves the implementation of licensed software such as ERP (enterprise resource planning) applications within end-user organizations is not suited to the fast-evolving business world of the 21st century. Almost invariably, situations in which organizations own and maintain their entire IT infrastructure lead to very high costs of ownership, and consequently high levels of IT spending, which can detract from the core business in which the organization is engaged. This has led to a situation in which some businesses doubt the benefits of IT (Carr, 2003), and some observers even contend that productivity improvements, once assumed to be the result of IT, are more likely to be the results of other factors such as longer working hours (Nevens, 2002). This backlash that followed the IT boom at the end of the last century has forced software vendors to seek more cost-effective models for the delivery of enterprise applications, and has led to the reemergence of the ASP (application service provider) model as an alternative to licensed software. Today, the ASP model (or software-as-a-service model) is a part of a more general trend toward utility computing, where the service provider delivers highly scalable application services to a large population of end-user organizations in a reliable and cost-effective manner, typically from a remote data center. Utility computing aims to supply application services on demand, similar to other utility services (e.g., gas or electricity), and relies on new technologies and architectures that enable the virtualization and sharing of resources across a large number of users in order to minimize costs and maximize utilization. The use of advanced service-oriented architectures (SOAs), grid computing, cluster technologies, and failure-resistant configurations enable the delivery of highly scalable application services in a reliable manner to a large population of users. These technological advances distinguish utility computing from the earlier ASP and outsourcing models, and will ultimately result in significant reduction in the costs of enterprise software solutions and wide adoption of the software-as-a-service model. Major IT vendors including IBM, Microsoft, Sun, Oracle, and HP are promoting utility computing, albeit under different names (e.g., on-demand computing, etc.), and are investing vast resources into the construction of data centers and related facilities (Abbas, 2003). Others, such as Salesforce.com, have been successful with providing hosted services for CRM (customer-relationship management) and other related types of applications, validating the ASP model and further confirming the trend toward utility computing.

As the enterprise application software market matures, major ERP vendors are changing their revenue model to decrease their reliance on new software licenses toward income generated from software-license upgrades and product support (Karpecki, 2004; Levy, 2004). This change combined with the fact that most organizations spend as much as 80% of software-related costs on software maintenance and related activities (Haber, 2004) creates a situation in which licensed software is de facto rented. It is precisely this high level of ongoing costs that motivate many organizations toward alternatives such as outsourcing and the ASP model.

In this article we first examine the business drivers for the ASP model and contrast the software-as-a-service model with the traditional software-as-a-license approach. We then discuss future enterprise computing trends, focusing on the reemergence of the ASP model for enterprise applications and the likely impact of the wide adoption of this model on the IT landscape. In conclusion, we summarize the main arguments in this article.

BACKGROUND

The economic downturn at the beginning of this decade resulted in organizations dramatically reducing IT budgets, leading to scaling down existing projects and in some cases discontinuing projects altogether. In this section, we consider the background of these developments and the main business drivers that are forcing the transition to a new model for the delivery of enterprise applications as services.

High Cost of IT Projects

Problems of controlling the costs associated with IT projects are well documented. Notwithstanding the long experience that the IT industry has with the implementation of enterprise applications, costs of many projects significantly exceed their original budgets. According to a study of ERP implementation projects of 117 U.S. companies, 25% exceeded their budgets, 20% were abandoned before completion, and 40% failed to achieve business objectives (Cooke, Gelman, & Peterson, 2001). There have been other studies of this type that clearly demonstrate that the traditional model that involves the in-house implementation and maintenance of enterprise applications is associated with significant risks that are not being addressed by new, improved implementation methodologies and more technologically advanced software platforms. Equally, there is ample evidence that the outsourcing of the implementation and support of enterprise applications to a third party does not always bring the anticipated benefits (i.e., cost savings, improved responsiveness to new requirements, etc.); this is most likely because the implementation methodologies and technology architectures used by outsourcing organizations are essentially the same as those used by end-user organizations.

Fast Rate of Technology Change

Another significant risk factor associated with enterprise applications is the rapid development of underlying technologies, often necessitating the time-consuming reengineering of applications and costly upgrades. There is growing evidence that end-user organizations are no longer able to keep pace with new technological developments as delivered by IT vendors. New technology platforms and new versions of enterprise applications are often mandated by vendors who are reluctant to support older versions of their products, delivering no direct business benefit to end-user organizations.

High Demand on IT Skills

The traditional licensed-software model is associated with the high demand on IT skills needed to implement enterprise applications. Many small and medium-size enterprises (SMEs) cannot justify the cost of retaining their own internal IT staff with the appropriate expertise. Another contributing factor is that the expertise of IT specialists employed by end-user organizations and third-party consulting companies is not fully up to date and often significantly lags behind the expertise available from technology vendors. This factor leads to poor implementation results and is a major cause of the high rate of failure of IT projects.

Complexity of Enterprise Applications

Enterprise applications are becoming increasingly more sophisticated and complex. This complexity is particularly evident in large (horizontal) ERP application systems that provide comprehensive functionality designed to address requirements across a range of end-user organizations irrespective of the industry and the needs of individual businesses. While providing a complex and comprehensive solution, the actual utilization of the overall functionality of an ERP system by individual end users is relatively low. Customization to suit the needs of individual client organizations requires a high level of expertise and often involves the setting up of a large number of configuration parameters. Limited knowledge of the client's business processes by third-party consultants is another key factor, according to recent studies, that inhibits the successful implementation of ERP systems (Karpecki, 2002). ERP systems are characterized by high complexity of operation, even in situations in which the corresponding business process is relatively simple, and that leads to a high cost of end-user training. Because of the increasing size and complexity of new software versions, there is a corresponding growth in the demand on hardware resources. All these factors lead to increased implementation costs of enterprise applications that the client organizations are no longer willing to accept.

Globalization of the Business Environment

Globalization impacts enterprise applications in two important ways. First, as a result of globalization and the formation of regional economic blocks with standardized business practices and regulations, ERP applications can be used across a larger (international) user base without extensive customization to suit individual countries. For example, in the European Union, with the growing number of member countries using similar business laws and regulation, enterprise applications are becoming standardized across the entire region. Second, the global deployment of enterprise applications is becoming a growing trend. Many large, multinational companies implement global applications across the entire enterprise, in some cases using a single centralized data center and centralized applications accessible via the company's intranet. This simplified environment, with standardized business practices across the entire global organization, is highly suited to implementation using the software-as-a-service model.

Increased Acceptance of Alternative Models for Enterprise Application Delivery

Over the last 5 years, there has been an increase in awareness of alternative models for the delivery of enterprise applications, in particular, the outsourcing model. Given the highly competitive global business environment, organizations are becoming aware of the need to focus on their core business and avoid devoting resources to IT-related activities. This leads to the willingness to consider outsourcing noncore business functions, including the implementation and support of ERP applications to external providers.

THE MAIN FEATURES OF THE SOFTWARE-AS-A-SERVICE MODEL

The software-as-a-service model has recently evolved into a sophisticated model for the delivery of enterprise applications that substantially differs from the traditional approach (Feuerlicht & Vorisek, 2003; Levy, 2004; McCabe, 2004; Vorisek, Pavelka, & Vít, 2003; Wainewright, 2004). Table 1 summarizes the key differentiators between the software-as-a-service and software-as-a-license models, identifying the features of the software-as-a-service model that benefit organizations in addressing today's IS and IT issues.

The comparison table includes a number of compelling arguments that are likely to make the software-as-a-service model a preferred solution for enterprise application delivery in the future. Many of the benefits listed are results of recent technological advances combined with the increasing sophistication of service providers and the ability to configure suitable architectures for the delivery of enterprise application services. There is little doubt that standardized applications such as CRM can

Table 1. Comparison of the software-as-a-service vs. software-as-a-license models

Key Differentiator	ASP Model (Software-as-a-Service Model)	Traditional Model (Software-as-a-License Model)
Design Approach	Designed for delivery as Internet-based service for a large number of customers. It includes specific HW and SW architectures, and business model.	Designed for implementation by specialists and for customers to operate and maintain.
Architecture	Multitenant service-oriented architecture enables support of thousands of users from different user organizations on a scalable basis.	Architecture suitable for deployment by individual company on a dedicated IT infrastructure.
Upgrade Cycle	Frequent (3-6 months) upgrades. The same version of the application is running for all users.	Infrequent upgrades (12-24 months). Individual clients using different versions of the software. High costs of version management.
Problem and Change Management Procedures	Short feedback cycle. Procedures enable almost immediate feedback. Support staff can directly identify and fix problems. Fixing a problem for one customer fixes it for everyone, which reduces support costs.	Problem solving is often indirect via intermediaries (VARs, SIs, etc.). Patches and upgrades are implemented at individual customer sites. Costly and unreliable, as customers often delay installation of patches and upgrades.
Start-Up Implementation	Short start-up implementation cycle.	Long start-up implementation cycle. Typically involves complex implementation of hardware and software resources and knowledge transfer.
Scalability	The volume of the service (i.e., number of users, number of transactions) can be scaled on demand.	Configuration needs to support peak requirements and cannot be scaled down.
Customization	Typically limited.	Extensive customization possible, but expensive.
Functionality	Often limited functionality. Application typically designed for narrow vertical market.	Can provide extensive functionality. Often only small part of the available functions is used.
Required Resources	Only limited client resources are needed. Most of the company resources are dedicated to core business.	Extensive internal resources used for IT support.
Resource Utilization	IT resources (hardware, software, IT specialists, etc.) are shared across all clients. Provider has advantages of economies of scale.	IT resources are dedicated to a single organization.
Cost	Predictable ongoing operating costs. Typically no initial investments required. Costs correlate with the volume of services.	Both investments and operating costs involved. The costs generally do not correlate with the volume of service.
Service Agreement	SLAs are widely used.	SLAs used occasionally.
Required Expertise	Only minimal IT expertise needed.	Wide spectrum of IT knowledge and expertise needed.

be delivered more effectively using the software-as-a-service model than by using the traditional approach. While such applications are good candidates for delivery as services, it is doubtful that the benefits extend to all application types and scenarios, necessitating the careful evaluation of candidate applications. For example, the software-as-a-service model may not be suitable for the following.

- Mission-critical core business applications: These types of applications are typically not available from external providers, and the critical nature of these applications dictates in-house implementation and control.
- Highly customized and specialized applications: Providers cannot achieve economies of scale as the number of clients using such applications is relatively small.
- Applications with extensive integration requirements: Such applications have close dependencies on other enterprise applications and cannot be effectively managed externally.

FUTURE TRENDS

The ASP model emerged toward the end of the 1990s with often-exaggerated claims of advantages for client organizations, in particular for SMEs. Notwithstanding many perceived advantages, the ASP approach did not gain wide acceptance as the new model for the delivery of enterprise applications. Many of the early ASP providers have not been able to establish a viable business model and have discontinued ASP services or went out of business altogether. Perhaps the most important factor contributing to the demise of early ASP providers was the lack of a suitable technological infrastructure for hosting a large number of complex enterprise applications in a scalable and secure manner. Customization capabilities and support for integration with other enterprise applications were also lacking. As a result of these shortcomings, early ASP providers failed to deliver cost savings to their customers, resulting in poor acceptance of the ASP model by the marketplace.

Recently, however, a number of important IT vendors have reconfirmed their commitment to the ASP model in the context of the new utility-computing approach, and have made significant investments in infrastructure for the delivery of application services (Dubie, 2004). The main idea of utility computing is that IT services are supplied on demand (i.e., as required by the end-user organization) via a grid of interconnected, dynamically configurable, highly reliable and scalable computing resources (i.e., servers, data storage, and application resources). Enterprise computing grids are widely regarded as providing a suitable architecture for application services with the ability to host a large number of enterprise applications in a scalable and reliable manner. Resource sharing, resulting in improved utilization of hardware and software associated with grid-computing architectures, provides a more cost-effective solution for hosting enterprise applications than a set of independent servers each dedicated to a specific application. The availability of low-cost commodity components such as storage devices and CPUs enable the construction of large clusters of servers, storage arrays, and other resources, and create virtual resources on demand as required by enterprise applications. A number of infrastructure-technology vendors (IBM, HP, Oracle) are in the process of building large data centers with the view of moving toward the utility-computing model (Eriksen, 2003). Investment in infrastructure on this scale clearly demonstrates a strategic commitment to utility computing and more specifically to the software-as-a-service model as the new outsourcing model for enterprise applications.

Another key trend favoring the software-as-a-service model over the traditional software-licensing model is the emergence of service computing. In addition to supporting business processes within a given organization, most enterprise applications today have a requirement to interoperate across enterprise boundaries to support electronic business (e-business). Service-oriented computing and more specifically Web-services standards and technologies are playing a key role in the implementation of e-business applications and are likely to become the dominant enterprise computing approach in the future. There is a close relationship between the ASP model and service-oriented computing. The wide adoption of Web-services standards across various computing environments (i.e., .Net, J2EE) makes Web services an ideal solution for application integration, and for externalizing business functions of complex enterprise applications. Web services can be regarded as the enabling technology for the integration of ASP applications, and for the delivery of low-granularity application services (Ferguson, 2004).

The emergence of the software-as-a-service model as the new paradigm for the delivery of enterprise applications will have a major impact on the IT landscape, creating new opportunities and challenges for both the providers and client organizations. The reduction in the size of the traditional software-license market, reduced demand for on-site implementation, and the corresponding increase in demand for application services will lead to further rationalization of the IT vendor market (Cohen, 2004). The shift toward the software-as-a-service model is likely to take several years to be fully realized, but the impact on the IT industry as a whole, and the software vendors and third-party consulting organizations in particular, is likely to be dramatic, leading to the restructuring and realignment of the major industry players that will favor large software vendors that already have significant penetration in the ASP market and proven track records in successfully delivering application services to end-user organizations. Consulting organizations whose main activity is implementing ERP systems and similar applications for client organizations will need to refocus their business activities as there are not likely to be very many large-scale implementation projects of this type in the future. The software-as-a-service model will be associated with new business and pricing models that are likely to dramatically reduce the cost of ownership of enterprise applications. The reduction of demand for in-house IT specialists will lead to the restructuring of the IT labor market, and will demand important changes from user organizations that will need to implement a suitable management structure and an IT architecture that enable effective participation in the world of service-oriented computing. Adoption of the software-as-a-service model will also demand a change in the culture of client organizations, including the redistribution of responsibilities for IT costs and benefits to ensure the successful introduction of this new model of enterprise computing.

CONCLUSION

The business and technological factors discussed in this article have created a situation in which the delivery of enterprise applications in the form of services becomes both technically possible and economically desirable. The software-as-a-service model provides a viable alternative to software licensing for many application types today, and it is likely to become the dominant method for the delivery of enterprise applications in the future. This will have a major impact on enterprise computing over the next 5 years, finally tipping the balance from licensed software toward software delivered as a service.

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KEY TERMS

ASP (Application Service Provider): A provider of application services over the Internet or an intranet.

CRM (Customer Relationship Management): Application system that allows a company to manage its relationship with a customer, including sales, marketing, customer service, and support.

ERP (Enterprise Resource Planning): System designed to support and automate business processes for manufacturing, distribution, payroll, and finances for an enterprise.

Grid Computing: Grid (network) of computing resources designed to provide computing and storage to applications in a scalable and reliable manner, ensuring high levels of utilization.

Outsourcing: IT resources are managed by an external provider who delivers IT services to the end-user organization.

Utility Computing: Computing services are provided on demand by a provider organization that uses its computers and facilities. Customers access the computers via a private network or over the Internet and are charged according to resource usage.

Web Services: Web-based application that uses standard Internet protocols and languages (SOAP, XML [extensible markup language]) to interact with other applications.

Entrepreneur Behaviors on E-Commerce Security

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INTRODUCTION

Electronic communication developments have always been associated with many security *risks* since the ARPANET implementation in 1960s. In 1972, John Draper (Captain Crunch) unlocked the AT&T phone network marking the beginning of the modern technology of hacking. Later in the 1980s, the seminal developments in the U.S. laid the conceptual and practical foundation for future electronic crime tools such as trapdoors, trojans, and viruses. More recently in the Internet environment, *electronic attacks* have reached an epidemic level (US-CERT, 2004). In South Africa alone, over 500 Web sites were defaced in January 2005 and e-crime losses are estimated at around 40 billion a year.

BACKGROUND

While electronic attacks present serious social and economic implications for small organizations engaged in e-commerce, these organizations are complacent about these attacks and continue to ignore *good security practices* (Jacque, 2003). One possible explanation for this *low regard for security* and subsequent attacks could be found in the examination of the *decision-making behaviors* of entrepreneurs during the e-commerce adoption process. While researchers have looked at *entrepreneurial traits* to explain the adoption process of e-commerce and many agree that personal characteristics of individual actors modulate the adoption of innovations (Wejnert, 2002), the potential impact of these traits on the adopted systems has not been examined. It is the view of the researcher that the decision-making behaviors of entrepreneurs at the time of e-commerce adoption affect the security of their information systems (IS). Entrepreneurs are mainly business owners who operate in uncertain environment and make all of the business decisions. They use intuition rather than data analysis and are often perceived to be somewhat irrational (Olson, 1985). *IS security* is the protection of information and the systems that use, store, and transmit that information.

This study examines the influence of entrepreneur decision-making behaviors on the quality of IS security. It explains why entrepreneurs ignore security, creates awareness of the dire consequences of *mistaken perceptions of security*, and emphasizes the importance of proper analysis of business and technological implications before the implementation of e-commerce. In the following sections, the decision-making behaviors of entrepreneurs, their potential influence on IS security, and the research propositions are presented. The research methodology is presented first. This is followed by the data analysis, the results of the survey, and finally the conclusion.

ENTREPRENEUR BEHAVIOR AND IS SECURITY

Two influential concepts in the field of entrepreneurship are used to examine this relationship. These are: entrepreneurial orientation (Miller, 1983) and entrepreneurial management (Stevenson, 1983). Entrepreneurship may be defined as the art of finding profitable solutions to problems.

Entrepreneurial Orientation

Entrepreneurship researchers have used the term entrepreneurial orientation to describe the methods, practices, and decision-making styles managers use to keep the firms competitive. Several researchers (Grundy & Kickul, 2001; Miller, 1983; Miller & Friesen, 1978) emphasize the need for risk-taking, innovativeness, and proactiveness. Risk-taking refers to taking chances in a decision-making situation. Innovation refers to doing new things by recombining parts of what is already being done, and proactiveness is the ability to take the initiative whenever the situation arises (Jun & Deschoomeester, 2004).

However, entrepreneurs take risks because they are unaware of risk implications or sometimes simply ignore them. They tend to have low-risk perception (defined as the subjective assessment of the probability of a risk (Sjöberg, Moen, & Rundmo, 2004)) and consequently implement risk prevention measures as a hurried reaction to a bad experience. Jun and Deschomester (2004) argue that *proactive risk-handling* is an important dimension of entrepreneurial orientation which has unfortunately received limited consideration. They contend that successful entrepreneurs do not only take risks, but also possess the propensity to handle them proactively. They define risk-handling as the process in which potential risks to a business are identified in advance, analyzed, mitigated, and prevented, and the cost of protection is balanced with the cost of exposure to the risk. In an electronic environment where market needs, technology requirements, and security challenges change very rapidly, proactive risk-handling is essential.

Entrepreneurial Management

Stevenson (1983) views entrepreneurship as a management approach of pursuing opportunity without regard to resources currently used. He categorizes management behavior into the following dimensions. These behaviors and their influence on IS security are discussed as follows. The research propositions are also named.

Strategic Orientation

Strategic orientation describes what factors drive the creation of strategy. For an entrepreneur, strategy is driven solely by the opportunity, not the resources needed to exploit the opportunity. Resources are defined here as assets, capabilities, routines, and knowledge used by an organization.

As entrepreneurs seek new opportunities, they give limited attention to resources and some organizational activities. Gifford (1998) contends that limited entrepreneurial attention explains many issues relating to entrepreneurial activities (e.g., limited firm size growth and innovation, the choice of resource procurement and relationship between managers and employees). Evidence shows that limited attention is often paid to the resources and system requirements needed to support e-commerce activities (Hoffman, 2003; Jain, 2003). Literature on the evolution of e-business (Earl, 2000) also confirms that in the early stages of e-commerce, there is limited use of IT by small organizations and systems security measures are usually basic. The adoption of technologies such as firewall and authentication systems is not extensive (Allan, Annear, Beck, & Beveren, 2003) and managers often shun good security practices (Jacque, 2003). Jensen (2004) found that security only became of much greater concern for the entrepreneurs once they had adopted e-commerce and for non-adopters, this was a matter of least concern. Katsikas and Gritzalis (2002) warn that if security is applied as an add-on or patch to existing e-commerce solutions, degraded services will be provided since existing e-commerce functional requirements cannot easily be altered a posteriori. By placing limited attention to resources and security requirements, entrepreneurs fail to handle security risks proactively. It is therefore hypothesized that:

H1: Entrepreneur's lack of propensity for systems risk-handling will negatively influence the quality of IS security.

Lack of propensity for systems risk-handling is the inability to proactively identify, analyze and prevent systems and e-commerce security risks. *Quality of IS security* refers to the degree to which the information system is protected from e-crime or cyber attacks.

The Commitment to Opportunity

According to Stevenson, entrepreneurs are ready to commit to action rapidly. Many writers report that key decision-makers in small organizations haven't the time to devote adequate attention to the appropriateness of their decisions. They instead rely mostly upon their intuition and feelings (Miller & Friesen, 1978). Studies by (Jensen, 2004) reveal that many entrepreneurs adopted e-commerce before fully examining the resource, financial & risk implications. Exploiting e-commerce opportunities irrationally may result into the failure to engage the right players; improper evaluation of the systems and resources; and failure to examine potential vulnerabilities, the regulatory environment and legal issues. It is hypothesized that:

H2: Entrepreneur's irrational commitment to opportunities will negatively affect the quality of IS security.

Irrational commitment to opportunities refers to the tendency to seize opportunities without proper consideration given to potential implications.

Commitment of Resources

Stevenson maintains that entrepreneurs will commit as few resources as possible at each stage of the project and may even try to pursue opportunities without the proper resources. Jain (2003) found that many small business owners are reluctant to purchase up-to-date hardware/software and argues that piracy is one extreme option available to them. They also approach novelty with caution due to the fear of loss and related cost implications (Wejnert, 2002). In their national study, Daniel and Myer (2001) found that the majority of entrepreneurs in the UK used a staged approach to e-commerce adoption due to limited resources. While this approach allowed entrepreneurs to gain some experience through trial and error, a number of costly, disintegrated and incomplete e-commerce applications were developed. By using immature, disintegrated, poorly tested or pirate systems the organization and its business partners are exposed to severe security attacks. It is therefore hypothesized that:

H3: Entrepreneur's propensity for resource minimization will negatively affect the quality of IS security.

Propensity for resource minimization refers to the orientation towards utilizing very limited resources.

Control Over Resources

Stevenson maintains that entrepreneurs will reduce as much as possible the amount of resources they own and use. Small organisations are poor in resources, which causes them to rely on external assistance. Overreliance on outsourced services can lead to loss of flexibility and control. In addition, some vendors usually parade the positive features of their wares and down-play issues such as compatibility, maintenance, training and security. Outsourcing services such as intrusion detection, e-mail and firewall systems may also lead to security problems since service providers often abide by their own policies rather than those of their clients. Furthermore, since providers offer customized services to several service receivers including competitors, concern arises over data confidentiality and reliability issues and the amount of assistance extended to each customer's problems. It is therefore hypothesized that:

H4: Entrepreneur's overreliance on external resources will negatively affect the quality of IS security.

Overreliance on external resources refers to the over-dependence on other organisations for human, technical and financial assistance.

Management Structure

The management structure of the entrepreneur organization is flat without clearly defined lines of authority or routine tasks. Entrepreneurs tend to have a strong desire for autonomy and control which could easily hamper the success of the organization (Curtis, 1983). They tend to be rigid, traditional and sometimes outdated in their business practices. In many such organizations there are no definitive duties or responsibilities drawn up for subordinates and the high degree of generality resulting from undertaking heterogeneous work prevent employees from developing expertise in areas such as IT security. Fear of loss of control and lack of trust also make delegation difficult (Kyobe, 2004). It is therefore hypothesized that:

H5: Entrepreneur's desire for control and autonomy will negatively influence the quality of IS security.

Desire for control and autonomy refers to the orientation toward retaining much control over the business activities. The research model for this research is presented in Figure 1. Quality of IS security is the dependent variable and the characteristics of the entrepreneur are the independent variables.

Research Methodology

Most of the measures used were adopted from previous studies, but modified to capture data relevant to the current study (see Table 1). A five-point Likert scale was used in which 1 indicated "strong disagreement" and 5 "strong agreement".

Data Collection and Sample

Based on a previously compiled list of Internet users in the Free-State and Kwazulu-Natal provinces, entrepre-

Figure 1. Research model

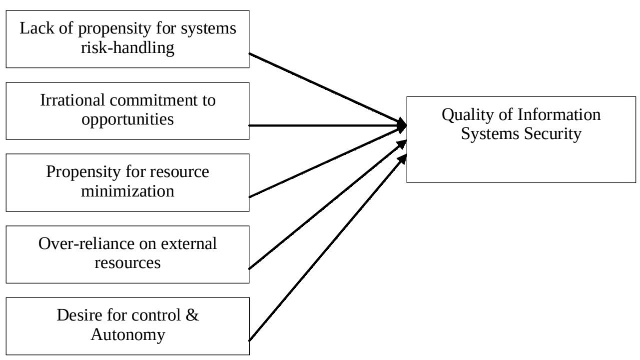

Table 1. Constructs and measures

Construct	Ref.	Measure	Adapted from
Lack of propensity for systems risk handling	RH1 RH2 RH3 RH4	Lack of : • Maintenance arrangements • Hardware/software guarantees • Insurance coverage • A security plan.	Jun and Deschoomester (2004).
Irrational commitment to opportunities	IC1 IC2 IC3 IC4	Failure to : • Consult with vendors, IT consultants and partners • Analyze e-commerce risks • Evaluate resources • Analyze costs & benefits.	Dean and Sharfman (1993).
Propensity for resource minimization	RM1 RM2 RM3	Approach used to engage resources. Type and quality of hardware/software used. Category & expertise of people involved.	Gable (1991); Croteau and Bergeron (2001); Thong (1999).
Over-reliance on external resources	OR1 OR2	Amount spent on outsourced resources. Number of applications and services outsourced.	Grover, Cheon and Teng (1994).
Desire for control & autonomy	MS1 MS2 MS3	Lack of : • Delegation of control • Allocation of tasks • Openness of communication.	Watson (1990).
Quality of IS security	QIS1 QIS2 QIS3	Number of attack incidents in past 12 months. Number of security measures implemented. Level of awareness of security risks and standards.	Straub (1990); Internet Security Alliance (2004).

neurs engaged in e-commerce were selected at random. 150 questionnaires were mailed of which 60 were returned. Five incomplete responses were, however, dropped. Follow-up letters and phone calls were made to encourage other respondents to participate. Fifteen additional responses were obtained after 3 weeks. The response rate was 47%.

Sample Characteristics

Respondents came from the manufacturing, retail, finance, construction, marketing, transport, training, entertainment, and agricultural industries. The majority were from the retail sector. The respondents' age ranged between 20-55 years and their computer and e-commerce experience ranged between 1-9 years. Most of these respondents were in business for less than 10 years.

Tests for Non-Response Bias

A test for non-response bias was done by comparing responses obtained in time with those obtained 3 weeks after follow-up letters were sent. It has been found that late respondents are likely to have similar characteristics to non-respondents (Thong, 1999). The T-test results show no significant difference between the two groups (T = 1.24; p = 0.185) at the 5% significant level, suggesting that non-response bias did not exist.

Data Analysis

Assessment of Validity and Reliability

Content validity was established by ensuring that most items used for measuring the constructs were obtained from prior studies. The reliability or internal consistency of each variable was assessed by calculating the Cronbach alpha coefficient. Table 2 shows that none of the Cronbach alpha was below 0.70 (Nunnally, 1978).

Factor analysis was also conducted to analyze interrelationships among the variables. Five factors were extracted as presented in Table 3 below. RH4 (0.812), ICI (0.838), RM2 (0.816), MS2 (0.803) had particularly high factor loadings.

The possibility of multicolinearity was examined using Person Correlation (see Table 4). None of the squared correlations was close to 0.80 to suggest possibility of this problem (Hair, Anderson, Tatham, & Black, 1995).

We also conducted correlation analysis to determine the relationship between the characteristics of the entrepreneur and the quality of IS security. Results are presented in Table 5. Except for *Propensity for resource minimization*, all other characteristics were both negatively correlated with the quality of IS security and statistically significant thereby supporting hypotheses H1, H2, H4, and H5.

Discussion

Correlation analysis revealed that there was a significant correlation between all entrepreneur characteristics. Except for *Propensity to minimize resources*, all other characteristics were significantly correlated with the quality of information systems security. *Irrational commitment to opportunities* had the highest mean (mean = 4.85, Std. = .61), indicating that entrepreneurs rapidly adopt e-commerce before analyzing its security implications. Table 3 shows that IC1 had the highest influence on factor 1 (0.838), emphasizing the importance of consultation in order to minimize potential security risks. Previous studies show however that IT service providers in the region charge high consultation fees and sometimes lack commitment (Kyobe, 2004). This perhaps discourages entrepreneurs from seeking such assistance. Table 3 shows that IC4 (failure to analyze costs/benefits) also loaded

Table 2. Assessment of reliability

Variable	No of Items	Mean	Std.	Alpha
Lack of propensity for risk handling & Proactiveness	3	4.14	0.53	0.70
Irrational commitment to opportunities	3	**4.85**	0.61	0.73
Propensity for resource minimization	4	**2.12**	0.48	0.70
Over-reliance on external resources	4	3.95	0.57	0.74
Desire for control & autonomy	4	3.50	0.44	0.72
Quality of info. system security	3	2.41	0.59	0.77

Table 3. Factor analysis

Components					
	Factor1	Factor 2	Factor3	Factor4	Factor 5
RH1		0.737			
RH2		0.708			
RH3		0.671			
RH4		**0.812**			
IC1	**0.838**				
IC2	0.774				
IC3	0.779				
IC4	**0.831**				
RM1			0.777		
RM2			**0.816**		
RM3			0.702		
OR1				0.641	
OR2				0.591	
MS1					0.607
MS2					**0.803**
MS3					0.533

Note: Factor loadings under 0.5 were suppressed

Table 4. Correlation matrix between the characteristics of entrepreneurs

Characteristics	Lack of propensity for risk handling (1)	Irrational commitment to opportunities (2)	Propensity for resource minimization (3)	Over-reliance on external resources (4)	Desire for control & Autonomy (5)
1	1.000	.468**	.102*	.124**	.333**
2	.468**	1.000	.244**	.450*	.517*
3	.102*	.244**	1.000	.113*	.102**
4	.124**	.450*	.113**	1.000	.121*
5	.333**	.517*	.102*	.121*	1.000

*** correlation is significant at 0.01 level*
** correlation is significant at 0.05 level*
Note: Composite statistics used

Table 5. Correlation matrix for Quality of IS security and entrepreneur characteristics

	Lack of propensity for risk handling	Irrational commitment to opportunities	Propensity for resource minimization	Over-reliance on external resources	Desire for control & autonomy
Quality of Info. systems security	-.366**	-.428**	**-.202**	-.110*	-.133**
Sig.	.000	.000	.111	.000	.003
N	70	70	70	70	70

*** correlation is significant at 0.01 level; * correlation is significant at 0.05 level*

highly on factor 1 (0.831). Entrepreneurs don't maintain formal records necessary for planning and lack the necessary skills to conduct financial and risk evaluations (Kyobe, 2004).

The failure of entrepreneurs to consult experts and to maintain formal records might have also influenced their ability to prepare security plans and arrangements for handling risks (factor 2, Table 3). This confirms earlier findings that small firms often fail to plan and to protect their resources (Kyobe, 2004). *Propensity for resource minimization* was surprisingly statistically insignificant, suggesting that it does not influence IS security. Analysis of factor 3 indicates however that RM1 and RM2 loaded highly on this factor (0.777 and 0.816 respectively). Most entrepreneurs adopted the ad hoc approach and used existing hardware and software to implement their systems. They relied on cheaper and somehow inexperienced resources (e.g., friends, children, and local firms) to implement their systems. This relationship should be invested further.

Items that measured the *quality of IS security* revealed that outdated and risk-prone hardware and software such as Windows98 and PentiumII computers were still used by many entrepreneurs. In most organizations anti-virus software and passwords were the only protection measures. Encryption and authentication technologies were not commonly used, there was a general lack of awareness of security standards and many suffered electronic attacks. Systems in these organizations were therefore not adequately protected.

The mean scores for *desire for control and autonomy* (mean = 3.95, Std. = 0.57 in Table 2) indicates that tasks were not allocated, authority was not delegated, and communication was not open. MS2 loading on factor 5 (Table 3) was particularly high (0.803) confirming the common problem of lack of task allocation which doesn't encourage IT skills development in many small organizations. Grundy and Kickul (2001) report that managers that helped employees feel connected to their vision and values were growing at a rate of 141% compared with 10% for those that did not. Our findings, therefore, suggest that entrepreneurs will continue to depend on external rather than internal resources for systems support and maintenance (see OR2 (0.591), OR1 (0.641) in factor 4).

FUTURE TRENDS

Emerging trends in e-commerce and security provide both promises and pitfalls for small organizations. While cheaper and secure solutions for SMEs are now provided by IBM, Microsoft, HP, and Cisco, security still remains a major problem. Organizations are, therefore, encouraged to adopt a holistic approach to e-commerce security, whereby individuals, businesses, vendors, and government work in partnership to address this problem (EURIM, 2003; US-CERT, 2004). Several other initiatives, such as improvements in reporting methods (EURIM, 2003), research into "trust" (Clarke, 2002) and emerging practices, and Netpreneur challenges (Grundy & Kickul, 2001), are already underway.

CONCLUSION

Our findings confirm that due to their decision-making behaviors, entrepreneurs do not implement e-commerce with security in mind. There is a need for careful evaluation of business and technological implications beforehand. In addition, entrepreneurs need to involve experts, invest in up-to-date resources, and ensure better work relations with employees. This study was only conducted in regional areas. An extension into urban areas where the profile of entrepreneurship differs may provide useful information for policy advisors.

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KEY TERMS

E-Crime: Is the illegal exploitation of computer technologies, such as the Internet.

Electronic Commerce: Use of electronic means to exchange information and to carry out transactions.

Entrepreneur: A business owner who takes all decisions and operates in uncertain environment.

Entrepreneurial Orientation: The practices and decision making styles managers use to keep the firms competitive.

Information Systems Security: The protection of information and systems that use, store, and transmit information.

Irrational Commitment to Opportunities: The tendency to seize opportunities without proper consideration given to potential implications.

Low-Risk Perception: Refers to the subjective assessment of the probability of a risk.

Risk-Handling: The process in which potential risks to a business are identified in advance, analyzed, mitigated, prevented, and the cost of protection is balanced with the cost of exposure to the risk.

SMEs: According to the South African Small Business Act (Act 102 of 1996), SMEs are businesses with up to one hundred employees.

E-Questionnaire for Innovative Adaptive-Learning Scheme

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INTRODUCTION AND BACKGROUND

As broadband connectivity to the Internet becomes faster, Web-based learning systems have appeared and play an important role for self-learning, especially for working people. Most of the systems are not adapting to the learner, so the learner has to spend a lot of time before reaching the learning goal that is suitable for him or her (Solomos & Avouris, 1999). This procedure may discourage the learner from continuing his or her studies (Bixler & Spotts, 2000; Fitzelle & Trochim, 2000).

To overcome these difficulties, we have to design an e-learning system that will be adapted to the learner's ICT level and knowledge. In our proposal, we introduce an e-learning schema that has these characteristics. Specifically, we consider the IEEE reference model (WG) of the Learning Technology Standards Committee and use it to model the architecture of an e-learning system. Our approach is based on the usage of electronic questionnaires (e-questionnaires) that are designed by experts and aim to detect the learner's ICT level and learning preferences prior to the learning experience as well as after its completion. Through the analysis of learner responses to questionnaires, learners may be assigned to their corresponding learner profiles so that they are served with learning material that best matches their needs.

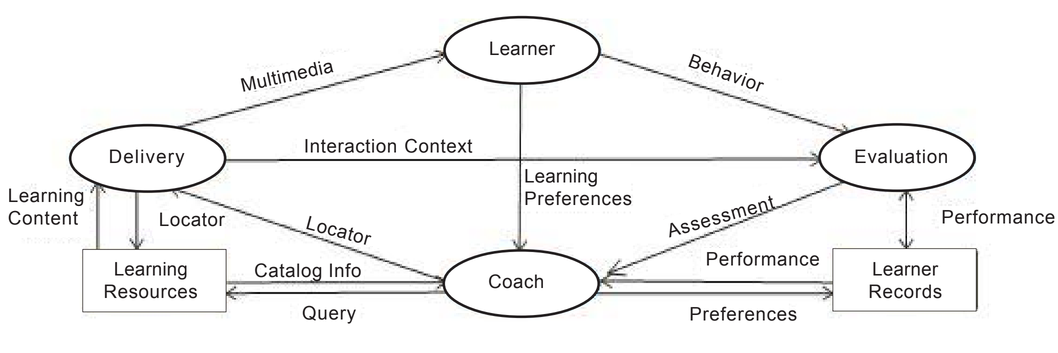
The structure of the article is the following. In the first section "Description of the E-Technology Application," we briefly present the generic structure of the e-learning system, as specified in the IEEE reference model (WG) of the Learning Technology Standards Committee, and then we present our approach to this model. Continuing, we outline the profile adaptation method that is used in our schema. Finally, in the section "Impact of the E-Technology Application," we refer to the SPERO project, in the framework in which the proposed system is being applied, and finally we list our concluding remarks.

DESCRIPTION OF THE E-TECHNOLOGY APPLICATION

Learning Technology Systems Architecture by IEEE

The proposed system is based on IEEE P1484.1/D9, the draft standard for a learning-technology system architecture (LTSA; IEEE P1484.1, n.d., http://jtc1sc36.org). This standard identifies a high-level architecture for e-learning systems that includes processes, stores, and flows as is depicted in Figure 1, and describes the interaction between these modules.

Figure 1. IEEE 1484.1 LTSA system components



This system, which could be adaptive for any educational course, contains two stores: learning resources and learner records. The learning resources store is invoked using a database that represents knowledge, information, and other resources that are used in the learning experiences. It may be represented as a collection of presentations, tutorials, experiments, or lessons. The other store of the IEEE LTSA system, the learner records, contains information about the learner as assessment information and certifications that the evaluation and coach processes have derived.

The learner entity, coach, evaluation, and delivery processes each have a main role in the system.

The main entity of the system is the learner entity, which represents a single learner or a group of learners with different needs. The learner process receives a multimedia presentation via the multimedia flow, which has been retrieved from the learning resources by the delivery process.

While the multimedia presentation is shown to the learner, his or her behavior and reactions are observed via the behavior flow, which provides information about the learner's activities. Information as keyboard clicks or mouse clicks is recorded in real time by the behavior flow and is used to evaluate the results of the learning.

The learning preferences flow is negotiated with the coach process based on language and cultural adaptation, as well as accessibility for people with physical limitations. The learner entity's observable behavior flow is an input to the evaluation process. The interaction context flow is a data flow from the delivery process to the evaluation process that may provide the necessary information for interpreting the information contained in the behavior data flow.

On the one hand, the evaluation process produces assessment information, which is sent to the coach process. On the other hand, the evaluation process creates performance information that is stored in the learner records. Performance information may come from both the evaluation process (e.g., grades on lessons) and the coach process (e.g., certifications). The coach may receive performance information from the learner records at any time. Performance information, such as assessment information and certifications, and preferences may be stored in the learner records by the coach process.

Based on this information, the coach process may generate queries and forward them to the learning resources store in order to request learning materials that are appropriate for each learner. The learning resources store replies to the coach process with catalog info flow, that is, with a list of locators that match the search query. The delivery process to retrieve learning content may use these.

Finally, the delivery process transforms information obtained, using the learning content store, into a presentation, which may be transferred to the learner entity, passing through the multimedia stream. The evaluation process that is described in the LTSA draft standard is not apparently adaptive to the learner as there is no mechanism that could provide this adaptation. In the proposed schema, we attempt to outline the procedure through which the LTSA draft standard may be applied with the direction of learner-centered content delivery. Our approach to understanding the learner's needs is outlined in the following section.

A NEW APPROACH TO LEARNING TECHNOLOGY SYSTEMS DESIGN

The presented procedure evolves around the notion of the e-questionnaire with the aim of the detection of the learner's learning preferences and ICT level, with respect to a specific learning topic. Through this procedure, learner adaptation to the proper learning topic and course can be achieved using an e-questionnaire. Our proposal could be considered as an extension of the IEEE LTSA draft, adding two stores, the questionnaire and learner profiles, and two processes, the e-survey and the experts' group, and enriching all modules that the IEEE LTSA contains with new functionalities with the purpose of effective collaboration between them (Figure 2).

In our case, the learner entity represents a teacher who works in the special educational needs sector (http://www.image.ntua.gr/questspero; Tzouveli, Tsapatsoulis, Kollias, & Michaelidou, 2003). The expert-group process is represented by a variety of people, such as teachers, teachers of the special-education sector, experts in e-learning, data analysts, psychologists, and software engineers. In our case study, the experts' group has designed and illustrated e-questionnaires, which are addressed to the teachers in the special educational needs sector and are intended to collect information for teachers' educational background, as well as their background in ICT. In addition, information concerning teachers' opinions about the pedagogical utilization of ICT and the amount of ICT they use in the teaching procedure are also extracted from these questionnaires.

It is noticeable that the experts' group is responsible for determining the learning issue that the e-learning schema can provide and for the learners' group in which this learning subject is addressed.

The questionnaire store is a database that contains various questionnaires designed for diverse educational needs and types of learners. Each of these questionnaires has a limited number of questions; these may be of various types, such as multiple choice, which include the appropriate values for the answers of each question. The questionnaire texts are defined and stored in the questionnaire store by the experts' group that has decided the learning subject, which the questionnaire will negotiate.

The layout of the questionnaire is automatically illustrated (by software that has been produced by the experts' group; Skordalakis, 1991; http://www.image.ntua.gr/questspero) through the delivery process, taking as input the questionnaire texts that are stored in the questionnaire store; they are provided to the learner though the multimedia flow (Figure 2) as hypertext that contains a form schema.

Likewise, statistic experts who belong to the experts' group assign the values of the answers of each question that the e-questionnaire contains. The emphasis is on the questionnaire, the answers to which can be processed in an automated manner and can be lead to the learner's classification and also to an e-survey.

In this way, the delivery process sends the values of the questions from this questionnaire to the evaluation process via the interaction-context flow. So, the interaction–context flow has been assigned with this function.

Once a learner replies to the e-questionnaire, his or her reply is submitted to the evaluation process via the behavior flow. This is necessary for the computation of the values that each learner has given taking under consideration the learners' profile store. The proposed schema needs this computation in order to find out the learner's level of knowledge in a specific subject and to classify the learner's profile, which is then stored in the learner records.

The new store, learner profiles, contains the current profiles that the e-learning system provides. The way in which these profiles are accumulated in the store will be analyzed in the following section (http://www.image.ntua.gr/statspero/profiles).

In the proposed scheme, the coach process of the IEEE LTSA draft has been improved so as to select the proper learner resources for learners according to their profiles; these are stored in the leaner records. If the learners have already accessed the specific e-learning system, they will not be asked to answer the questionnaire but will receive the proper learning material according to their profiles, stored in the learner records. Otherwise, if the learners access the specific e-learning system for the first time, they will receive the questionnaire that is proper for the learning topic that they will take.

The e-survey process can provide statistics over the learners' answers, taking as input the learner's records where the learner's answers to the e-questionnaire are stored, as well as providing a statistical analysis on these records. The e-survey process is added for statistical reasons, and the results of this procedure can be useful for the scientific section that the questionnaire has as a subject (http://www.image.ntua.gr/statsspero).

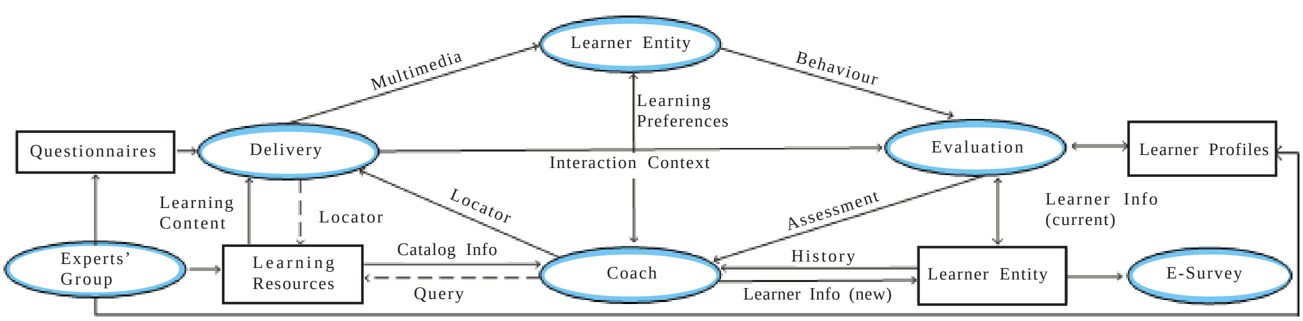
For example, if the questionnaire includes questions about computers and the Internet, as it happens in our case study, a statistical analysis for the learner's familiarity with ICT can be carried out (Papoulis, 1984).

PROFILE ADAPTATION

Among the research community dealing with personalized learning and intelligent learning applications, it becomes clear that the results to be achieved from any kind of electronic questionnaires or surveys will not have the desired effectiveness unless major focus is given to individual learner profiling and the corresponding learner behavior. Such functionalities define learners' capabilities and also to some extent define learners' future choices. Additionally, major profits evolve from learner profiling, especially when used in interactive learning systems and information-retrieval methods for learning (Mylonas, Tzouveli, & Kollias, 2004).

However, automated learner-profile extraction from several sources of knowledge is, in general, a complex task (Wallace et al., 2004). It is expected that it can be tackled when dealing with specific application domains.

Figure 2. Proposed system components



Herein, we focus on any information bit that may be utilized in order to either enhance the learning experience that will be offered to the specific learner in the future, or enhance the system's interaction with other learners as well, applying the principles of collaborative learning. The term collaborative learning refers to the hypothesis that similar learners will act in a similar manner when faced with similar situations, which allows for a group of learners to be handled by a system through a single learner profile.

This section describes the algorithms that may be utilized for the analysis of feedback collected from the learner in the form of replies to e-questionnaires, as well as the way to utilize the mined information in order to enhance the learning experience provided by the system.

The adaptive operation of the proposed system relies on the principles of collaborative learning (Solomos & Avouris, 1999); thus, a small set of predefined, static profiles needs to be included in the profile database before learners can be efficiently served. The population of the database with the initial profiles is achieved with the aid of a group of experts. In order to acquire the necessary input for the generation of the initial learner profiles, the experts' team designs an e-questionnaire that is forwarded to a characteristic sample of learners.

The initial e-questionnaire is specially designed to detect the learners' ICT levels concerning the topic of the instruction, their learning preferences, any learning or accessibility difficulties they may have, their approach toward the topic of instruction as well as toward e-learning tools, and their interfaces and their preferred language of instruction. The primary aim of this questionnaire is to allow for the learners of the characteristic sample to be divided into groups of learners, with learners of each group displaying similar learning behaviors.

When designing the questionnaire, together with the questions and the sets of corresponding answers, the experts also indicate the way to interpret each answer according to the value of the question. Using this information, the questions are divided into groups depending on the type of information that they provide about the learner. Moreover, distance metrics among answers corresponding to questions of the same group are defined, indicating the degree to which the answers are incompatible.

The learner profiles that have been defined by the experts' team are stored in the learner-profile store. Each one of them describes, in addition to the characteristics of the learner it describes, the learner's needs and preferences. Thus, once a learner is assigned to a learner profile, the coach may use this information in order to locate in the learning-resources store the learning materials that best match his or her learning needs and preferences.

As a first step of processing, learners' replies are checked for consistency. Specifically, the average sum of distances between answers (for questions of the same group) is used as an indicator of the consistency of the replies. A large percentage of incompatibilities in learner answers corresponds to either a poorly designed set of questions or to a poorly designed answer-interpretation scheme. In either case, this is a strong indication that the e-questionnaire needs to be reconsidered, and possibly reanswered by learners, before the process of data analysis proceeds.

Once this step is over and the learner replies have been verified as consistent, the process of the detection of typical learner behaviors starts. This is undertaken through the clustering of learner replies.

In the beginning, the group of experts calibrates the possible answers of each question, and these values are stored in the e-questionnaire store. Afterward, initial static profiles are defined by the group of experts according to possible combinations between answers of the questionnaire, and these profiles are stored in the learner profiles. The categories of these static profiles are three now: beginner, intermediate, and expert learners.

Next, the evaluation process (Figure 2), whose functionality has been extended in the proposed schema, collaborates with the learner entity with the aim of retrieving each answer that the learner has chosen. Having these values, the evaluation process applies the k-means algorithm (Duda, Hart, & Stork, 2000), computing the distance between each answer and the centres of each category stored in the learner-profiles store. Selecting the nearest centre defines the profile in each question that the learner has indicated, and the average of the questions' profiles defines the learner profile, which is stored in the learner records.

The experts use average learner replies from each learner group in order to define the corresponding collaborative learner profile. Specifically, the experts have to specify

- which learning resources are suitable for learners in each profile and
- what the characteristics of each collaborative profile are.

The latter is needed in order for a new e-questionnaire to be designed with the aim to quickly, that is, using a much shorter e-questionnaire, classify new learners to the collaborative profile that best matches them. All new learners are required to reply to the questions of this e-questionnaire before the system can serve them with learning material that suits them.

Learners are also required to provide answers to questionnaires after completing an e-course. Answers to these e-questionnaires are used by the system to adapt its operation to the changing needs and ICT levels of the learners. Specifically, learners are classified, based on their answers, to the collaborative learner profiles of the profile database. In this process, it is possible for a learner to be assigned to a different profile than the one he or she originally belonged to; in this way, the system's future interaction is adapted to the new learner characteristics.

IMPACT OF THE E-TECHNOLOGY APPLICATION

The proposed schema has been developed under the European project SPERO: TeleInformatics System for Continuous Collection, Processing, Diffusion of Material for Teacher Training in Special Education (Leonardo da Vinci program, Theme 5: E-Learning, 2001-2004).

The overall objective of the SPERO project has been to provide data concerning the field of special educational needs in order to identify the meaning of exclusion and to introduce policies and strategies for social inclusion. For this reason, SPERO has collected and processed material for training teachers mainly in special education that offer valuable information in the area of training. Data have been collected by the "clever" questionnaire, which is developed based on the proposed schema. Automatic statistic analysis is used to analyze factors and variables that may lead to unemployment and social exclusion. Emerging issues can lead to proposed actions that may be adopted in order to prevent the risk of unemployment.

CONCLUSION

In the era of the information society, surveys should not only be used to record information about a particular subject in particular time instances. Their main conclusions need to be usable in a dynamic manner. In this article, we have presented how an e-questionnaire, designed for conducting a survey about the ICT level of knowledge of teachers working in the special education sector, can be used in the framework of a dynamic distance learning scheme so as to achieve user adaptive-learning facilities. Work is continuing in this area through the collection of large numbers of teacher responses from many European countries, aimed at attempting to apply the proposed schema to large multinational populations.

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KEY TERMS

Distance Education: Distance education takes place when an instructor and student are separated by physical distance, and various technologies (e.g., the Internet, videoconferencing, etc.) are used to bridge the distance. These types of instructional delivery systems can provide nontraditional students with a second chance at a college education, and reach those disadvantaged by time constraints, physical disability, or remote geographical locations. It is sometimes called distance learning.

E-Course: An online educational program that introduces and explains a specific educational subject

E-Learning: Technologically mediated learning using computers whether from a distance or in a face-to-face classroom setting (computer-assisted learning).

E-Questionnaire: A questionnaire in an electronic form that can be completed via the Internet.

E-Survey: A survey that is based on answers of an e-questionnaire.

ICT Level of Knowledge: The level of knowledge in the field of information and communication technologies that someone has.

User Profile: The user profile specifies what data and network resources a user can access and the type of access.

E-Shoppers' Perception of Web-Based Decision Aid

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INTRODUCTION

The WWW, for better or worse, has forever changed the way retailers do business nowadays. E-shoppers, who become more sophisticated and mature nowadays, are demanding increased flexibility and intelligent aids in accessing product information, making purchasing decisions, and obtaining e-services (Anupam, Hull, & Kumar, 2001; Chen, Gillenson, & Sherrell, 2004). The Internet facilitates interactive selling approaches, whereby product offerings can be tailored to individual preferences. It allows e-shoppers to easily gather, retrieve, and analyze product information. Ultimately, the Web offers the ideal vehicle for delivering intelligent online support tools directly to customers (Grenci & Todd, 2002).

Unfortunately, most e-commerce sites are rarely aware of taking advantage of such Internet-driven customer aid. Rapid advancements in Internet technology have offered a solution of Web-based customer decision support system (WCDSS) that can improve transactional efficiency by providing tailored merchandising information, offering sales support and consultation, facilitating sales promotion and advertising, and enhancing the consistency, availability and quality of online support to e-shoppers (O'Keefe & Mceachern, 1998). As the WCDSS aims to empower e-shoppers by enabling them to make informed decisions online, the question of how they would perceive such support arises.

In this article, we aim to establish a theory-founded framework to understand and explain e-shoppers' perceptions of the proposed WCDSS functions. We look at the key features of WCDSS functions that may have impact on e-shopper's perceptions, and how to scale and analyze e-shoppers' perceptions regarding specific functions. The specific objectives are threefold. We aim (a) to verify the role WCDSS can play in facilitating e-shoppers, (b) to identify the key issues that impact e-shoppers' perceptions of WCDSS, and (c) to suggest ways in designing and improving WCDSS functions and interfaces.

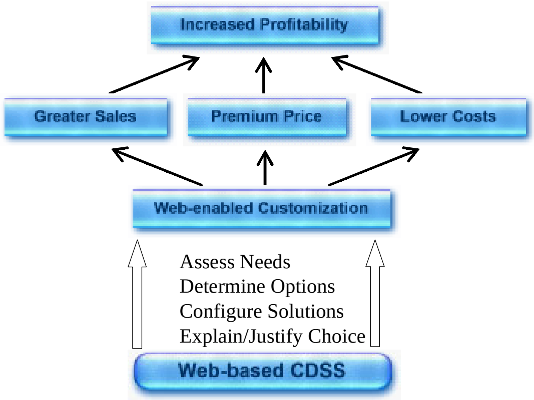
BACKGROUND OVERVIEW

Throughout the e-commerce literature, customer-side researches have repeatedly stated that customers are at the core of all businesses no matter they are brick-and-motor or virtually online (Hughes, 2002; Rodgers, Yen, & Chou, 2002). E-commerce success depends on effectively managing relationships with the customers and understanding their online behavior and preference in a comprehensive and interactive way (Rowley, 2002). With the advent of the Internet, customers have realized the benefits of shopping online including convenience, broader selection, and competitive pricing, but on the other hand, their involvement in online retailing is impeded by factors such as information overload and other technology barriers or unfamiliarity (Chen et al., 2004).

Taking advantage of the Internet-driven technology, WCDSS, a Web-based customer decision support system, offers an ideal vehicle that provides customized and intelligent real-time assistance for e-shoppers in overcoming substantial impediments to participation and satisfaction online. Starting more than 40 years ago, long before the Web and notions of e-commerce access, there has been great interest in the human decision making process (Forgionne, 2000). In Gregg, Goul, and Philippakis (2002), work on decision support development, they proffered that "it is now possible to access these DSS using the Internet" (p. 233). A WCDSS is thus defined as a Web-based system that connects a company to its existing or potential customers, providing support for the customers' online decision-making process (O'Keefe & McEachern, 1998).

A WCDSS is believed to have the ability to offer significant value to the entire customer decision-making process, especially in the Internet era of self-service, configure-to-order buying (Grenci & Todd, 2002). The complexity of configuring and selecting the customizable goods and services sold on the Web suggests there is particular value in an interface that guides and directs customer choices and markets complex and customizable products (Grenci & Todd, 2002). Such WCDSS-enabled

Figure 1. WCDSS in support of e-commerce activities



personalization and customization will then lead to lower transaction cost, premium product pricing, and greater promotional sales which all together will result in increased profitability. Figure 1 depicts the aforesaid functions and features of a WCDSS and its impact on the e-commerce performance.

Although the WCDSS is gaining momentum in facilitating online shopping, much work has been done on the algorithms of the proposed approach with little consideration of the interaction with the potential customers (Anupam et al., 2001). One exception is a simple framework proposed by Chiasson and Lovato (2001) to understand the factors that influence the formation of a user's perceptions of a DSS innovation. Those factors include subjective norms, adoption stage, user competence, implementation processes, and organizational factors. However, e-commerce introduces new business objectives, enables new business activities, and creates new channels in which the service experience and data gathering about the customer are closely coupled (Rowley, 2002). As a result, the old measures of customers' perceptions of general DSS functions may no longer apply in the context of e-commerce. To fill the gap, this study offers such an exploratory investigation on e-shoppers' perceptions of the specific WCDSS functions. The framework proposed in this study links the WCDSS features and functions to each e-shoppers' decision-making step, and helps WCDSS designers and implementers in their development, implementation, evaluation, and ongoing utilization of the system.

FRAMEWORK TO UNDERSTAND E-SHOPPERS' PERCEPTION

To explore e-shoppers' perceptions of the WCDSS functions, we first look at the specific steps involved in the customer shopping process, what parts of the process can be supported by the WCDSS, and how the customers would perceive such Web-based support. From a decision-making perspective, the customer shopping process breaks down into five stages of decision-making steps (see Table 1).

Throughout the process, WCDSS could provide proper decision aids to facilitate certain tasks within each stage. Based on an early work on the impact of design elements and policies on customer attitudes (Hahn, 2001), we identify two dimensions of e-commerce system, which reflect the proposed WCDSS functions: Market Site-Structure and Market Techno-Structure. We define EC Site-Structure as related to the presentation and navigation of items or instructions. EC Techno-Structure refers

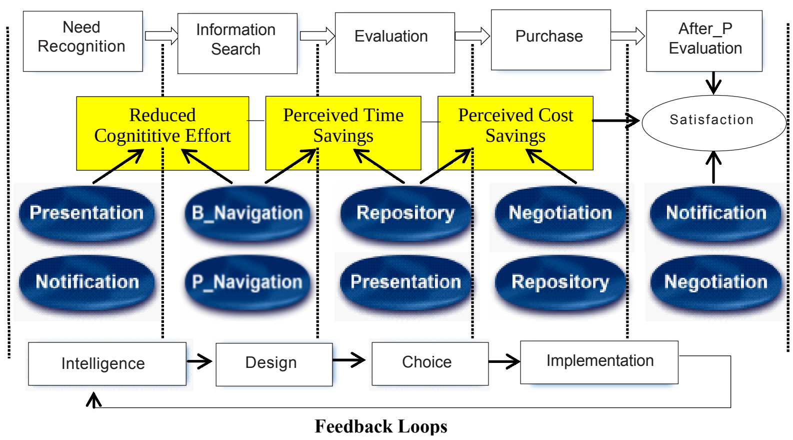
Table 1. Overview of e-shoppers' decision making stages

E-Commerce Shopping Stages	E-Shoppers' Decision-Making Steps (O'Keefe & McEachern, 1998)	General Decision-Making Steps (Forgionne, 2000)
Need recognition	E-shoppers must recognize they have a need that can be satisfied through a purchase online.	Intelligence—Observe reality and gain problem or opportunity understanding.
Information search	E-shoppers then search for a product or service that satisfies this need, along with outlets that can provide it.	Intelligence—acquire needed information; design—develop decision alternatives.
Evaluation	E-shoppers use decision heuristics to evaluate and compare goods, often using surrogate measures where limited information is available.	Choice—logically evaluate the decision alternatives and develop recommended actions that best meet the criteria.
Purchase	E-shoppers place an order, pay for it (or arrange payment), and possibly arrange for collection, delivery, or maybe installation.	Implementation—gain confidence in the decision, develop an implementation plan, and put into action.
After purchase evaluation	E-shoppers evaluate purchases with a view to future decision making.	Feedback loops—utilize the outputs to guide further decision-making process.

Table 2. WCDSS facilities in the context of e-commerce

EC-Dimensions	WCDSS Facilities
EC Site-Structure	Basic navigation support, Personalized navigation aids, Item presentation
EC Techno-Structure	Negotiation mechanism, Notification mechanism, Rules repository

Figure 2. Influence of WCDSS on e-shoppers' perceptions in e-commerce



to formalized institutional procedures that govern trade execution between market participants. Within each dimension, we identified a set of features to address the major WCDSS functions (see Table 2).

In the current context, our metrics for customer attitudes and perceptions concentrated heavily on satisfaction with the proposed WCDSS functions. Specifically, reduced cognitive decision effort and perceived time and cost savings have been identified to be associated with an e-shopper's satisfaction with the online purchase making process (Pereira, 1999; Todd & Benbasat, 1991). We then establish a comprehensive framework that facilitates a better understanding of e-shoppers' perceptions of specific WCDSS functions (see Figure 2).

- **Basic Navigation Support:** WCDSS offers basic navigation tools such as the internal search on the Web site and links to (and guidance on) external sources which provide browsing aids for searching (O'Keefe & McEachern, 1998). Such basic navigation support can facilitate the e-shoppers' Information Search phase and result in perceived time savings and reduced cognitive search effort. Reduced cognitive search effort refers to the expectation that the goal-directed search for specific information is expected to be much more effective if the e-shoppers have the navigation support delivered through a WCDSS.
- **Personalized Navigation Aids:** Assisted by IT-enabled technologies, WCDSS can effectively mass customize and market product information to meet individual customer needs (Grenci & Todd, 2002). Such facilities include but are not limited to structural interaction and question/answer sessions and customer profile where information will be captured and customized to the customer's personal tastes and needs automatically (Claypool, Le, Wased, & Brown, 2001). Similar to the basic navigation support, such personalized navigation aids also enables e-shoppers search for product related information more efficiently and effectively.
- **Item Presentation:** How items are presented is important in that this affects the buyers' information seeking and item comparison/evaluation behaviors (Hahn, 2001). WDMSS presents virtual catalogs, 3D picture display, and samples and trials (e.g., customized virtual model in Apparel e-commerce sites) that assist product presentation and promotion (Need Recognition phase) and help customers better evaluate and compare the products (Evaluation phase). Therefore, effective item presentation facilities will lead to reduced decision effort and perceived time and cost savings in online purchases.

- **Negotiation Mechanism:** WCDSS enables certain negotiation facilities such as pointers to (and information on) the product providers as well as other existing customers, structural interactions, and question/answer sessions (O'Keefe & McEachern, 1998). E-shoppers' sensitivity or preference data can be captured and stored at the same time. Accordingly, such negotiation capabilities will guide e-shoppers through the Purchase and After Purchase Evaluation phases and eventually enhance the e-shoppers' trust on the site and ensure their satisfaction with the purchase.
- **Notification Mechanism:** WCDSS can utilize unique Web features to allow customer information captured to change dynamically for flexible decision making aids. Interactive notification, such as customer support via e-mail and a newsgroup, may increase customer engagement and satisfaction and help them identify product/service that match their needs (Need Recognition) and evaluate the purchase afterwards (After Purchase Evaluation) more effectively.
- **Rules Repository:** FAQs and other summaries as well as evaluative models can be delivered through a WCDSS to help e-shoppers make informed decisions online. Specifically, when evaluating a candidate product, the e-shopper can interact with the WCDSS and experiment on different choices or matches by specifying his or her preferences and corresponding weights. When check out, the e-shopper can always refer to the WCDSS rules repository for needed information to accomplish tasks in an error-free manner.

In summary, as illustrated in Figure 2, the proposed WCDSS functions facilitate e-shoppers' purchase making process in an integrated and continuous way. E-shoppers who have access to the WCDSS are kept updated with new product information and sales or promotions that would stimulate their shopping needs and help them specify the requirements (Need Recognition). With WCDSS, e-shoppers would easily be able to locate product candidates, which closely match the preferences they specify in their initial searches (Information Search). The use of the WCDSS will then provide e-shoppers with the capability to screen information efficiently so that s/he can focus on alternatives that best match his or her preferences (Evaluation). The embedded rules repository supports the e-shoppers' order process, ranging from adding products to their shopping basket to entering the credit card information for completion (Purchase). Finally, the WCDSS presents a structural evaluation form that could help the e-shoppers review their purchase experience in a systematic way (After Purchase Evaluation). As a result, the use of WCDSS throughout the five online purchase stages will result in reduced cognitive decision effort, perceived time savings, and perceived cost savings that will eventually lead to the e-shoppers' satisfaction with the purchase.

Accordingly, such influences, either positive or negative, of the WCDSS on e-shoppers' perceptions need to be incorporated into future WCDSS design and development. Firstly, in order to reduce the e-shoppers' cognitive decision effort, the provision of models, including evaluation models in Evaluation phase and preference models in Information Search phase, in a WCDSS should be straightforward (O'Keefe & McEachern, 1998). Otherwise, data entry and the time to execute the model are both burdens to e-shoppers. Therefore, sufficient care should be taken to ensure that e-shoppers understand the assumptions and limits of any model in a WCDSS.

Secondly, the WDSS interface can be very problematic. As Grenci and Todd (2002) proffered, the degree of online support for a custom purchase is reflected in the interface design of a Web-based decision support. Effective WCDSS interface design, with respect to reduced cognitive decision effort and perceived time savings, should consider product complexity and the e-shoppers' expertise in question. For instance, a passive interface that offers minimal guidance or advice may be ineffective for a novice e-shopper, and an active interface that offers a lot of assistance may be annoying and inefficient for an expert e-shopper. Similarly, complex products with a large number of configurable components may require expert-driven decision support techniques that use e-shoppers' preferences to filter out irrelevant or undesirable choice options (Grenci & Todd, 2002).

Last but not the least, the WCDSS should be structured in a way that strengthens the bond of the e-shoppers' trust of the e-commerce site. Trust, especially in the depersonalized setting of the Internet, is very fragile. Trust builds with transactions and interactions, but a key element of trust relates to how the system uses customer information and knowledge (Rowley, 2002). Personalized decision support should not interfere with e-shoppers' security and privacy concerns. Irrelevant, inaccurate or inappropriate decision support customization may weaken e-shoppers' trust and eventually result in dissatisfaction with the purchase. Therefore, to deliver reliable and accurate support is more effective in building e-commerce trust than just present seemingly enticing advertisements.

FUTURE TRENDS AND DIRECTIONS

So far, we have established a conceptual framework to explore e-shoppers' perceptions of the WCDSS functions. This exploratory investigation offers opportunities

Table 3. An illustration of the theoretical framework operationalization

WCDSS Site-Structure Perception		
Variable	*Description*	Reference
Basic navigation support	I think the internal search saves me time finding useful product information.	*Chen (2000);*
	I desire the browsing capability that could help me identify product more effectively.	
Personalized navigation aids	I'd like to be identified and welcomed once I revisit the e-commerce site.	*Hahn (2001);*
	I'd like to make my own search criteria and get personalized navigation support.	*Kumar & Feldman (2000);*
Item Presentation	I'd like to see the 3D pictures before making final purchasing decisions.	
	I desire to get price and other feature comparison report of the items I feel interested.	
Notification mechanism	I want to be informed timely about the sale and promotion information.	*Reck (1997);*
	I'd like to get immediate responses to my questions when shopping online.	
Negotiation mechanism	I think real time guide would be useful while searching or buying products online.	*Hahn, (2001);*
	I desire to ask the seller questions interactively about the item of interest.	
Rules repository	I would trust the site more if it allows interactive evaluation of the items I feel interested.	*Rowley (2002)*
	Complete FAQs and other tips would make it easier for me to accomplish a purchase.	
WCDSS Techno-Structure Perception		

for future endeavor on this interesting topic. For instance, the "satisfaction with the proposed WCDSS functions" construct is based on validated theories from the literature. To further broaden the application base and offer specific empirical experience, the framework proposed in this study can be implemented and evaluated in a field setting. This effort could possibly involve an operationalization of the conceptual framework to construct perception and attitude scales for a survey study and a structured experimental study in which, ideally, potential e-shoppers are revealed to a specific type of WCDSS or prototype illustration. Such endeavor could possibly generate more empirical evidence on the topic and offer more concrete guidelines in WCDSS design and development.

As an illustration of the framework operationalization, we draw a list of 25 sample survey statements addressing e-shoppers' perceptions of the WCDSS. Table 3 shows a sample operationalization of each feature and the corresponding survey statements.

CONCLUSION

People who are affected by a decision should have an opportunity to influence it. Since WCDSS affects e-shoppers' purchasing activities, we believe they should have the right to speak out their opinions, and their feedbacks will enlighten the WCDSS interface and functionality design in turn. In this study, we identified five phases involved in e-shoppers' decision making process, including Need Recognition, Information Search, Evaluation, Purchase, and After Purchase Evaluation. We also specified Site-Structure features and Techno-Structure features of a WCDSS in e-commerce applications and examined their respective impact on e-shoppers' perceptions in each phase of the purchase decision making process. Then we elicited important WCDSS design implications with respect to enhancing e-shoppers' engagement and satisfaction with a purchase.

As an exploratory study on e-shoppers' perception of WCDSS functions, this study offers both theoretical contributions and practical implication. In theory, the framework helps in understanding WCDSS key features and their corresponding impact on e-shoppers' perceptions in each decision making stage. In practice, the findings assist WCDSS designers and developers in identifying the key factors that influence the adoption of WCDSS in e-commerce applications.

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KEY TERMS

Basic Navigation Support: Basic WCDSS navigation structures such as the categories of offerings that provide browsing aids for searching.

Customer Shopping Process: The entire process that an e-shopper completes a purchase, which involves five stages: Need Recognition, Information Search, Evaluation, Purchase, and After Purchase Evaluation (O'Keefe & McEachern, 1998).

EC Site-Structure: An e-commerce system dimension that is related to the presentation and navigation of items or instructions (Hahn, 2001).

EC Techno-Structure: An e-commerce system dimension that is related to the formalized institutional procedures that govern online trade execution between e-market participants (Hahn, 2001).

Item Presentation: WCDSS product display and promotion formats such as virtual catalogs, 3D picture display, and samples and trials.

Negotiation Mechanism: The means of a WCDSS to enable e-shoppers to interact directly and interactively with representatives or other parties and adjust their shopping actions before they have committed to an erroneous result.

Notification Mechanism: The means of a WCDSS to provide e-shoppers immediate and continuous alerts to tailored merchandising information, sales promotions and advertising, and other purchase related information.

Personalized Navigation Aids: Customized WCDSS navigation structures such as the personal shopping gallery that meets individual customer needs or desires.

Rules Repository: WCDSS information and knowledge base that contains directions and instruction to help e-shoppers make informed decisions online.

WCDSS: Web-based customer decision support system that connects e-commerce companies to their existing or potential customers and provides online support for the customer decision-making process (O'Keefe & McEachern, 1998).

E-Supply Chain Orchestration

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INTRODUCTION

The world today is witnessing a growing interest in conducting supply chain business processes electronically. Different supporting technologies are emerging, and many are already available on the market. The adoption of these technologies is hampered by the fact that organizations constantly face new requirements, constraints and demands. Recent research has shown that service-oriented architectures and its supporting technology, Web services, can address many major issues encountered in complex supply chains. However, one of the largely unsolved issues is the orchestration of the variety of Web services in the supply chain. This chapter presents an investigation on orchestration of supply chain business processes using portals and Web service technologies. The portal-based orchestration concepts were carried out in a project for supporting end-to-end supply chain logistics in the United States Department of Defense. A second supply chain study looked at the added value of Web service orchestration.

BACKGROUND

Cheap transportation options and advanced use of information and communication technologies enable organizations to source and to sell globally, and to host their supporting services in any place of the world. As a result, organizations in the current business era create alliances with partners so as to form business networks (Bradley, Hausman, & Nolan, 1993; Nohria & Eccles, 1992). As a result, operational business processes tend not to be self-contained within an organization. When products or services are followed through the network, the successive steps of value addition in the network are often described with the term "supply chain" (Simchi-Levi, Kaminsky, & Simchi-Levi, 2003). The choice for the term supply chain is unfortunately because it leads to confusion. "Chains" evoke linear, unchanging, and powerless images. "Supply" feels pushy and savors of mass production rather than mass customization. Better names like "demand network" or "customer driven Webs" have been proposed. Yet, the name "supply chain" seems to have stuck (Johnson & Pyke, 2000). Strictly speaking, the supply chain is a network of multiple businesses and relationships (Lambert, Cooper, & Pagh, 1998). Because of globalization and short-term contracts, modern supply chains include external partner processes that have a limited visibility. This increases the difficulty for decision makers to understand and redesign the process orchestration in the business network. In addition, the dynamic nature of the business network, for instance changing numbers and types of partners, and an involvement in several networks, increases the difficulty and complexity to manage supply chain processes. Information and communication technologies that can help organizations to design, manage, and maintain these complex inter-organizational processes are urgently required.

In a pilot project for the U.S. Department of Defense (DoD), the authors were part of a large, multidisciplinary team that designed and tested prototype solutions for supply chain integration. The project showed the feasibility of portaled solutions for real-time support for end-to-end supply chain management in a complex organization. The next section illustrates how portaling technologies can be seen as a first step towards solving the management problems of DoD's complex supply chains (Boyson, Corsi, & Verbraeck, 2003; Boyson, Harrington, & Corsi, 2004).

SOLUTIONS FOR E-SUPPLY CHAIN ORCHESTRATION

Portaling Technologies as the First Solution Step

In the project, a first version of a supply chain orchestration portal was built to provide Web-based business functionality, asset visibility, and total system intelligence to the supply chain managers of the U.S. Air Force (Boyson et al., 2003). A portal is an infrastructure providing secure, customizable, personalizable, integrated access to dynamic content from a variety of sources, in a variety of source formats, wherever it is needed (Smith, 2004). The study focused on providing timely information on spare parts for one of the engines used in the Air Force. Currently, mechanics who work on the engines use a paper-based system for requesting parts needed for maintenance. Once the mechanic has completed the assessment of the engine, he or she prepares a hard copy paper parts list of items needed to complete work on the engine. This article parts list is subsequently entered into a database, which is then processed by a parts manager, who searches existing inventory to determine availability. Based on the result of that search, a decision is made about how to transfer the part from one base to another or even from one location on a base to another location on that same base. If the part or parts are not available from existing bases, then a requisition process is initiated (Boyson et al., 2003).

As one can imagine, this sequential process is very inefficient. There are significant delays as one action must be completed before another one can be started. Furthermore, there is no central place for information about the mechanic's order once he or she completes the parts request list. Often, the mechanic has no further information about the order until the parts actually are delivered. There is no visibility to the mechanic about the status of the order as it moves from one step to another. Often, one organization is waiting for information from the other, and the phone is used often to clarify why delays occur. Consequently, planning and anticipation in both organizations is difficult, and most business process activities wait till a previous activity has been completed. When activities would have been carried out in parallel, and real-time information would have been used, much time and effort could have been saved. The main idea of the portal project for the U.S. Air Force supply chain has been to implement these ideas.

Using the U.S. Air Force spare parts supply chain as a reference model, a comprehensive electronic platform was built that combined real-time data from the field, ERP systems, advanced planning systems, and collaborative planning and forecasting systems in both organizations. A test portal was built for evaluation by participants in the supply chain in order to experiment with these kinds of online functionality.

The prototype showed how the current stovepiped decision-making and orchestration in the spare parts supply chain could be transformed into an integrated high-performance process (Boyson et al., 2004). Supporting benefits include improved financial performance, inventory availability and reduced life cycle costs by providing the right information to the right people to make the best decisions in near real time. The portal solution uses middleware to link systems and orchestrate processes, and to create a seamless supply chain for system users while hiding the transactional level processing complexity. The system integration relied on the Tibco message bus that made it possible for the diverse systems to talk to one another.

Linking the databases and information systems of the different organizations to the message bus took a lot of effort. Furthermore, the message bus in itself did not help much in streamlining the inter-organizational processes. The business processes of the participating organizations were analyzed by hand, and the Java-based software to link the different business processes was specifically written for this project. In order to carry out projects like this more effective and more efficient, the standardization of the middleware should take place on a higher level than the message bus. Ideally, the description of the business processes would take place on such a level that it could be used to automatically generate parts of the solution applications. The next three sections describe service-oriented architectures, and so-called orchestration standards that can help to overcome the labor-intensive activities to streamline inter-organizational business processes.

Service-Oriented Architectures and Web Services

Service-oriented architectures (SOA) based on Web services technology facilitates interactions and sharing of information in a heterogeneous environment, as it is based on the exchange of messages in XML. Supply chain process partners need to share and access information like stock levels and inventory. Web services can "glue together" applications running on two different platforms, enable database information to be accessible to others, and enable internal applications to be made available over the Internet (Kreger, 2003).

A Service-oriented architecture (SOA) is essentially an architecture that describes the communication pattern between services communicating with each other, functions and their operations (Papazoglou & Georgakopoulos, 2003). These architectures provide the ability to register, discover, and use services.

In the perspective of SOA a service is a function that is well defined, self-contained, and does not depend on the context or state of other services. An SOA defines how two computing entities interact in such a way that it enables one entity to perform a unit of work on behalf of another entity. The unit of work is referred to as a service, and the service interactions are defined using a description language. Each interaction is self-contained and loosely coupled, so that each interaction is independent of any other interaction.

Web services technology facilitates collaboration between services and their orchestration and in addition defines how to describe these services, the operations and their flows. It uses a loosely coupled integration model that allows flexible integration of heterogeneous systems in a variety of domains including business-to-business, business to customer and enterprise application integration (IBM, 2001). As an Internet-based technology, Web services technology includes all network layers, but on top of it, various authors have added specific layers that make uniquely suitable for facilitating business processes. These layers include for instance a process layer, a description layer, and a messages layer (Curbera, Khalaf, Mukhi, Tai, & Weerawarana, 2003). Martin (2003) describes additional layers relating to the technology components and functions, such as presentation, process flow, transaction, discovery, description, messaging and transport. Furthermore, Kreger (2003) adds business- and service-level agreements as technology components. When we are able to provide service levels for the interaction between different business processes, we can describe the actual and needed coordination or orchestration of the business processes.

Orchestration is especially interesting in a supply chain context, as was explained for the DoD case. The lack of services and tools for orchestration provided the biggest problem for the U.S. Air Force e-supply chain portal. Orchestration describes how Web services can interact with each other at the message level, including the business logic and execution order of the interactions (Peltz, 2003). These interactions may span both applications and organizations, and result in a long lived, transactional, multi-step process model. Another aspect is choreography which tracks the sequence of messages that may involve multiple parties and multiple sources, including customers, suppliers, and partners (Peltz, 2003). Choreography is typically associated with the public message exchanges that occur between multiple Web services. In this article orchestration refers to both aspects.

Web Service-Based E-Supply Chain Orchestration

In a modern supply chain, there are many interactions between the partners that might benefit from well-orchestrated Web services interactions. In order to access and use the Web services, the service description need to be formalized and clear, and process orchestration needs to be taken care of to be able to effectively use the service. In line with the DoD case, we carried out a case study, called the Faplin case, to assess the added value of Web Service orchestration. The Faplin case is based on the Web Services-Interoperability Organization's supply chain case from www.ws-i.org. In the case, we considered three main business processes that are also relevant for the DoD case, namely: "catalog access", "purchase goods" and "replenish stock". Figure 1 shows part of the interaction diagram for the "purchase goods" business process. To describe the interfaces of the services, we used the Web service description language (WSDL). For the whole supply chain, 19 services were defined using WSDL.

The business processes that make use of these Web services were described and implemented in business process execution language for Web services (BPEL4WS, or BPEL for short). Each business process flow was formally described using BPEL. BPEL was mainly selected because it is the de facto standard that is widely accepted by major software vendors and businesses. BPEL4WS addresses many current business process challenges such as coordinating asynchronous communication between services, correlating message exchanges between parties, implementing parallel processing of activities, manipulating data between partner interaction, supporting long running business transactions and activities, and providing consistent exception handling mechanisms. It also supports the modeling of numerous process patterns (van der Aalst, Hofstede, Kiepuszewski, & Barros, 2003).

The specific tool used was Collaxa orchestrator, now called Oracle Process Manager. Instead of centralized orchestration, as in the case of the DoD portaling project, here the orchestration is federated, which means that each partner designs its own orchestration using internal and external services. The architecture behind the implementation is shown in Figure 2. For example, the customer sending an order from the Faplin Web site, initiates the interaction of the "purchase good" process. The order is received at Faplin and the orchestration continues further to the warehouses, using the various Web services, until the order is fulfilled or a failure response is returned.

Figure 1. Interaction diagram for the "purchase goods" business process

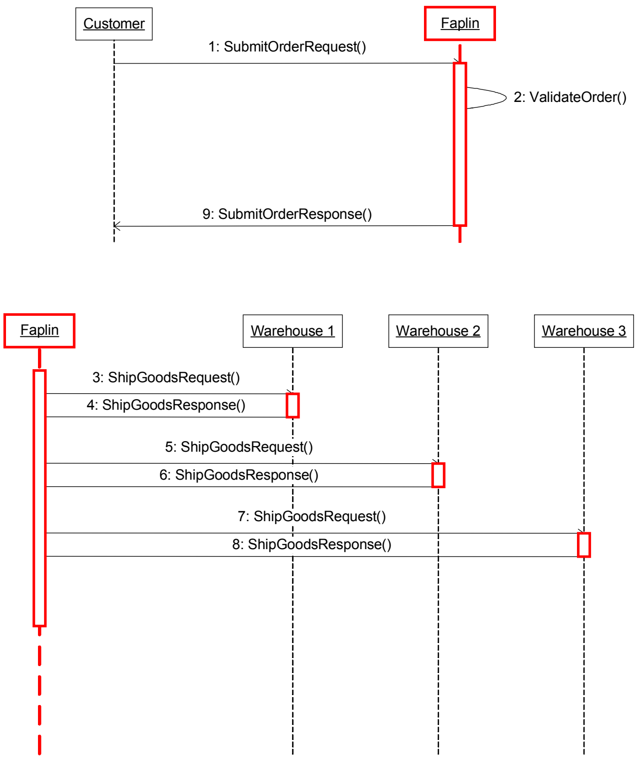
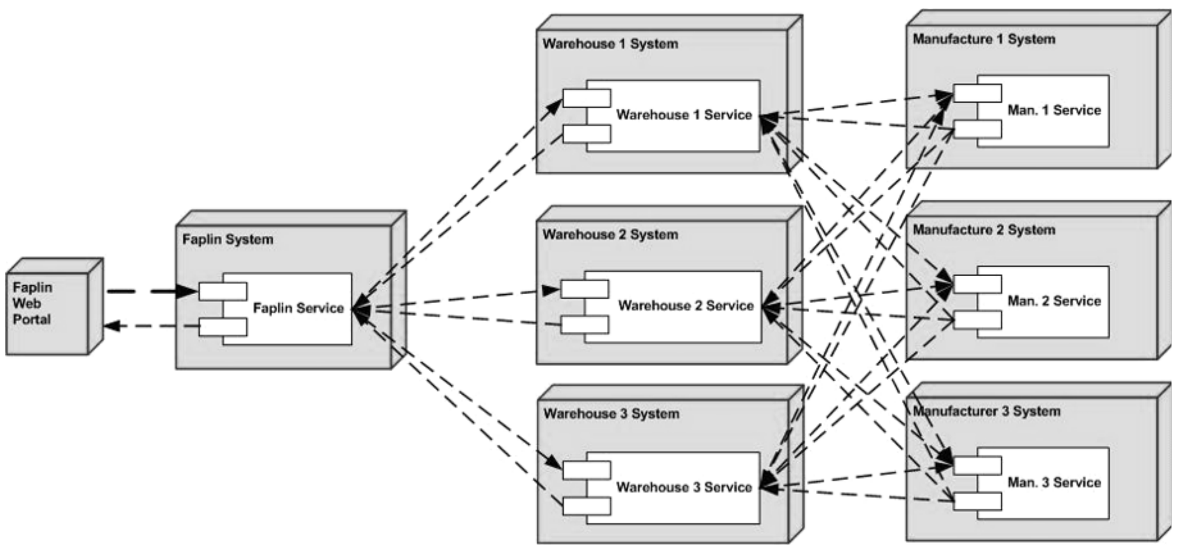


Figure 2. The architecture of the system



BPEL is an XML based language. XML can only support data transfer in the network environment but it cannot store data or handle variables. The facts that the business partners need to store data and even handle changing data such as stock levels and inventory levels were therefore handled by developing a database system. Web services technology provides an interface that can be used to access information from applications developed with different technologies and platforms. Therefore, we implemented a database using MySQL to enable handling such variables. Figure 3 shows as an example the implementation layout for the Replenish stock business

Figure 3. Replenish stock business process

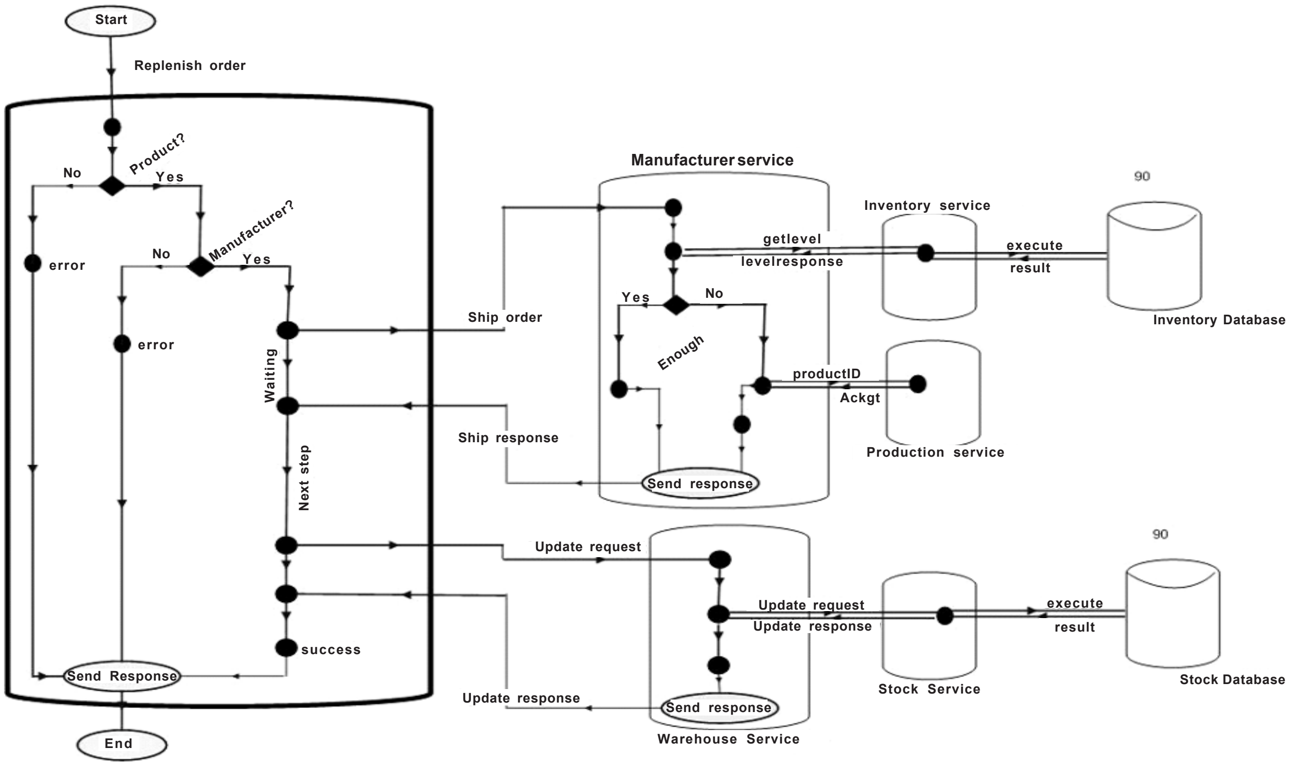


Figure 4. Example of a BPEL orchestration definition

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    p terk name etorS eric e" p rter= g satorS eric e"
      ptar Role= b etorS eriveP rovdr>
  ...
  p terk s>
  ables >
    abe ame entorRequest"messagepg etor ySeric eRequestMsge>
    abe ame entorRespe"messagepg vetor ySeriveR esponeMs sg e>
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    r ecei ame"eceipt"p terk ="cet"pr ptF p "operation= Purcha eOrderS ubmt"
      abe P ORequest" cetest ay es>
    ink e p terfitor ySerive"prtT pg p torS eric e" operatioh= vetor poes s"
      ptV able etor R equest" outptVable ethorR esp se>
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          asi g am eoutpta ue>
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              fr om a iableP ORequest" pta ameters" />
              to able S NRespone"p= pame ters" />
            /c op >
          /asi g
          ink e am e" abC ett" pater L k ett"pr tp= s: Fp aba "
            operatioS p oteS ubmt"ptV abl e=S NRespone>
        /sequen>
      /< case>
      ...
    </swt h
    ...
  /sequen>
</process>
```

process that involved access to various services from different partners, as well as databases.

Because BPEL4WS is built on top of the interoperable infrastructure of Web service, it uses XML to describe and specify processes. It depends on WSDL (Web service description language) and WSDL extensions. BPEL4WS can be seen as a layer on top of WSDL not only because the later is needed to invoke other Web services and to offer the process as a Web Service, but also because the data types in the WSDL documents are used to describe the exchanged information inside the process. A typical BPEL4WS scenario structure is shown in Figure 4.

The deployment of the services for accessing on the Web uses Collaxa BPEL server software. However, the user interface provided by this software gives right to any user to access all files. Enhancing system security, we developed separate user interfaces. The user interfaces were required to be dynamic so as to enable users to send information or data to the system or in real business to the dealer. Due to the dynamic nature of the Web pages, a programming language was required that allows part of the page contents to be dynamic, while the other part remains static. Also the platform independency was another criterion to choose the programming language. Servlets and Java server pages (JSP) were the options that could be used to develop such user interface. However, most of the contents of the Web site were static and very few were changing; only the data input fields. JSP is more suitable when most of the content on the page is static and few are dynamic, as opposite to the servlets. JSP was selected since the most of the content on the Web pages were required to be static. Several user interfaces were implemented in the portal to test the correct handling of a chain of business processes and exceptions. Several demonstrations to experts in the field have shown the practical applicability of the concepts.

FUTURE TRENDS

Service oriented architecture addresses important supply chain orchestration issues such as interoperability, flexibility and adaptability. It is expected that SOA to be used in standardizing process orchestration in supply chain, and BPEL as the de facto standard for implementing process orchestration. Papazoglou and Georgakopoulos (2003) stress the importance of SOA and Web services with regards to business processes in supply chains. They covered the issue of coordination, monitoring, conformance, and quality of service compositions. Meredith and Bjorg (2003) point out how contracts and trust can be reached between partners using Web services for their business processes.

The basic idea of SOA is to real-time create new business processes using readily available Web services. Management-oriented issues are not dealt with in the Web services protocol stack. It is expected that mechanisms ensuring the reliability, availability security, the automatic generation of service level agreements and payment mechanisms enabling payment per use will arise. This will make the vision of the real-time creation and management of business processes feasible.

CONCLUSION

In this article we presented two e-supply chain process orchestration cases using portaling technologies and the emerging Web services technologies. The DoD case showed that portal technology can support and simplify business process orchestration in a real-time setting. However, one of the important missing parts turned out to be the standardized orchestration of inter-organizational business processes. The second case study showed the potential benefits of using Web services and the BPEL standard for orchestration of processes in supply chains. The well-established XML, SOAP, WSDL and the de facto BPEL standards enable not only cross-platform information system integration but also the inclusion of supply chain business logic. We found the technology relatively easy-to-use and the models are human readable. A disadvantage is that theories and methods are still lacking for measuring or evaluating the performance of processes facilitated with Web services. Additionally, commercial cases and experiments that focus on real orchestration of processes are still lacking. Given the first successes, it is to be expected that industry implementations will be carried out, which will provide ample results to analyze further.

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KEY TERMS

Middleware: Technology enabling the exchange of information between information systems and encapsulating implementation details.

Portals: An infrastructure providing secure, customizable, personalizable, integrated access to dynamic content from a variety of sources, in a variety of source formats, wherever it is needed.

Service-Oriented Architecture (SOA): A service-oriented architecture is an architectural style, according to which application functionality is not provided by one large monolithic application, but is provided by services that can be combined to get the required functionality.

Supply Chain: A distribution channel of a product, from its sourcing, to its delivery to the end consumer (also known as the value chain).

Web Service Choreography: Web service choreography defines the sequence and conditions of public message exchanges between multiple Web services (www.w3c.org).

Web Service Orchestration: Web service orchestration is the process of invoking internal and external Web services from a predefined process flow that is executed by an orchestration engine (www.w3c.org).

Web Services: Web services is a technology that enables the provisioning of functionality, on an application level or on a business level, by means of a standardized interface in a way that they are easily invoked via Internet-protocols.

EU SMEs and E-Business Innovation

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INTRODUCTION

Although motivating electronic business (e-business) adoption and implemention by small- and medium-sized enterprises (SMEs) is endorsed by policies and initiatives introduced by the European Union (EU), a number of challenges arise as the result of a limited conceptual understanding of the relationship between SMEs and information and communication technologies (ICTs). Relatively little is known about how SMEs respond to the opportunities provided by ICTs, and even less is known about why and how small businesses use ICTs (Dixon, Thompson, & McAllister, 2002).

In the first section of this critical review of the academic and government bodies of literature related to EU SMEs, e-business and policy initiatives and definitions of SMEs are explained, the unique characteristics of SMEs and entrepreneurial characteristics are outlined, and the case is made that there is a clear need for more comprehensive research on SMEs in the European Union.

The second section concentrates on e-business. Many of the factors that compel organisations to adopt and implement innovation are pertinent to the adoption and implementation of e-business. These have hitherto largely been treated as separate bodies of literature, however. In this section, the benefits of e-business are explored, the factors that motivate or act as barriers to e-business adoption and implemention are outlined, and the organisational and management attributes that would seem to ensure the success of the innovation of adopting and implementing e-business are discussed.

The third and penultimate section explores EU policy initiatives relevant to SMEs and to the promotion of e-business. The most wide-ranging and prominent initiatives directed at SMEs are examined here. The final section of the paper concludes with suggestions for further research.

BACKGROUND

There is no single definition of an SME, but schemes that are targeted at SMEs usually adopt a variety of working definitions depending on their particular objectives. The importance of the SME sector as the cornerstone of a country's economic prosperity is widely recognised: SMEs comprise approximately 95% of the enterprises in most nations, and are responsible for employing between 60-70% of a nation's workforce (OECD, 2002). Consequently, the SME sector is crucial to the EU's competitive development, collectively and for each individual member nation (Mulhern, 1995). SMEs contribute to local economic growth by providing local services, employment opportunities, and by enabling participation in the economic development of their own communities. They also play a vital role in innovation, as the intermediaries between the public research infrastructure and large organisations, as developers of new ideas, and as adopters of new technologies. SMEs have the potential to act as vehicles for the industrial and economic change of entire regions, as entrepreneurship attracts many who would otherwise withdraw from the labour market. Entrepreneurship can provide a positive way out of unemployment, particularly in disadvantaged communities, where the potential wider benefits of enterprise can be even more significant. Small businesses often stimulate productivity growth amongst rival businesses (BarNir & Smith, 2002; Jeffcoate, Chappell, & Feindt, 2002, 2004; Small Business Service, 2004), and their dynamism can stimulate competition and innovation throughout the economy as a whole.

The unique characteristics of SMEs that set them apart from larger organisations create particular issues, because in day-to-day business operations the organisational, entrepreneurial, familial, and social structures in SMEs differ from those of larger organisations. An understanding of the constitution and circumstances of SMEs is essential in order to be able to identify the fundamental differences between large and small organisations and the effects of these differences on innovation—especially e-business innovation—adoption and implementation (Cheney, Mann, & Amoroso, 1986). SMEs face both economic and organisational constraints, a lack of access to capital, cash-flow difficulties, limited ICT skills, a chaotic organisational structure, and heavy workloads—all factors that may impede innovation (Small Enterprise Telecommunications Centre, 2002). SMEs also have their own unique qualities in terms of their environment, structure, psycho-sociological climate, management, and technology usage and adoption (Castleman, Coulthard, & Hewett, 2000; Smallbone, North, Vickers, & McCarthy, 2000; Thong, 2001). SMEs tend not to have the resources available to large organisations, and this lack of resources creates time, financial and expertise constraints. Facing these constraints, SMEs are likely to be more cautious than large organisations to adopt new technologies (Huang, Hart, & Wiley, 2004).

Entrepreneurial attributes such as creativity, flexibility, and dynamism are associated with the SME sector. The importance of creating an environment rich with opportunities through the support of entrepreneurial characteristics cannot be overstressed. Entrepreneurship relies not only on individuals or groups possessing the skills to recognise and harness potential, but also on conditions that permit, encourage and sustain them in their endeavours. Governments can create the economic, fiscal and regulatory framework, infrastructure and environment in which entrepreneurs and the organisations they found and run are able to recognise, realise and maximise potential competitive advantage. Although few government policies are specifically directed at creating an entrepreneurial culture, cumulatively all government policies affect the long-term factors that create conditions that (can) foster entrepreneurs (HM Treasury, 2001). A stable and transparent economic and fiscal environment with steady economic growth can not only provide entrepreneurs with appropriate opportunities to foster entrepreneurial experiments, but also with a chance to convince the market of their potential contribution.

Entrepreneurship is closely liked to the psychological and behavioural aspects of individuals, and it would seem that an entrepreneur's personal initiative therefore dominates the potential for the success of many SMEs (Howarth, 2002; Kuemmerle, 2002; Quayle, 2002a, 2002b; Vrazalic, Bunker, MacGregor, Carlsson, & Magnusson, 2002). Entrepreneurs share a commitment to the consistent and methodological exploration of possibilities to improve a business's potential (Drucker, 1998). Entrepreneurs also share the distinctive characteristics of feeling comfortable skirting the boundaries of propriety, assuming enormous personal risk, being willing to shift strategies quickly, being profoundly opportunistic, and doing whatever it takes to close a deal (Kuemmerle, 2002).

Having examined not only a number of the characteristics of SMEs but also the issues pertaining to their operations, we turn now to examine e-business in more detail, as it is a form of technological innovation that can profoundly impact SMEs.

EU SMEs AND E-BUSINESS INNOVATION

E-business presents significant challenges to academic research. These challenges arise from its recent emergence, the rapid change that characterises the domain, the variation in behaviour in (apparently) similar contexts, the enormous media attention it has generated (with its resultant distortion of terminology and data), the lack of familiarity with e-business technologies by many management scholars, and the lack of established research approaches (Drew, 2002). It has been difficult for researchers to isolate trends in the separate innovation, ICT, and e-business canons from more general economic and organisational change drivers. Moreover, research has often failed to examine the roles of size, age, sector experience of ICTs and management support within single integrated studies, types of exporting activities, awareness of benefits, types of customer and imposition by larger trading partners. These factors have served to exacerbate the "patchy" nature of much research (Dixon et al., 2002).

Nonetheless, e-business has profound beneficial consequences for business practice and research. Technology-driven change is revolutionising business, requiring companies to redefine their strategies, products and processes in a business-operating climate that has become increasingly competitive, turbulent, and uncertain (Goldman, Nagel, & Preiss, 1995). Organisations that have adopted e-business believe that it contributes to improved performance in four main ways:

- The development of new products and services;
- The generation of new customers and business channels;
- A reduction in costs; and
- Improved productivity (HM Treasury, 2001).

E-business is a resource that is rapidly innovating not only traditional business processes but also the very nature of competition, as e-business enables market fragmentation, with its ability to treat mass clients as individuals, convergence between products and services, generation of global production networks, and simultaneous cooperation and competition between organisations. As e-business facilitates this radical transformation of both technical and business operations, it is truly innovative. Innovation is an important engine of long-term competitiveness, growth and employment. The OECD estimated that between 1970 and 1995, more than half of the total growth in output of the developed world resulted from innovation, and that this proportion is increasing as economies become more knowledge-intensive (Irwin, 2000). The cross-functional nature of innovation management requires strong leadership in managing through turbulence (Tushman, 2002).

The *Innovation Scoreboard* (which analyses statistical data in the areas of human resources, knowledge creation and the transmission and application of new knowledge, and innovation finance output and markets) found that sales of innovative products as a proportion of total turnover increases with organisation size: 15% for small, 21% for medium-sized, and 38% for large organisations. The *Innovation Scoreboard* (European Commission, 2000a) also found that large organisations spend nearly twice the proportion of their turnover (4.2%) on innovation activities as do SMEs. Similarly, the *Statistics on Innovation in Europe, 2000* (European Commission, 2000a) also found that the larger the organisation, the more likely it is to be an innovator (36% of small, 49% of medium and 71% of large firms are innovators) and that SMEs account for only 18% of Europe's innovation productions. *Building an Innovation Economy in Europe, 2001* (European Commission, 2000b) was the first in a series of Innovation Policy Studies undertaken for the European Commission's Enterprise Directorate-General to promote the message that not only is innovation important, as competitiveness increasingly depends on the ability of industry sectors to meet turbulent market needs quickly and efficiently, that innovation is pervasive and diverse, taking place in firms of all sizes, across all regions and all sectors, and that innovation is unevenly distributed, but also that innovation is systemic rather than linear, with multidimensional processes.

In order to develop these ideas, we must draw further upon the literature to explore and extend questions concerning the motivation(s) for, and genesis of, innovation. There is no single reason for an organisation to innovate: In some cases, innovation is triggered by new knowledge, in others by the opportunity to fulfil a market need (Mahdjoubi, 1997). Multiple forces inhibit change and maintain the status quo. Some of these forces are group performance norms, fear of change, member complacency, and a lack of skills (Bergquist, 1993). For lasting change to occur, new behaviours must be learned so that attitudes and routines can be replaced (Senge, 1990). Although the implementation of innovative ideas is an organisational change process (Hoffer, George, & Valacich, 1996), lasting competitive change takes application, time, and involves individual and organisational learning and adjustment. An organisation must possess (and be willing to commit) the resources needed to implement a new technology for innovation adoption and implementation to be successful (Amidon & Mahdjoubi, 1999). An organisation's size, financial resources and technical know-how all influence the adoption of technological innovation. Customer and competitive pressures, along with support from business partners, can also be strong influencing forces in the adoption decision (Iacovou, Benbasat, & Dexter, 1995; Premkumar & Roberts, 1997).

The 1999 KITE project's *Analysis of E-Business Practice in SMEs* reported that SMEs typically have more difficulty in achieving e-business success because of these characteristic SME attributes (Chappell & Feindt, 1999). The KITE project also found that SME e-business adoption and implementation success is dependent on the following factors:

- Having an original idea and/or targeting a unique market niche;
- Developing a business case for e-business;
- Finding sufficient funding to carry out e-business properly, without being dependent on third parties, or having to update sites out of hours, etc;
- Finding the right business, technology and promotional partners;
- Ensuring the right "fit" between the company's product or service and internet demographics;
- Being flexible enough to be able to respond to competition and changing technological conditions; and
- Being able to manage and scale the growth that may result (Chappell & Feindt, 1999).

Having examined the concepts of e-business and innovation, we turn now to examine EU policy initiatives directed at promoting e-business innovation amongst SMEs.

FUTURE TRENDS

A series of EU SME policies have been introduced to create a favourable competitive business environment in which SMEs can flourish. However, relevant technological innovation policy promoting e-business adoption and implementation depends on an understanding of what "really" drives adoption and implementation, of the external barriers that prevent or delay it, and of how it impacts on competitiveness and employment. Incentive schemes and policies intended to benefit the SME sector need, therefore, to take into account the culture, performance, and abilities of SMEs. Although an evolution towards more interactive support is visible, there is a high degree of heterogeneity in policy instruments aiming to foster innovation in SMEs throughout the European Union (HM Treasury, 2001). Current EU government-funded projects designed to assist SMEs to adopt e-business include the promotion of online trading and the creation of virtual business networks to promote technology diffusion (Papazafeiropoulou, Pouloudi, & Doukidis, 2002).

A number of EU policies have been formulated and introduced to facilitate the creation of a business environment in which SMEs can innovate and flourish. Most EU member state governments recognise that SMEs often have difficulty finding appropriate independent sources of business advice and information, and face skills shortages. Accordingly, they have launched national and regional initiatives to assist SMEs to acquire or adapt e-business skills (Mulhern, 1995). Many of these policies, schemes and programmes are interlinked. For example, the European Union's 1994 *Regional Technology Plan* (RTP), which was inspired by the 1993 *White Paper on Growth, Competitiveness and Employment*, was in turn instrumental to the development of the 1996 *Green Paper on Innovation*, which was created to develop an EU-wide strategy for the promotion of innovation. The 1996 *Action Plan for Innovation in Europe* paved the way for a common European analytical and political framework for innovation policy. Building on this framework, the *Trend Chart on Innovation in Europe* was introduced as a tool for policy makers. Formulated along the lines of the 2001 *Community Innovation Survey* (CIS), which is jointly implemented by Eurostat and DG Enterprise under the aegis of the European Innovation Monetory System (EIMS), *The Trend Chart* updates and analyses information on innovation policies EU-wide and at national level, and provides a forum for benchmarking and for the exchange of "good practices" in innovation and technological policy development.

The 2001 *Innovation and SME Programme* promotes innovation and supports SME participation in the *Fifth Framework Programme* (FP5) in order to optimise their potential advantages from such participation. FP5 aims to diffuse good practices and to encourage interregional cooperation in innovation by improving support infrastructures, in addition to introducing complementary policies for innovation and technology transfer through a set of interrelated projects: the *Regional Innovation Strategy* (RIS), the *Regional Innovation and Technology Transfer Infrastructures and Strategies* (RITTS) and the *Regional Technology Transfer Projects* (RTT). The RIS and RITTS projects share the same methodology and philosophy as well as many objectives in common. Both are based on building regional consensus and agreement, referenced to the same core specifications, and are able to give access to international experience. Twenty-eight European regions have been participating on RIS and RITTS projects since they were launched in 1994, and an additional forty regions have enlisted for similar initiatives. This calculates to approximately one region in four across the European Union participating in projects concentrating on enhancing local innovation capabilities, providing the most comprehensive structure for the development of regional systems of innovation in the world, by far (European Commission, 2000e).

The DEEDS Forum generated from the G7 Policy Group project *A Global Marketplace for SMEs* (1996-1999), and seeks to provide an open forum of EU policy makers to stimulate, discuss, exchange, and monitor national policies. The project has a particular focus on the uptake of e-business practices by SMEs, as did *The Bologna Charter on SME Policies*. Held in 2000, it was the first conference of EU ministers responsible specifically for SMEs. The subsequent European Council Summit in Lisbon, 2000, announced the EU's goal of becoming the "most competitive and dynamic knowledge-based economy in the world" by 2010. This objective necessitated the creation of innovation policy initiatives at EU national and regional levels (many of these initiatives were still being framed in mid-2005). The Summit called for a series of benchmarking exercises to monitor progress by member states towards the implementation of effective policies in support of innovation. The European Union responded in 2000 to this request with *The Integrated Programme for SMEs: A General Framework for all Community Actions in Favour of SMEs*, which, combined with *Innovation in a Knowledge-Driven Economy, 2001*, has contributed to an improved coherence in technological innovation policy in Europe, and also to the development of a framework for dialogue on innovation policy making and policy coordination. *eEurope 2005 - An information society for all: An Action Plan*, endorsed by the Feira European Council in June 2000, also forms part of the overriding Lisbon strategy. *Europe 2005* addresses issues relevant to internet and e-business adoption and use, consisting of national and multinational actions on e-government, e-health, e-learning, and e-business, generated with the aim to improve participation, to open up opportunities, and to enhance skills.

The European Union has devised a number of broad umbrella policies to promote the benefits of e-business and other technological innovations, not least for SMEs. Such framework policies often set clear and ambitious targets, and coordinate with other policies to ensure that the various components serve common goals. They cover a broad spectrum of initiatives, from awareness actions, to establishing SME support networks, to providing consultancy and customised services to SMEs. These initiatives aim to influence policy across the economies of countries or regions, and are often both horizontal and vertical in concept: horizontal in that they cover most business sectors and act as a bridge between education, business and the citizen; and vertical in that they can impact upon primary, secondary and higher education (in the form of training and up-skilling initiatives).

In 2002, the *Go Digital* (European Commission, 2002) initiative administered by the e-Business Policy Group (EBPG), was launched as a collaboration of representatives of the EU member states and the European Commission services. *The Third Multiannual Programme for SMEs in the European Union* (European Commission, 1996) was also adopted as the cornerstone of the European Union's actions aimed at improving the conditions in which SMEs operate. Under the *Fifth Framework*

Programme (FP5) (European Commission, 1998), it supported European SMEs to participate in FP5 actions and to optimise their advantages—especially in relation to technology—from such participation. The outcomes are still being formulated. FP5's successor, the *Sixth Framework Programme* (FP6) (European Commission, 2003), was formally launched in November 2003 (Keown, 2002).

The SMESPRIT project aims to develop a knowledge-based system that will provide support to SMEs introducing and managing e-business adoption and implementation. This is interlinked with the *COMPETE* and Brite-Euram programmes, both of which fall under the umbrella of the *Esprit* research programme (Chappell & Feindt, 1999). *COMPETE* aimed to strengthen European SME competitiveness through technology. Running from 1997 to 2002, *COMPETE* brought together more than 45 companies delegating 70 specialists and representing more than 50 EU-funded projects. Encouraging and facilitating collaboration and joint ventures for SMEs were also key aims of Brite-Euram, which enabled groups of SMEs with insufficient resources to commission university laboratories and research centres to carry out research and development (R&D) activities for them, and encourage them to pool resources with other SMEs. Thematic networks brought together various individually run projects that shared similar technological or industrial objectives, with the intention of bringing greater coherence to research activities and encouraging the exchange of knowledge and technologies. The outcome of the projects has been shared by all participants, and has also served to inform the decision-making process on future EU-funded R&D (Chappell & Feindt, 1999).

CONCLUSION

Many organisations recognize the potential strategic opportunities offered by e-business, and seek to realize them. However, other than the need to adhere to legalities (such as tax and VAT requirements) most SMEs seem to be unaware of projects, policies or initiatives intended specifically to benefit them. This strongly indicates that such projects, policies and initiatives could be better targeted to their intended audience. The overall take-up rate of e-business amongst SMEs also indicates a lack of success for these initiatives. It would seem that crucial changes could be made to policy formulation, in order to render the outcome more relevant, coherent and accessible to SMEs.

Through presenting an outline of the various domains and approaches that are present within the literature relating to SMEs, e-business and policy initiatives, the implicit aim of this article is to indicate gaps in the literature. A transdisciplinary approach such as information systems (IS) offers considerable scope for moving between these theoretical and empirical parameters. The IS perspective also creates an opportunity to study relationships that have not as yet received adequate attention between SMEs, e-business, and policy initiatives. These include the relationship between SMEs and their government(s), the organisational implications of integrating e-business into a small organisation's business, and the implications of governments adopting a more inclusive approach to creating a dialogue with SMEs. By adding texture to the study of these subjects, the opportunities that e-business affords SMEs can be opened up to scrutiny, with the potential to gain a more nuanced understanding of how governments can contribute to SMEs successfully adopting and implementing e-business.

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KEY TERMS

EBPG (E-Business Policy Group): A collaboration of representatives of the EU member states and the European Commission services.

E-Business (Electronic Business): Those business activities related to the business operations of an organisation online. E-business encompasses all commercial activities. The definition of e-business that was agreed by the Organisation for Economic Co-operation and Development (OECD) and the European Union is the method by which the order is placed, which determines whether a transaction is e-business, not the payment or delivery channels. Shifting business activities from paper-based, local, face-to-face and manual processes to electronic, dispersed, mediated, and automatic processes is the essence of e-business, whether in dealing with customers or suppliers (Wilkins et al., 1999). E-business activities include, but are not limited to:

- Web sites;
- E-mail order confirmation;
- Intranet;
- E-mail;
- E-procurement;
- Web catalogues;
- Staff remote online ERP via Web;
- Trading exchanges;
- Internet auctions;
- B2C;
- Online ordering on our ERP; and
- View orders on ERP online.

E-Government: The use by government agencies of ICTs that have the ability to transform relations with citizens, businesses and other arms of government. These technologies can serve a variety of different ends: better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information, or more efficient government management. The resulting benefits can be less corruption, increased transparency, greater convenience, revenue growth, and/or cost reductions (World Bank, 2002).

Innovation: The process of innovation is divided into the following broad activities:

- **Agenda setting:** general organisational problems create a perceived need for change;
- **Matching:** an organisational problem is fitted with an innovation;
- **Redefining/Restructuring:** the innovation is modified to fit the organisation, and it alters the organisational structure(s);
- **Clarifying:** the relationship between the organisation and the innovation is clearly defined; and
- **Routinising:** the innovation loses its identity as it becomes an ongoing element in the organisation's activities (Rogers, 1995).

EU: European Union.

ICT: Information and Communication Technologies.

IS (Information Systems): An information system has been described as "a system to collect, process, store, transmit, and display information" (Avison & Wood-Harper, 1990, p. 3).

SMEs (Small- and Medium-Sized Enterprises): In February 1996, the European Union adopted a single definition of SMEs to be applied across all EU programmes and proposals dating from December 31, 1997. The communication recommended that member states, the European Investment Bank and the European Investment Fund adopt the definitions. However, the communication permits the use of lower threshold figures, if desired. The European Union recommended definition for a "micro" business is that it must have a maximum of nine employees. A "small" business must satisfy the following criteria:

- A maximum number of 49 employees;
- A maximum annual turnover of 7 million euros;
- A maximum annual balance sheet total of 5 million euros; and
- The maximum of 25% owned by one, or jointly by several, enterprise(s) not satisfying the same criteria.

The EU recommendation states that a "medium-sized" business must satisfy the following criteria:

- A maximum number of 249 employees;
- A maximum annual turnover of 40 million euros;
- A maximum annual balance sheet total of 27 million euros; and
- The maximum of 25% owned by one, or jointly by several, enterprise(s) not satisfying the same criteria.

Category: Concepts, Trends, and Challenges

Evolution of Computer-Based Distance Learning

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INTRODUCTION

Distance learning (DL), distance education, remote education, online learning, e-learning, learning at a distance, and distributed learning are all synonyms for *electronic learning*, a phenomenon that over 80 years has evolved into the delivery of instruction via the Internet. The legacy of those years has provided a theoretical foundation and a history of best practices that can offer today's distance learning practitioners a sound basis for exploring new instructional models utilizing technologies of the 21st century. This article describes some of the major milestones and accomplishments upon which today's computer-based distance learning tools and practices are based.

BACKGROUND

The First Half of the 20th Century

The theoretical foundations of electronic learning are rooted in seminal works on self-instruction pioneered in the 1920s by Edward Lee Thorndike and later by Frederic Burk and Mary Ward (Foreman & Turner, 2000). The first manifestation of technology in instruction was the teaching machine invented in 1924 by Sydney L. Pressey used for rudimentary drill and practice (Pressey, 1926). In the 1950s, the behaviorist B. F. Skinner invented the *Skinner box*, a small chamber used to conduct research on operant conditioning with animals. With the introduction of programmed instruction (PI), Skinner extended his theories of operant conditioning to teaching and learning. Skinner's methodology was the basis for *linear PI*, first demonstrated in the format of paper-and-pencil self-instructional manuals. Skinnerian PI was characterized by clearly stated behavioral objectives, small frames of instruction, self-pacing, active learner responses to inserted questions, and immediate feedback regarding the correctness of a response (Clark, 2000).

The Turning Point

Despite Pressey's 1924 invention of the teaching machine and the 700 related patents taken out in the 1930s, Skinner, in the 1950s, introduced a "new" technology that he too called teaching machines; these were based on linear PI (Benjamin, 1988). Norman Crowder in 1958 extended Skinner's work and developed *branching PI*, which was characterized by, among other things, multiple-choice, response-directed instructional branches in PI manuals (Crowder, 1960), a technology that would later evolve into computer-assisted instruction (CAI). For more than 10 years, teaching-machine technologies and methodologies were prominent and controversial topics in both the academic and popular press.

Lumsdaine (1959) noted three distinguishing characteristics of the Skinner and Crowder teaching machines that were being marketed at that time. These were the following.

1. Continuous active student response was required, providing explicit practice and testing of each step of what was to be learned.
2. A basis was provided to inform the learner, with minimal delay, whether each response was correct, leading directly or indirectly to the correction of the learner's errors.
3. Learners proceeded on an individual basis at their own rates—faster ones completing an instructional sequence before slower ones—all machine tutored with patience customized to the learner's needs.

In 1962, at the height of the teaching-machine movement, Crowder, who like Skinner pursued entrepreneurial ventures related to teaching machines, predicted that by 1965 half of all American students would be using teaching machines for one or more courses (Gilmore, 1962). And while his time frame and technology forecast were wildly wrong, due mainly to IBM's introduction of the revolutionary IBM System 360, the "third generation" of digital computers in the 1960s (Campbell-Kelly & Aspray, 1996), Crowder's forecast would prove to be more or less accurate—but almost 40 years later!

Rooted in Instructional Theory

With teaching machines as a basis, in the 1950s through the 1960s the development of instructional theories and methodologies provided a foundation for future educational technology-based instructional and learning practices. Four of these are behaviorism, constructivism, cooperative learning, and individual learning. These can be described in terms of the theoreticians that have contributed to them, and the contribution of each to the technology that succeeded teaching machines: computer-assisted instruction. Appendix A provides a summary of these four theories and key theoreticians that have contributed to them. Appendix B provides a summary of contributions that each of the theories has made to the development of computer-assisted instruction (Scheepers, 2001).

These appendices clearly reflect a decades-long development of instructional theory based on technologies that are more than 50 years old, and a body of knowledge that provides a solid foundation of theory, research, and practice, one that remains valid even today.

Computer-Assisted Instruction

Beginning in the late 1950s, CAI was introduced as a mode of instructional delivery in which a learner accessed mainframe-computer-based lesson material (courseware) developed and programmed by teams of instructional designers and computer programmers. It is worth noting that over the years, there has been much debate concerning the appropriate label to assign to activities related to the delivery of instruction via the computer. Terms such as CBE (computer-based education), CBT (computer-based training), and CBI (computer-based instruction) are only a few that may be found in the literature, each focusing on different and sometimes only nuanced aspects of the technology. This article uses the term CAI to encompass all of these.

The first CAI system was the IBM 650 Inquiry Station interfaced to a text-based typewriter used to teach binary arithmetic. The IBM 650 was the first mass-produced digital computer and the very first computer acquired by many universities. Tannenbaum (1999) describes the next major instructional technology initiative and the context in which it was introduced:

During the early 1960s, IBM researchers had experimented with computer-based instruction, using earlier computers and an assembler-level language they called Coursewriter. The success of these experiments, together with the demand for better education fueled by the Russian Sputnik successes and the programmed learning research of such psychologists as B. F. Skinner, led IBM to develop the IBM 1500 system. The system was purchased by about a dozen other educational institutions (including school districts in Montgomery County, Maryland, and Kansas City, the Ohio State University and the University of Alberta in Canada).

The hardware cost more than $250,000 (the equivalent of more than $1.25 million today) for a system that could accommodate a maximum of 16…simultaneous users, about $16,000 ($80,000 today) per user. ... In the early days of developing routine courseware for the 1500 system, we estimated 100 to 300 hours of development time for each hour of learner time.

The IBM 1500 was unique. It delivered online, individualized instruction in a (proprietary local-area) networked environment, driven by a multiuser operating system. It allowed course authors to integrate (character) graphics, audio, and still images into their courseware (Buck & Hunka, 1995); it was the first computer-based, multimedia, distance learning platform.

Multimedia

The mid-1960s through late 1980s was characterized by the improvement of CAI and CBT with enhanced multimedia. During that time, debates raged regarding the definition of multimedia. A somewhat later publication offered a definition that reflected the eventual resolution of some of those debates:

The term multi-media [sic] originated with the audio-visual industry, to describe a computer-controlled, multiple-projector slide show with a sound track. In computer terms, multi-media [sic] is viewed as a blending of media types: text, audio, visual, and computer data in one convenient delivery system. (Philips International, Inc., 1988, p. 3)

Two of the dominant multimedia CAI systems of the 1960s were PLATO (Programmed Logic for Automatic Teaching Operations) and TICCIT (Time-Shared Interactive Computer Controlled Information Television).

PLATO was produced under a partnership of the University of Illinois' Computer Education Research Laboratory (CERL), the Control Data Corporation, and the National Science Foundation (NSF). PLATO courses were developed with the course-authoring (scripting) language TUTOR (later to evolve into Macromedia Authorware). Courses were run on a time-shared mainframe computer that serviced hundreds of concurrent users. In addition to the pioneering hardware development of the plasma display integrating graphical images into the courseware, PLATO system developers created user-to-user communications tools that were the predecessors to the synchronous communications tools prevalent in today's learning management systems (LMSs; Woolley, 1994).

MITRE's TICCIT, funded by the NSF in 1968, was based on television technology products controlled by a time-shared computer system, and was designed to provide individualized instruction to large numbers of students. TICCIT's TV-based audio and color video delivered a full multimedia learning experience based on the concepts of learner control (a concept underlying today's learning management system usage) and component design theory (Allessi & Trollip, 1991). For a number of reasons, however, the system, which was eventually turned over to Hazeltine Corporation for commercialization in the mid-1970s, failed to deliver on its promise.

It is interesting to note that PLATO still exists today, but as a commercial venture. While the company's pioneering multimedia and communications systems have long been made obsolete by newer technologies, PLATO Learning, Inc. markets assessment and courseware, and states that it is "the original education software company, with a history of successful student outcomes" (http://www.plato.com/aboutus/index.asp).

Personal Computers

Few would argue that the 1981 announcement of the IBM PC (personal computer) was the impetus for the computerized society in which we live today, but the real revolution began in about 1974 when Intel introduced the i8080, the first true general-purpose microprocessor. During those 7 years, affordable microcomputers from Tandy, Commodore, Atari, and Apple enabled a new generation of hardware and software hobbyists to experiment with technologies that had previously been the purview only of corporate development groups. Easy-to-use programming tools (particularly the language BASIC, developed more than 10 years earlier at Dartmouth College) enabled novice programmers, unencumbered by corporate standards and practices, to experiment with color, graphics, and sound to produce a wide array of new and exciting multimedia computer applications.

In about 1980, as a result of 10 years of research, another technology, derived from what then had been the completely separate industry of consumer electronics, made its first appearance: the analog, laser, optical videodisc. In 1979 to 1980, IBM and MCA (the media and entertainment company) formed a joint venture, DiscoVision Associates (DVA), and together with the Japanese company Pioneer Electronics began manufacturing laser discs and players, primarily as a distribution medium for motion pictures. Within only a few months of the creation of the joint venture, personal-computer hobbyists had connected stand-alone DVA videodisc players to Apple II microcomputers to produce innovative dual-screen multimedia applications controlled by Apple II software.

By 1985, recognizing the potential of multimedia computer applications, IBM introduced the IBM InfoWindow System, a professional and expensive integrated videodisc and PC touch-screen-controlled system targeted primarily for education and training (Reisman & Carr, 1991). InfoWindow System applications, authored in a revised form of the 20-year-old CAI language Coursewriter, were difficult, time consuming, and expensive to create. To produce high-quality audio and video (A/V) content required expertise unique to the film industry. At the same time, to develop courseware required computer expertise with significant input from instructional designers. Although integrated multimedia courseware was exciting for learners, the cost of hybrid analog and digital products, and the complexity of course development made the applications inaccessible to most education institutions.

A cost-effective alternative to a totally integrated, computer-controlled multimedia experience emerged as early as the middle 1970s. Computer-managed instruction (CMI) systems used the computer as an instructional supervisor and media guide for learners. For example, a CMI system might direct students to read off-line text, view off-line movies, listen to off-line audio, and also deliver scripted CAI instruction. The system administered pre- and posttests, collected and analyzed performance data, and guided learners from instructional module to module. In many ways, CMI was a precursor to today's learning-management systems that present and display learning objects in supervised learning environments.

Digitizing Multimedia

Optical storage technology continued to evolve through the 1980s, not because of the high costs and complexity of the applications described above, but to develop inexpensive, high-volume digital data-storage products for the computer and entertainment industries. Through the 1980s, Philips and Sony standardized the compact disc (CD), resulting in a two-decade-long evolution of new optical storage devices, from CD read-only memory (CD-ROM), to CD-recordable (CD-R), and more recently to the CD-rewritable (CD-RW) format (Khurshudov, 2001).

As these technologies were being developed, new, affordable, and easy-to-use personal computer-based or -related A/V digital capture, edit, and production hardware and software products were being developed and acquired by a new generation of innovative personal computer users. By the middle of the 1990s, it was common for digitally produced A/V to be integrated into personal computer applications. While more instructional applications using CD technology controlled by PC-resident courseware could access and play digitized CD-ROM-based A/V segments, there were still significant deterrents to the extensive use of computer-based instruction.

CURRENT AND FUTURE TRENDS

The Internet and the World Wide Web

Until the mid-1990s, enterprises wishing to support networked learning stations had to be concerned about network configurations and support, server compatibility, network operating systems, and workstation compatibility. The Internet, for the first time in the almost half century of commercial computing, leveled the playing field for computers users. The nonproprietary Internet communications protocol TCP/IP (transmission-control protocol/Internet protocol) could be deployed on virtually any workstation using any operating system, facilitating cost-effective communication among all nodes on a network.

Prior to the Internet, distance learning was CAI. Learners worked independently at stand-alone workstations; the networking of workstations was typically not a part of the delivery of instruction, due mainly to the complexities and costs of network technologies. Learners had to be physically present where the hardware resided in order to access courseware. Even though local workstations had become sufficiently powerful to deliver multimedia CAI, learners were not able to effectively share learning materials or to communicate electronically with one another or with the instructor as an integral part of the learning experience.

Through Web browser software technologies, learners can now access courseware locally or remotely, execute multimedia vignettes that are either resident on their local workstations or accessible remotely, and communicate synchronously or asynchronously with instructors and other students on the Internet network, regardless of the kinds of workstations they use: PC, Mac, Sun, and so forth. The ubiquity and relatively low cost of all this technology for home use has generally raised the computer literacy level of virtually all students at all levels of education. Unlike in the past, when novice students had to overcome difficult technology barriers and learning curves to even begin to use CAI courseware, today, those barriers and that learning curve are practically nonexistent. And into this environment a new technology has appeared: learning-management systems.

Learning Management Systems

Today, the application of computers to technology to instruction focuses on Internet-enabled student access to learning objects (LOs) via LMSs. Today's model resembles CMI, but with a few minor exceptions. In CMI, scripting-language-based computer programs (a) directed learners mainly to off-line learning materials, (b) administered pre- and posttests, and (c) permitted or prevented learners from moving on to other sets of learning materials. LMSs are environments within which students, in a TICCIT-like learner-control fashion, access learning objects available within the LMS. LMSs do not use directed learning; hence, there is no need for scripting-like programming languages such as Coursewriter or TUTOR. An LMS-based course is a framework and structure that contains LOs and directions to students from the instructor regarding how and when they should be accessed. With LMSs, instructors can focus their energy and expertise on the creation or utilization of LOs and the day-to-day management of their courses.

Probably the most prevalent LMSs in use today in education are Blackboard and WebCT. Blackboard, which was developed at Cornell University, was founded in 1997; in 2004, more than 2,000 schools, of which more than half are U.S. colleges and universities, used Blackboard ("Big Program on Campus," 2004). WebCT, which originated in 1995 at the University of British Columbia, claims on its Web site (http://webct.com) to be installed in "thousands of colleges and universities in more than 70 countries."

Blackboard, WebCT, and a host of other LMSs have much in common; all offer instructors an LO presentation platform, communication tools for students and instructors (e-mail, videoconferencing, telephone-like voice over Internet protocol (VOIP), chat, instant messaging, bulletin boards, etc.), and a variety of course-management utilities. Currently, issues and debates about these systems center around such matters as (a) the relatively high cost to license them, (b) their complexity, from an IT standpoint, to maintain, (c) how best to integrate them with an institution's enterprise applications, (d) LO incompatibility, (e) the difficulty of importing LOs developed on one system into another, and (f) best practices regarding the design, implementation, and management of LMS instruction.

Some solutions to these issues include (a) cost sharing through system-wide or consortium licensing, and the creation of new open-source LMSs such as Sakai (see http://sakaiproject.org/press/sakai-rc1.html), (b) local vs. commercial application service provider (ASP) hosting, (c) application integration via enterprise portals, (d) the definition and deployment of LO standards (National Information Standards Organization [NISO], 2004), (e) the use of libraries of shareable and open-source digital LOs (see http://merlot.org) and courseware (see MIT's OpenCourseWare initiative at http://ocw.mit.edu/index.html), and (f) the design of innovative hybrid courses (Swenson & Evans, 2003) as well as the formation of professional societies with journals and meetings that encourage discussion and debate regarding these and other issues.

The steady growth of distance learning has been and continues to be remarkable. Reisman (2003) reported that the market for fully online degree programs is growing at an annual rate of 40%, and in 2001 and 2002, more than 350,000 students were enrolled in fully online degree-granting programs generating $1.75 billion in tuition. He goes on to state that U.S. spending on online training is expected to skyrocket during the next 8 years, from less than $10 billion in 2002 to projected spending of more than $210 billion in 2010. From a new business standpoint, these statistics are truly remarkable. But from an eight-decade-long educational-technology perspective, we can finally state, "It's about time!"

CONCLUSION

This article chronicles 80 years of technology milestones that have contributed toward the development of the methods and practices of distance learning. All these milestones have been building blocks for a new kind of learning environment different from any other that has ever existed. Learners can be physically remote from one another and from their instructor; learners can learn at their own pace; learners and instructors need rarely, if ever, to meet in person; learners and instructors can communicate on a very regular basis using a whole host of Internet-enabling technologies; through Internet search engines, learners have immediate access to a worldwide collection of online materials; and instructors have immediate availability to shareable learning objects that they can reuse to create new online curricula. If Socrates could see all this, he would be dumbfounded.

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KEY TERMS

Computer-Assisted Instruction (CAI): An extension of the branching model of teaching machines in which a learner accesses computer-based lesson material (courseware) developed and programmed by teams of instructional designers and computer programmers.

Computer-Managed Instruction (CMI): A form of CAI in which a computer serves the role of an instructional supervisor and media guide for learners, directing them to different curricular materials and/or media based on their performance in computer-administered pre- and posttests.

Laser Discs (Videodiscs): Analog optical storage devices first commercialized as a distribution medium for motion pictures in a 1980 joint venture, DiscoVision Associates, between IBM and MCA. Laser discs provided the foundational technologies for Philips' and Sony's CD formats that have evolved into CD-ROMs, CD-Rs, CD-RWs, and DVDs (digital videodiscs).

Learning-Management Systems (LMS): Software environments within which students access learning objects provided by an instructor. An LMS-based course is a framework and structure that contains LOs and directions to students from the instructor regarding how and when they should be accessed. With LMSs, instructors focus their energy and expertise on the creation or utilization of LOs and the day-to-day management of their courses.

Learning Object (LO): Reusable digital learning material.

Multimedia: A term that originated in the audiovisual industry to describe a computer-controlled, multiple-projector slide show with a sound track. Multimedia is now viewed in computer terms as a blending of media types: text, audio, visual, and data in one convenient computer-based delivery system.

PLATO (Programmed Logic for Automatic Teaching Operations): A CAI system produced by the University of Illinois, the Control Data Corporation, and the National Science Foundation. Courses authored in the TUTOR scripting language ran on a time-shared mainframe servicing hundreds of concurrent plasma-display-based terminals. PLATO's user-to-user communications tools were predecessors to synchronous communications tools prevalent in today's LMSs.

Teaching Machines: Invented in 1924 by Sydney L. Pressey to administer rudimentary drill and practice. They were also manufactured in the 1950s as programmed instruction devices based on either B. F. Skinner's linear curriculum-delivery model or Norman Crowder's branching model.

TICCIT (Time-Shared Interactive Computer Controlled Information Television): A CAI system developed by the MITRE Corp. and funded by the NSF in 1968, based on television technology products controlled by a time-shared computer system, designed to provide TV-based individualized instruction.

APPENDIX A

Theoretical Foundations to Computer-Assisted Instruction

Behaviorism	Constructivism	Cooperative Learning	Individualization
John B. Watson - Founder of behaviorism, laws of frequency, recency	M. Wertheimer - Gestalt psychology, emphasis on insight, laws of proximity and closure	L. Vygotsky - Social development	H. Gardner - Multiple intelligences
Edwin R. Guthrie - Contiguity theory, maintaining stimuli	J. Piaget - Development of schemata, accommodation and assimilation, four stages of intellectual development, conservation	A. Bandura - Social learning theory, imitation, modeling, self-efficacy	J. Piaget - Genetic epistemology
Edward L. Thorndike - Law of effect, satisfiers and annoyers	L. Vygotsky - Social development	J. Lave - Situated learning	J. P. Guilford - Structure of intellect
Clark L. Hull - Postulates and theorems, oscillations	J. Bruner - Constructivist theory	J. Dewey - Learning a result of disequilibrium	D. Rumelhart & D. Norman - Modes of learning
Robert M. Gagne - Development of hierarchical organization	A. Bandura - Social learning theory, imitation, modeling, self-efficacy	G. Pask - Conversation theory	F. Marton & N. Entwistle - Phenomenonography
B. F. Skinner - Rejection of intervening variables, reinforcement, operant behavior, shaping, behavior modifications	E. Ernst Von Glaserfeld - Radical constructivism		G. Salomon - Symbol systems
G. Miller - Information processing theory	J. Lave - Situated learning		R. Sternberg - Triarchic theory
I. Maltzman - Originality	J. Bransford - Anchored instruction		L. Cronbach & R. Snow - Aptitude-treatment interaction
E. Tolman - Sign learning	C. Rogers - Experiential learning		P. Cross - Adult learning
	J. Dewey - Learning a result of disequilibrium		M. Knowles - Andragongy
	R. Spiro - Cognitive flexibility theory		J. Dewey - Learning a result of disequilibrium
	C. Reigeluth - Elaboration theory		L. Festinger - Cognitive dissonance
	T. Sticht - Functional context		

E

APPENDIX B

Positive Aspects of Theories of Instruction to Computer-Assisted Instruction

Behaviorism	Constructivism	Cooperative Learning	Individual Learning
Stating the objectives of the software	Learner uses active mental processes to develop meaning and knowledge	Develops interdependence	Good for introverts and shy learners
Applying appropriate reinforcers, be it text, visual, or audio	Cross-field/cross-curricular integration	Students develop prosocial behavior	Builds self-confidence
Provides repetition and immediate feedback to learner	Learning occurs in lifelike situations	Improved self-esteem and appreciation of school	Safe, free from peer pressure
Shaping, chaining, modeling, punishment, and award principles are used	Learner develops holistic problem-solving skills that can be transferred to other situations	Greater psychological health	Intrinsic motivation: Challenged by competing with oneself (doing better next time), curiosity (can explore new, interesting facts without justifying it to the group), control (use own time and sequence, do not need to report to others), and fantasy (allowing oneself to daydream on certain aspects of the work)
A scoring system is very often present	Reflective and metacognitive abilities of learner are developed	Students develop positive peer relationships	Develops self-discipline
The software provides the status of progress of the learner	Learner is internally motivated to solve problems through discovery and experience	Social and communication skills are developed	Can accommodate own learning style, cognitive style, and learning approach
By using these packages, individual learners can master the subject matter on their own time and at their own pace, which addresses Blooms mastery learning principle	Internal motivation leads to development of long-term memory	Improved intrinsic motivation	Can work on own time and at own pace
Motivation is also enhanced as the student continually is kept on track of his or her performance	Learner is in control of own learning; learns to organize and manage himself or herself	Groups provide an academic and personal support system	Repetition of work as many times as necessary to master it
In contrast to being a mere receiver of information, the learner now actively participates	Social and communication skills are developed	Reflective and metacognitive abilities of learner are developed as students seek to clarify, explain, and justify their stand	Develops personal gratification
The learner's concentration is improved by the use of these packages addressing the environmental factors that should induce learning	Requires teamwork/cooperation among learners and educator	Promotes greater competencies in critical thinking	
Presents user with multiple realities	Learner learns to accommodate various perspectives on an issue	Cognitive rehearsal results in enhanced short- and long-term memory	
Frees educator of rote work	Higher cognitive levels, like analysis, synthesis, and evaluation, are developed	Learner learns to accommodate various perspectives on an issue	
Has good record-keeping facilities of students' progress		Positive attitudes toward the subject areas studied	
These packages come in various forms: drill and practice, simulations, and tutorials		Higher achievement and greater productivity	

Category: Concepts, Trends, and Challenges

Evolution of Information-Hiding Technology

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INTRODUCTION

Information-hiding technology is an ancient art and has existed for several centuries. In the past, messages could easily be intercepted because there was no technology of secret communication. Hence, a third party was able to read the message easily. This was all changed during 440 B.C., that is, the Greek Herod's era. The Greek historian Herodotus in his writing of histories stated that Demaratus was the first person who used the technique of information hiding. Demaratus, a Greek who lived in Persia, smuggled a secret message to Sparta under the cover of wax. The main intent was to warn Sparta that Xerxes, king of Persia, was planning an invasion on Greece by using his great naval fleet. He knew it would be very difficult to send the message to Sparta without it being intercepted. Hence, he came up with the idea of using a wax tablet to hide the secret message. In order to hide the secret message, he removed all the wax from the tablet, leaving only the wood underneath. He then wrote the secret message into the wood and recovered the tablet with the wax. The wax covered his message to make the wax tablet look like a blank one. Demaratus' message was hidden and never discovered by the Persians. Hence, the secret message was sent to Sparta successfully. Greece was able to defeat the invading Persians by using the secret message.

Another example of information hiding was employed by another Greek named Histaiaeus. Histaiaeus wanted to instigate a revolt against the Persian king and had to deliver a secret message about the revolt to Persia. He came up with the shaved-head technique. Histaiaeus decided to shave the head of his most trusted slave and then tattooed the secret message on his bald scalp. When the hair grew back, the secret message was covered, and then Histaiaeus ordered the slave to leave for Persia. When the slave reached his destination, his head was shaved, showing the secret message to the intended recipient.

Around 100 A.D., transparent inks made it into the secret field of information hiding. Pliny discovered that the milk of the thithymallus plant could easily be used as transparent ink. If a message was written with the milk, it would soon evaporate and left no residue. It seemed that the message was completely erased. But once the completely dried milk was heated, it would begin to char and turned to a brown color. Hence, the secret message could be written on anything that was not too flammable. The reason it turned brown was because the milk was loaded with carbon, and when carbon was heated, it tended to char.

Information hiding became downfallen and won no respect until World Wars I and II. Invisible inks, such as milk, vinegar, fruit juices, and urine, were extensively used during the wars. All of them would darken when they were heated. The technology was quite simple and noticeable. Furthermore, World War II also brought about two inventions of new technologies. The first one was the invention of the microdot technology. The microdot technology was invented by the Germans to convey secret messages to their allies. The microdot was basically a highly detailed picture shrunk to about the size of a period or dot, which permitted hiding large amounts of data into the little microdot. By using a microscope, the hidden message would be revealed. The Germans would put their dots into their letters, and they were almost undetectable to the naked eye.

The other technology was the use of open-coded messages. For open-coded messages, certain letters of each word were used to spell out the secret message. Open-coded messages used normal words and messages to write the buffer text that hid the message. Because they seemed normal, they often passed the check of security. For example, the following message was a common example of open-coded messages and was actually sent by a German spy during World War II.

Apparently neutral's protest is thoroughly discounted and ignored. Isman hard hit. Blockade issue affects pretext for embargo on by-products, ejecting suets and vegetable oils.

By extracting the second letter in each word, the secret message was revealed:

Pershing sails from NY June 1.
This technique was effective because it could pass through the check of security and was easy for someone to decode (Johnson, Duric, & Jajodia, 2001; Katzenbeisser & Petitcolas, 2000; Schaefer, 2001).

The technologies mentioned here are different ways of information hiding in different eras. With the development of computer technology, it is becoming hard for the third party to discover the secret message.

BACKGROUND

In recent years, information-hiding technology has become the glittering palace in multidisciplinary fields, including image and signal processing, compression, cryptography, communication and coding theory, and so forth. The characteristics of information-hiding systems also have been widely discussed, including imperceptibility, robustness, tampering resistance, low computation cost, and false-positive rate (Cox, Miller, & Bloom, 2000; Lou, Liu, & Li, 2004; Lou & Sung, 2004). Table 1 summarizes some characteristics of information-hiding technology (Lee & Chen, 2002; Lou & Liu, 2000). However, a scheme that meets all these requirements is not an easy work. Take embedding messages as an example. Such a scheme may not cause noticeable artifacts, but may be too weak to stand the attacks of signal processing. Moreover, if we want to hide a massive message in an image, the problem of low robustness will appear. Hence, it is an important issue to develop a good scheme of information hiding with a better trade-off between these characteristics.

Information-hiding technology became a remarkable field after the 9/11 attack in the United States by terrorists. U.S. officials said that Osama Bin Laden's followers downloaded easy-to-use encryption programs from the Web, then Bin Laden posted instructions for terrorist activities in chat rooms, pornographic bulletin boards, and other Web sites. The Internet has proven to be a boon for terrorists.

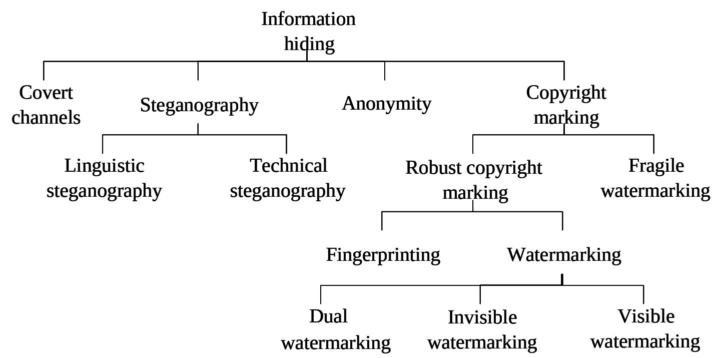
Table 1. A summary of characteristics of information-hiding technologies

- Imperceptibility
- Robustness
- Security
- Capacity
- Unambiguous
- Undetectable
- Blind detection
- Low computation cost
- False-positive rate
- Tamper resistance
- Multiple watermark

In general, information-hiding technology has several applications as given in Figure 1 (Petitcolas, Anderson, & Kuhn, 1999). Other applications (Anderson & Petitcolas, 1998; Cox & Miller, 2002; Katzenbeisser & Petitcolas, 2000; Maadonks, 2004) include the following.

1. **Automatic Monitoring of Copyrighted Material on the Web:** There are two technologies that can trace the use of copyrighted material. One is verifying the copyrighted material by comparing the digests of the images that are downloaded from the Internet with the ones that are registered in the database. The other is to identify illegal usage by using a robot to search the Web.
2. **Automatic Audit of Radio Transmission:** This involves using a computer to listen to a radio station and search for a special piece of advertisement or music that has been broadcast.
3. **Data Augmentation:** Information is added for the benefit of the public. This can be details about the work, annotation, other channels, or buying information so that someone listening to the radio in a car can simply press a button to order the goods that he or she wants. Moreover, in order to cause more retrieval from the database, the information can also be hidden to find pictures or music tracks.
4. **Authentication and Recovery:** A digest can be hidden into digital media to prevent or detect unauthorized tampering or destruction, and even to recover the media.
5. **Indexing for Archive:** Metadata (e.g., data about the owner, title, scene, director, cameraman, location, etc.) are added to the material for an indexing archive.
6. **Transaction Tracking:** This involves adding copyright notices, identifying recipients, and tracing the source of illegal copies.
7. **Proof of Ownership:** Copyright notices are added as proof of original ownership.
8. **Remote Control:** Information is added that will allow the triggering or control of devices in a broadcast chain.
9. **Copy Control:** Some message is added to prevent the copying of copyrighted material.
10. **Medical Safety:** The date and the patient's name are embedded in a medical image as a useful safety measure.

Figure 1. The classification of information-hiding technology



The applications mentioned above were discussed in various conferences. The first academic conference on information hiding was held in Cambridge, England, in 1996. Several following conferences also focused on the protection of intellectual property and some other applications. The sixth international conference on information hiding was held in Toronto, Canada, in 2004.

There are two popular researchable areas called steganography and digital watermarking, shown in Figure 1, that are generally referred to as information hiding. There are different applications for the two areas depending on the intent of use. Steganography comes from the Greek words steganos and graphein (steganos means covered, hidden, or secret; graphein means writing or drawing), and literally means "covered writing," which in turn means hiding messages in carriers such as image, audio, and video files. The main intent of steganography is to conceal a message and prevent the detection of it. The research of the subject in the scientific literature may be traced to the prisoners' problem (Simmons, 1984). There were two prisoners, Alice and Bob, who were arrested and shut in two separated cells. They wished to hatch an escape plan secretly, but all communication between each other is controlled by the warden named Wendy. If Wendy found any encrypted message, she would frustrate their plan and place them in solitary confinement. Hence, Alice hid a message in a cover-medium to produce the stego-medium, where the cover-medium could be an image, audio, or video.

Steganography and cryptography are cousins in the spy-craft family. However, steganography must not be confused with cryptography. Steganography is concealing the existence of a message so it cannot be seen. However, cryptography is concealing the content of a message by scrambling a message so it cannot be understood. The latter protection is often not enough. For example, an encrypted message delivered over the Internet may cause suspicion, while an invisible message will reduce the chance of it being suspected (Anderson & Pelitcolas, 1998).

On the other hand, digital watermarking can be thought of as commercial applications of steganography. The main intent of digital watermarking is establishing the identity of media to prevent unauthorized usage. A digital watermark is a message, such as a copyright logo or data about the authorship, that is secretly embedded into multimedia and still remains detectable or extractable after suffering from attacks. Hence, it can be used to identify the legal owner for the protection of intellectual property. Due to the distribution and duplication of digital multimedia, digital multimedia is easy to duplicated, but it is difficult to distinguish between the original and the duplicated one. Hence, the copyright protection of digital multimedia has become a severe problem. Digital watermarking may be an effective solution and may play an important role in copyright protection.

Steganalysis is another art of detecting, extracting, confusing, and disabling hidden information (Johnson & Jajodia, 1998). The major intent of steganalysis, just like cryptanalysis, is to discover hidden information and even to make the hidden information invalid. There are several types of attacks, described as follows.

1. **Stego-Only Attack:** Only a stego-object is available for analysis.
2. **Known-Cover Attack:** Both the cover and stego are known.
3. **Known-Message Attack:** In some cases, the message is known. Analyzing the stego-object pattern for this embedded message may help to attack similar systems.

4. **Chosen-Stego Attack:** The steganographic algorithm and stego-object are known.
5. **Chosen-Message Attack:** Here, the steg-analyst implements many steganographic tools for a chosen message and compares the stego-objects with the one to be analyzed, trying to find the algorithm used in the process.
6. **Known-Stego Attack:** The cover, object, and steganographic tool used are known.

Moreover, there are different existing methods for steganalysis, including the following.

1. **Statistical Steganalysis:** This involves comparing the original image to the tampered one for differences by mathematical computation.
2. **Visual Comparison:** The original image is compared to the tampered one by human eye. This method is quite simple but ineffective because it requires much time and cannot even enable one to find out where the picture has been tampered.
3. **Software Detection:** A message is detected by software that is created to detect different methods of steganography.

If a steg-analyst wants an effective attack, he or she must understand and acquire the related technology and information. However, sometimes even though the attacker has enough information, the embedded message may still be difficult to extract. Brute force can be successful in detecting or extracting the hidden information, but it requires much processing time to achieve this intent (Katzenbeisser & Petitcolas, 2000).

A GENERAL MODEL OF INFORMATION-HIDING TECHNOLOGY

The general model of an information-hiding system is given in Figure 2 (Barni & Bartolini, 2004). In order to increase security, in the embedding process, the data *m* is embedded into the carrier C through the key *k*. In general, the security of the cryptosystem cannot depend on the algorithm but on the key used (Barni & Bartolini). The carrier C may be an image, an audio file, or a piece of video. The embedding process can be classified into two groups. The first is the spatial-domain technique (Lou & Liu, 2002; Lou, Liu, & Tso, 2004; Lou & Yin, 2002), which embeds a message by directly modifying the pixel values of images. The least significant bit (LSB) method is the simplest technique. Its advantage lies in its lower computational complexity because it does not need to perform signal transformation. However, the disadvantage is its lower security and weakness to common attacks. The second embedding process is the transform-domain technique (Lee & Chen, 2002; Shieh, Lou, & Tso, 2005), which embeds a message by modulating the coefficients of the transform domain, such as through the discrete cosine transform (DCT) and discrete wavelet transform (DWT) techniques. In general, embedding the watermark into a transform domain can give more imperceptibility, security, and robustness than a spatial domain.

The second part of Figure 2 is the transmission channel. This part describes the carrier that covers the data through the channel, and may be manipulated by intentional or unintentional attacks. An intentional attack means the explicit intent of destroying the hidden carrier, including a steganalysis attack, active or passive attack, collusion attack, counterfeit attack, and so forth. An unintentional attack means the undergoing of signal processing, including filtering, lossy compression, blurring, sharpening, and so forth. Table 2 summarizes some of the attack modes (Anderson & Petitcolas, 1998; Katzenbeisser & Petitcolas, 2000; Kutter & Petitcolas, 1999).

The last part of Figure 2 is the process of information retrieval. Steganography schemes can retrieve the hidden data by using the key without the original carrier and data. Watermarking schemes for watermark extraction depends on whether the original carrier is necessary or not. In general, the schemes that require the original carrier for the watermark-extraction process are robust against the attacks of signal processing. Furthermore, the schemes are not feasible in practice such as in DVD copy protection, where the original information may not be available

Figure 2. The general mode of an information-hiding system

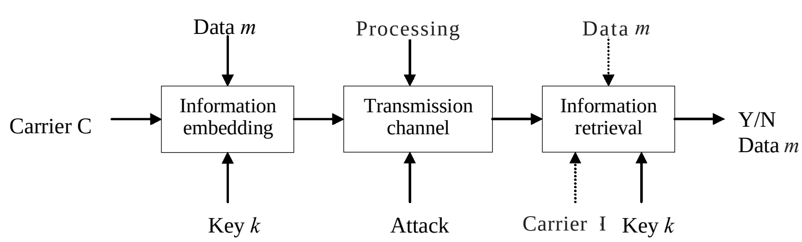


Table 2. A summary of the attack modes

- Steganalysis attack (active attack, passive attack)
- Filtering (blurring, sharpening, low-pass filtering, etc.)
- Noise adding
- Lossy compression
- Geometric transforming (translation, rotation, scaling)
- Data reduction (cropping, histogram modification)
- Data composition (logo insertion, scene composition)
- D/A and A/D conversion (print-scan, analog TV transmission)
- Transcoding (BMP to JPEG, H.263 to MPEG2)
- IBM attack
- Mosaic attack
- Statistical averaging
- Collusion attack
- Copy attack
- Counterfeit attack
- Multiple watermark
- Tampering
- Protocol attack
- Statistical attack
- Common-cover-carrier attack
- Overmarking
- Jitter attack

for watermark detection. On the other hand, the schemes that do not require the original carrier for the watermark-extraction process, called blind detection, are more feasible in that situation. However, the schemes have lower robustness than the former ones.

INFORMATION-HIDING SCHEMES

Classical information-hiding carriers include tablets, hollow heels, images under stamps, tiny photographs, word arrangements, and so forth. With the progression of computer techniques, the hidden carriers are transferred to digital types. These digital carriers are widely applied to information hiding, and many different technologies have been proposed. The schemes include the following (Johnson et al., 2001).

1. **Hiding in Text:** A document may be modified to conceal information by manipulating the positions of lines and words. HTML (hypertext markup language) files can be used to carry information because adding spaces, extra line breaks, invisible characters, and tabs are ignored by the browser. The extra spaces and lines are not perceptible until the source code of the Web page is revealed. Another example is open code or null cipher, which has been mentioned above.
2. **Hiding in Disk Space:** The way to find unused space is not readily apparent to an observer. For example, early Windows 95, drive formatted as FAT16, without compression used cluster sizes of around 32K. That means the minimum space allocated to a file is 32K. If a file is 2K, then an additional 30K is wasted due to the way storage space is allocated. Another scheme is to create a hidden file in the file system. If the user knows the file name and password, then access is granted to the file. No evidence of the file exists in the system.
3. **Hiding in a Network Packet:** Inherent characteristics in network protocols can be used to hide information. For example, the header of the TCP/IP (transmission-control protocol/Internet protocol) packet has some unused space and other features that can be manipulated to hide information.
4. **Hiding in Software and Circuitry:** Data can be hidden in a carrier based on the physical arrangement of the work. The arrangement itself may be an embedded signature that is unique to the creator (e.g., the layout of code distribution in a program or electronic circuits on a board). The intent is to identify the origin, and it cannot be removed without significant change to the work.
5. **Hiding in Images, Audio, and Video:** There are many different schemes for hiding information in images, audio, and video. These schemes may include hiding information in unused space such as the header of a file. Embedding techniques can range from the placement of information in imperceptible levels, the manipulation of the compression algorithm, the manipulation of the masking model, to the modification of carrier characteristics.

SOFTWARE OF INFORMATION HIDING

Many information-hiding software are available on the Internet. SandMark is a steganographic tool developed by the University of Arizona for software watermarking, tamper proofing, and code obfuscation of Java byte code. The ultimate goal of the project is to implement and study the effectiveness of all known software-protection algorithms. Currently, the tool incorporates several dynamic and static watermarking algorithms, a large collection of obfuscation algorithms, a code optimizer, and tools for viewing and analyzing Java byte code. Software-watermarking algorithms can be used to embed a customer identification number (a fingerprint) into a Java program in order to trace software pirates.

In recent years, the broadcast-monitoring technique has given rise to a lot of interests in copyright protection. Many film owners hope to get accurate information on when and where their films are broadcast. This is also a problem crying out for a solution. The Teletrax video-watermarking system is a broadcast-video-monitoring system that embeds a watermark in video content to monitor how broadcast material is used around the world and even to identify the source of these copies.

Moreover, the cryptanalysis technique is also getting respect. Stegdetect is an automated tool for detecting messages in an image. It is capable of detecting several different steganographic methods to embed hidden information in JPEG images. The detectable schemes include Jsteg, Jphide, Invisible Secrets, Outguess 01.3b, and F5. Tables 3 and 4 summarize some software of the technology.

FUTURE TRENDS

With the development of digital technologies, it has become necessary to protect multimedia content from unauthorized usage. Recently, there are two fundamental technologies, encryption and digital watermarking, that have been identified for protecting copyrighted multimedia content on the Internet.

The protection of digital intellectual property has motivated most of the research in the fields. There are many other applications of increasing interest to both the academic and business communities. Moreover, many researchers are also interested in hiding information or, conversely, in preventing others form doing so.

There exists a number of image-processing-based benchmark and cryptanalysis software. However, it is a question if these techniques can successfully destroy the existing information-hiding schemes. Moreover, these techniques still need to be improved due to the lack of modular researching results (such as the software for statistical attacks).

Regarding the security issue, if an attacker understands the algorithm of a scheme without obtaining any other information, such as the key, the scheme is supposed to be secure (Anderson & Petitcolas, 1998). However, with the development of computer techniques, the speed of cryptanalysis is more and more rapid. Thus, the issue of security will be more important.

The problem of digital-content piracy has become more and more critical, and major content producers are seeing their businesses drastically reduced because of the way in which digital content can be copied and distributed. This is the reason why digital rights management (DRM) is currently garnering much attention from the industry and academia (Barni & Bartolini, 2004).

Table 5 summarizes some of current research topics of information-hiding technology.

Table 3. A summary of steganography tool

- Steganography 2.8
- SecurEngine Professional 1.0
- Hermetic Stego
- Steganos Security Suite 7
- StegComm
- Stegsafe
- Stegsign
- Gifshuffle
- Invisible Secrets 4
- CryptArkan
- OutGuess
- Info Stego 3.0
- MP3Stego
- StegParty
- TextHide
- Stealthencrypt
- Steghide
- wbStego4.3open
- Stego Watch #
- Stegdetect #

Detection tool

Table 4. A summary of watermarking tool

- Teletrax video-watermarking system
- SandMark
- StegMark
- AiS WPP
- CoxWmk
- ImageBridge
- EIKONAmark
- AudioMark
- VideoMark
- VolMark
- Digimarc
- Giovanni
- Verance
- Eikonamark*
- UnZign !
- StirMark !
- Checkmark !
- Optimark !
- 2Mosaic !

*Embedding and detection tool
!Removal tool

Table 5. A summary of current research topics

• Anonymous communications
• Covert channels in computer systems
• Detection of hidden information
• Digital elections
• Information-hiding aspects of privacy and confidentiality
• Low-probability-of-interception communications
• Steganography and steganalysis
• Subliminal channels in cryptographic protocols
• Watermarking for the protection of intellectual property
• Authentication of multimedia
• Robust watermarking and fingerprinting of multimedia
• Software protection
• Stego-engineering
• Digital cash and electronic commerce
• Digital forensic and forensic analysis of digital multimedia
• Attacks to watermarking security
• Digital rights management
• New applications, legal aspects, and security issues (including encryption, tamper resistance, watermarking, fingerprinting, etc.)
• Identification of digital content
• Security analysis of existing watermarking schemes
• Proposal of secure, practical watermarking algorithms
• Lossless data embedding
• Image database
• Informational-theoretical aspects of data hiding
• Practical systems with aspects of data hiding
• Watermarking quality evaluation and benchmarks
• Data-hiding applications in biometrics
• Embedding and attack software for data hiding

CONCLUSION

Information-hiding technology is not only an ancient art, but is also existent in the development of computer technology, which has brought a new vision. Though the development of computer networks has made the exchange of information easier, information-hiding technology is an effective tool for protecting personal information, rights, and benefits. The critical issues discussed in this article offer many implications and challenges to businesses, academia, and governments. With greater emphasis being placed on this technology and its capabilities, these issues must be dealt with continuously without delay, and as the new technology continues to develop, newer issues will arise and present new challenges to the user.

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KEY TERMS

Collusion Attack: By averaging together the carriers of hidden information, the watermarks may be canceled out.

Cover-Medium: A medium that does not contain any message.

Digital Watermark: It is a process that secretly embeds a message, such as a logo or data about the authorship, into multimedia. The watermark information still can be detected or extracted after suffering from attacks. Its major intent is establishing an identity of multimedia to prevent unauthorized use.

Fingerprint: It is also called a label. It is a feature of the carrier and is used to distinguish it from other carriers. Moreover, it allows the copyrighted owner to trace pirates if the carrier is redisseminated illegally. The major difference between watermarking and fingerprinting is whether the identity of the transmitter or that of the recipient is embedded in the carrier.

Fragile: After a message is embedded into a carrier, the hidden message is destroyed if the carrier is destroyed or modified. The scheme is not suitable to prove a legal copyright but useful to detect a carrier tampered with.

Imperceptibility: After a message is hidden into carrier, it is difficult for a viewer or listener to distinguish between the carrier that contains the hidden message and those that do not.

Robustness: It is the resistant ability of a hidden message against various attacks; that is, a message that is hid in a carrier can be reliably detected after the carrier has been attacked.

Steganalysis: Discovering the existence of hidden information. Hence, its major intent is to discover hidden information and break the security of the carrier.

Steganography: Hiding the existence of a message by hiding information into various carriers. The major intent is to prevent the detection of hidden information.

Stego-Medium: The medium after hiding a secret message into a cover medium.

Category: Concepts, Trends, and Challenges

Evolution of Marketing to E-Marketing

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INTRODUCTION

The Internet was initially developed for military purposes but soon grew into an academic tool intended to disseminate research from one institution to another. In the 1990s, the Internet was introduced into the business arena and has steadily grown into a very important business tool that has helped businesses to achieve and improve on their strategic goals. The Internet has created new revenue streams; it has broken geographic boundaries to new markets and has ushered in a new level of convenience. The Internet has not only impacted on the overall organisation, but it has also impacted on functional areas such as finance, production, human resources, and marketing. This article examines the extent to which marketing has changed as a result of the Internet.

BACKGROUND

What is Marketing?

Marketing is often confused with advertising or sales, and many people believe that marketing, advertising, and sales are one and the same and hence use the terms synonymously. Marketing, however, is the overarching discipline that encompasses advertising, sales, research, and other activities. Kotler (2003) defined marketing as "the art of identifying and understanding customer needs, and creating solutions that deliver satisfaction to the customers." Perrault and McCarthy (2000) defined marketing as a set of activities to accomplish the organisations goals by anticipating customer needs and supplying them with need satisfying goods and services. According to Singh (2001), the central themes that emanate from these definitions are need identification, need satisfaction, and profit, which he terms the *marketing equation*. The marketing equation assumes, ceteris paribus, tha, if organisations can identify customer's needs and satisfy them, then quantities demanded would increase, resulting in a profit for the organisation. Need identification is generally based on market research such as surveys, focus groups, and observation. In attempting to satisfy the customers need, marketers employ the Marketing Mix, or the 4P's of Marketing, to develop their offering. The 4Ps are Product, Price, Place, and Promotion (Perrault & McCarthy, 2000). The four activities of the Marketing Mix revolve around the consumer. The 4Ps are like baking a cake—quantities can be adjusted, based on the organisations resources. However, a change in one activity will affect others; for example, an increase in promotion expenses will result in an increase in price. How does any of this relate to the Internet?

INTERNET MARKETING

Many articles and books are being written about Internet marketing and e-marketing to guide marketers to look to the Internet to develop new markets and exploit the purchasing power of the global consumer. In essence, Internet marketing involves using the Internet to perform marketing activities. In order to explain this, the concepts explained earlier—that is, need identification, need satisfaction, and the marketing mix—will be discussed in relation to the Internet.

NEED IDENTIFICATION

The Internet has speeded up the need-identification phase. The World Wide Web (hereafter referred to as the Web) has become a very effective market and marketing research tool. Using traditional marketing research methods has proven unreliable; customers rush through surveys conducted in person and often do not return postal surveys. Focus group members often do not arrive for the session, and some even disrupt the session. The Internet makes data collection more reliable, whereby questionnaires are sent directly to the customer. Responses are returned almost immediately. However, this is dependant on the customer's willingness to fill in the questionnaire and to return it. Another limiting factor is access; the Internet market is a very small community, which limits online research to Internet users only (Strauss, El-Ansary, & Frost, 2005). Chat sessions online are quick and easy to arrange and do not incur costs of bringing people together in one venue. However, online anonymity makes it difficult to determine who is on the other end. This could skew the results obtained.

Figure 1. The buying decision process (Adapted from Kotler, 2003)

Market and marketing information can be purchased online from many reputable market-research houses. Information is also available for free online from public and government departments. Internet service providers and other Web-based organisations are willing to sell or make information available free of charge.

NEED SATISFACTION

When purchasing high-involvement products such as appliances, electronics, clothing, perfumes, and motor vehicles, the consumer generally follows a buying decision process (see Figure 1).

The Internet serves as an invaluable tool in the consumer's information search phase and post purchase behaviour. It also plays a lesser role in the evaluation of alternatives and the actual purchase. Making business information available is one of the most important ways of satisfying one's customers. The Internet makes information easily accessible, and it is information that gives the customer greater control over the purchase (Peters, 1999). Detailed online information assists the customer in making an informed decision. The Internet also makes the information search easier with the multitude of search engines that can locate sites that contain the information being sought by the customer. According to Ries (2000), one of the benefits of the Internet is that it provides the consumer with price comparisons, which is most beneficial to customers who are price sensitive.

Some Web sites known as infomediaries have features that aid the consumer's evaluation of their product choices, prices and features (Awad, 2004; Schneider, 2004). Some infomediaries also assist the customer with the purchase of the product by linking the customer to a store's Web page, where the customer will conclude the purchase by filling in delivery details and credit card particulars to complete the purchase.

Postpurchase behaviour, such as, queries and complaints can be handled a lot quicker, as a result of the Internet. Web sites allow feedback from customers. Contact via e-mail is quick, cheap, and easy and facilitates immediate handling of complaints (Reedy, Schullo, & Zimmerman, 2000). Some organisations preempt customer queries based on previous feedback and develop a frequently asked questions database. Companies assign Web pages to contain frequently asked questions and their answers (Perrault & McCarthy 2000, Strauss et al., 2005).

THE MARKETING MIX

It is evident that the Internet has made it possible to identify and to help satisfy customer's needs. However, it has also impacted on the marketing mix. All four components of the mix have been affected.

Product

According to Bickerton, Bickerton, and Pardesi (1996) customers do not purchase the product, they purchase the benefits. The Internet makes it possible for a company to extol the benefits of their product or service at minimal cost. Detailed information, such as product specifications, alternate uses, demonstrations, and instructions are available online. However, getting the customer to use a firm's Web site is a challenge for e-marketers.

Branding is often one of the product benefits that consumers look for, and e-branding has attracted extensive debate. E-brands are unique brands to the Internet such as Amazon, Yahoo!, and eBay, or they could be aliases for offline brands such as Egg, which is the online arm of Prudential Insurance Company. According to Moodley (2000), establishing e-brands and more importantly, e-brand loyalty is an extremely difficult task. This notion has been supported by Cohen (1999), who is of the opinion that the Web defies all brand logic: What is successful off-line does not enjoy the same success online. It is hard to encourage loyalty, because customers are worried that once the organisation makes the money, the site will be gone. Bickerton et al. (1996) are of the opinion that established non-Internet brands have an advantage over their competitors when they market on the Internet. However, strong off-line brands do not always translate easily to the Web. This is supported by Ries (2000), who wrote that "taking your real world name and putting it on the Internet, is fundamentally wrong" (Ries, 2000, p. 1); for example, Nike, one of the world's biggest and best known brands, does not enjoy the same success online. The values that are imbued in Nike's offline messages of speed, and agility, are absent on the web. Except for the swoosh, the site is slow and takes a long time to process pictures, which contradicts Nike's main selling points. It is difficult to take an offline brand and replicate it online (Cohen, 1999). Developing Internet branding is difficult because of the following:

- There are no visual cues, such as an eye catching pair of earrings in a store window, to direct one to a site. A brand is invisible until you input it into your browser.
- It does not allow touching, feeling, and testing.
- It does not provide a smile and a cup of coffee, the personal touches that build brand loyalty. (Ries, 2000)

Furthermore, physical environments contribute to the value of a brand. It is impossible to capture on a computer screen the smells of perfumes, freshly baked bread, aromatic spices, and freshly ground coffee as one walks through a supermarket.

According to Ries (2000), organisations need to create news surrounding their site. They need to launch a "massive publicity campaign" and then use advertising as reminders. In developing Web brands, organisations need to:

- be like Yahoo, Amazon.com and Ebay;
- be unique by having abstract names, which are hard to imitate;
- be consistent and give the same service to all customers;
- be focussed; that is, the brand must mean the same thing to everyone, like Fedex means overnight delivery and Woolworths means quality; and
- be in it for the long haul by building loyalty over a long term period. (E-Brands. Brand … 2000)

Building brands, however, is not enough. E-brands are a living entity that needs nurturing. Firms must constantly monitor, respond to inputs, and update their brands to ensure their survival (Komenar, 1996).

Price

The rules for pricing on the Internet are no different from the rules of pricing in traditional organisations. Cost recovery is still paramount for the success of the Internet organisation. According to Reedy et al. (2000), Web pricing levels the playing field when dealing with manufacturers and retailers, and the Internet may turn out to be a price equaliser rather than a price cutter. Internet pricing is more transparent (Strauss et al., 2005). The Internet provides customers with instant price comparisons, forcing Internet retailers to have a price orientation (Ries, 2000). According to Lambin (2000), the Internet market is too perfect for products: consumers have full knowledge of prices and worldwide comparisons of seller's offerings. Therefore, competing on price is not enough: sellers have to develop strong brands to ensure continued sales.

The Internet has been able to lower prices as a result of lower overheads (Ries, 2000). The virtual organisation does not require large premises, inventories and staff. These cost savings translate to lower prices for the customer. Priceline.com lets the customer offer a price that he or she is willing to pay for an airline ticket, and the site searches for the match (Peters, 1999). Pricing is in the hands of the customer. If the price is not right, it is cheaper a click away. No longer will the seller have the upper hand in the mysteries of pricing (Reedy et al., 2000), because the consumer now controls pricing more immediately and more directly (Komenar, 1996).

Place

Several hundred manufacturers are using Web sites for marketing, buying, or selling goods and services to other businesses (Roberts, 2000). The Internet is more than just a new sales channel (Peters, 1999). *Cybermarketing* is the term used to describe Internet marketing. Cybermarketing involves selling in market space rather than in a market place (Kotler & Armstrong, 1999). Virtual stores and virtual organisations are mushrooming every day. According to Haag, Cummings, and Dawkins (2000), "virtual organisations are a network of independent vendors linked together by Information Technology to exploit market opportunities by sharing skills, costs and market access." The Internet has made it possible to bring stores and manufacturers closer to the customer. In fact, the Web has made the physical distance between buyer and seller immaterial (Rai, Chandra, & True, 1999).

Direct selling from the manufacturer to the consumer in the traditional market is logistically unsound. However, the Internet makes direct selling a more viable option (Bickerton et al., 1996). Dell Computer Corporation is able to keep ahead of its competitors because of its effective use of the supply chain (King & Conner, 2000). The Internet has made it possible to eliminate the middleman. However, the Web has introduced its own middleman, known as *metamediaries* (Strauss & Frost, 2001). Metamediaries assemble the content and information centred on a theme such as weddings, parties, and other lifestyle products and services.

Besides threatening traditional businesses, the Internet has given rise to the virtual mall, also known as *cybermalls*. The cybermall, like traditional malls, leases space to vendors to conduct business, whilst the mall looks after advertising and maintenance of the site (Alderman, 1996). The advantages of joining a cybermall include the possibility of attracting new customers and developing a brand identity and brand loyalty that may benefit vendors of that mall (Alderman, 1996). Vendors belonging to a mall with a strong brand may not need to develop a brand of its own. Cybermalls, however, add to the vendor's costs, which affects pricing.

Bricks-and-mortar businesses may be threatened by virtual organisations, but, they will not be replaced entirely. Traditional stores may grow smaller as cybershopping increases, but as long as poverty and illiteracy exist, physical stores will continue to exist.

Promotion

Guiltinan and Paul (1991) defined promotion as the activities associated with marketing communications. Grant (1999) collectively called marketing communications MARCOM. She states further that MARCOM is one of the business areas that is experiencing dramatic changes in strategy and execution due to the Internet. The Internet serves as a new channel for marketing communication, and it is changing the nature of what can be done to promote a company and its products (Grant, 1999).

Personal Selling

According to Kotler (2003), the market will see a decline in travelling salespeople as a result of the Web. The Internet is replacing salespeople, clerks, brokers, and other middlemen by serving the customer directly. Merril Lynch is confident that its future is on the internet, to the extent that the jobs of 14,800 stockbrokers are at risk (Graham, 2000). Robertson (cited in Ochman, 2000), however, stated that customers will gather information and intelligence on prices from the Internet, but to conclude the deal, they still want the reassurance of a traditional handshake that one does not get over the Internet.

Direct Marketing

The Internet provides an additional channel for home shopping (Cravens, 2000). E-mail-based catalogues cost less to produce than physical catalogues printed on glossy paper. Delivery is quicker, more accurate, and even cheaper than the postal service. The cost of sending a thousand e-mails is the same as sending one (Grant, 1999). Video, sound, and detailed information are adding a new dimension to flat traditional brochures (Grant, 1999).

Publicity

As mentioned previously, Ries (2000) is of the opinion that organisations need to gain publicity first before getting onto the Net. Getting publicity on the home pages of CNN, Financial Times, and Independent Online, Web versions of popular news media, increases the credibility of a press release, or any other newsworthy activities of a firm.

Just like traditional media, publicity on the Net is also short lived and is only effective whilst it is still "hot news."

Sales Promotion

The effectiveness of sales promotions on the Web is no different from normal promotions. Web promotions also rely on incentives in the form of electronic coupons, special offers, free accessories and contests, amongst others, to generate sales. Taste testing however, is not possible, which could affect the sale of new food products.

According to Strauss and Frost (2001), e-coupons are big business. Electronic coupons can either be printed, or used in normal stores, or they can be redeemed online at virtual stores. Electronic coupons create commitment (Mohammed, Fisher, Jaworski, & Cahill, 2002).

Loyalty awards can also be accumulated for Web purchases (Grant, 1999). Internet organisations could also offer customers rewards for introducing new e-customers. This is known as *word-of-click* or *viral marketing*, the same as *word-of-mouth* advertising.

Contests, which are normally expensive, are cost effective on the Internet and are able to generate invaluable information, such as biographical and contact details of contestants, which could be used later as sales leads (Grant, 1999).

According to Silver (2000), businesses should apply the "bonus pile on" (p. 2). Adding "free" extras makes the price seem a lot less expensive than the perceived added value that the customer is receiving. Internet "freebies" could include personalised e-mail addresses, Web space for a year, software, and subscriptions to electronic magazines.

Knight (2000) recommended that a successful online sales promotion must be a part of the overall marketing campaign to ensure consistency. He also advises that the promotion should run for a limited time only. Start and finishing dates must be set and adhered to, in order to give the firm control of the promotion. One promotion is not enough. There must be constant activity which creates a vibe around a promotion.

Advertising

When advertising on the Internet first appeared, many critics said it would never last. However, it is here to stay and is gaining momentum. American Internet advertising spending in 1997 amounted to $907 million (Advertising on the Internet, 2000). This figure in 2004 grew to $2.1 billion (Rashed, 2005). The Internet is the best and most effective way of advertising in the new millennium (Advertising on the Internet, 2000). Internet advertising is also the cheapest form of advertising, as there is no limit to the amount of information that can be distributed (Rai et al., 1999). The Internet changes advertising in that it is a new channel for advertising, and it offers new places for placing advertisements (Grant, 1999). The Internet has extensive international reach and is the permanent ambassador of the firm. There are two types of Internet advertising, namely, own Web-page advertising and paid advertising.

Paid advertising is similar to regular advertising, except that it can be either space or time based or both. Banner adverts are strips of information that appear either as fixed features on a Web page, or they appear as animations that float across the top of the screen. A static banner price is determined by the space it occupies on a web page, and an animated banner price is determined by the time it takes to flash the message across the screen, and the space that the banner occupies. Banners need to be as accurate and concise as possible, with a link to the advertiser's site. A boring banner can be easily clicked away, hence losing a potential buyer. Interstitial advertising is an effective means of occupying an Internet user whilst he or she waits for something to happen, such as the download of files (Grant, 1999).

Web-page advertising is the best option in terms of cost versus benefit (Rai et al., 1999). The development and hosting costs of a Web site are a fraction of a full advertising campaign (Advertising on the Internet, 2000). A Web site can attract or repel customers with a single mouse click. Therefore, Web sites have to be developed in such a manner that they grab and hold the attention of the consumer. Having a Web site is not enough. The site has to be monitored and maintained, and it needs to be supported with traditional media, by publishing the site address in normal adverts, on company stationery, and on all other promotional tools (Lambin, 2000; Tiedt, 2000; Wilson, 2000).

Unless one is looking for a Web site that they were referred to, or saw in some other medium, everything on the Web is invisible. This statement raises questions with regards the effectiveness of Internet advertising. The effectiveness of Internet advertising is best measured in relation to other media. Table 1 illustrates the effectiveness of Internet advertising in relation to television and newspaper advertising (Barker & Gronne, 1996).

Reach is the size of audience that can be reached by the medium. Selectivity is the precision with which the advertising reaches the target audience. Feedback is the ease with which feedback is given to the advertiser. Cost is the expense that is incurred in reaching the audience and capacity is the amount of information disseminated by the medium. It is evident from Table 1 that the Internet is an effective advertising medium. Internet advertising is especially effective as a medium for the transfer of large volumes of information to a select audience, with instant feedback at the lowest cost, and the effectiveness of which is measured almost instantly. However, the reach of Internet advertising is limited to those who can afford the technology. The Internet has changed the way marketing activities are conducted. The greatest impact has been on the marketing mix. Will Marketing change anymore?

FUTURE TRENDS

Traditional Marketing as discussed in this article is aimed at mass markets and uses a one size fits all approach. E-Marketing in the form of customer relationship marketing (CRM) takes a personalised approach to individual customers (Strauss & Frost, 2001). CRM enables marketers to use technology to develop databases of individual customer's needs, wants, and preferences. Based on the information, marketers can develop products that are best suited to the individual. Banks are using their extensive databases to develop individual banking profiles of customers, which they then use to offer the customer more

Table 1. Effectiveness of advertising media (Adapted from Barker & Gronne, 1996)

	Internet	Television	Newspaper
Reach	Low	Very High	High
Selectivity	High	Low	Medium
Feedback	Very High	Very Low	Low
Capacity	Very High	Low	Medium
Cost	Very Low	Very High	High

credit, investment opportunities and even send them customised birthday cards. With the trend towards the mobile Internet, advertisers will be able to send adverts to mobile devices. Fast-food outlets stand to gain immensely from mobile marketing and mobile ordering systems. According to Ankeney (2001), research indicates that a 6-second increase in transaction speed can boost a fast-food franchise's revenues by 1%, therefore being able to order fast foods on a mobile device before reaching the outlet could benefit both the consumer and the supplier.

CONCLUSION

This article has highlighted the fact that the Internet is a revolution. It has redefined the way that business is conducted. However, when one reads the media, people talk about e-strategies, e-business plans, and e-marketing plans among others. Businesses need to remember that the Internet has not captured the entire world population and therefore they need to serve those markets using traditional means. Furthermore, the Internet is just a new medium for conducting business across the globe. Therefore, sticking to basic principles of business, such as identifying customers needs, satisfying those needs, recovering cost, and treating the customer as a king or queen are still essential to business success. An e-marketing plan has to form a part of the marketing plan, which has to form a part of the overall business strategy. Electronic marketing is here to stay. Marketers need to embrace the trend and find ways and means to exploit it to the mutual benefit of the customer and the organisation.

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KEY TERMS

Customer Relationship Management: The use of technology especially databases that help customers profile individual customers in order to provide them with customized products and services.

Electronic Marketing: Conducting marketing activities on any electronic device, including cell phones, PDAs, laptop computers, and fax machines.

Internet: The Internet is the technology that facilitates global communication using computers. It is a worldwide system of computer networks in which any one computer can get information from any other connected computer linked to the Internet.

Internet Marketing: Conducting marketing activities on the Internet.

Market Research: An activity that is carried out to determine the potential customers who are willing and able to purchase a firms products or services.

Marketing Research: An activity carried out among existing customers to determine their level of satisfaction with the firm's products or services. Marketing research is also carried out to determine the effectiveness of a firm's marketing activities.

World Wide Web (Web): The Web is an application that runs on the Internet, and is a collection of electronic documents, or Web pages, that can be viewed on your computer using a Web browser. The words Internet and Web are used synonymously, although by definition they are very different.

The Evolution of Trust in Business-to-Business E-Commerce

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INTRODUCTION

E-commerce is defined as a means of conducting business electronically via online transactions among trading partners. Forrester Research predicted that B2B (business-to-business) e-commerce could be worth $5.7 trillion by the end of 2004. This study aims to examine the evolution of e-technologies and its impact on trust. Trust refers to reliance on and confidence in one's business partner (Mayer, Davis, & Schoorman, 1995). We discuss the evolution of e-technologies in light of the evolution of trust in technology trust (or transactional trust) and relationship trust or (relational trust). Electronic data interchange (EDI) was the prominent technology used in the 1970s and '80s. As we approached the 21st century and with the advent of the Internet, businesses feared that the lack of presence on the Internet would hinder their competitive and strategic advantages. Internet competition in most industries is forcing businesses to search for ways to improve product quality, customer service, and operation efficiency in supply chain management (SCM) in order to remain competitive. Today e-commerce has moved beyond EDI via value-added networks (VANs) by leveraging into the Internet and extending into Web technologies. The Internet is transforming and reshaping the nature of interorganizational commerce by enabling new types of interorganizational relationships. The business benefits include lower costs and more flexible systems that provide a facilitating structure for virtual relationships, enabling the easier identification of suppliers and products and more integrated supply chain management (Dai & Kaufmann, 2000). The Internet has impacted the SCM e-commerce environment by creating a centralized, global business and management strategy (e.g., make to order, assemble to order, and make to stock), and online real-time, distributed information processing to the desktop, thereby providing total supply-chain information visibility and the ability to manage information not only within firms, but also across firms and industries.

On the other hand, uncertainties, technical complexities, and concerns about trust have kept many firms from participating actively in B2B e-commerce. Uncertainties reduce the confidence both in the reliability of online B2B transactions and more importantly in the trading parties themselves. In a survey of 60 procurement trading partners involved in supply chain management at U.S. firms conducted by New York-based Jupiter Media Metrix Inc. in 2001, the findings indicated that 45% of the trading partners suggest a lack of trust prevented them from buying goods and trading online more frequently. In the next section we discuss the evolution of e-technologies, followed by its role in supply chain management and impact on trust.

THE EVOLUTION OF E-TECHNOLOGIES AND TRUST

We discuss the evolution of e-technologies from traditional EDI via VANs to Internet-based EDI, extranets, e-marketplaces, and Web services commonly used in supply-chain activities today. Further, we link these e-technologies and their impact on trust. The study provides a novel discussion on how management is affected by using e-technologies for SCM activities. More importantly, we discuss how the evolution of different types of e-technologies impacts the evolution of trust. The next section describes the e-technologies.

Traditional EDI via Value-Added Networks

The traditional EDI-via-VANs technology has been used for almost three decades and has brought its users significant advantages resulting in increased productivity and efficiency. EDI is defined as the computer-to-computer exchange of intercompany business documents and information through standard interfaces that requires hardware, software, and communications technology that permit computers to transfer the data electronically (such as purchase orders, invoices, shipping notices, and price lists).

Organizations that used EDI relied mostly on VANs and private messaging networks, both characterized by relatively high costs and limited connectivity. As an automated information exchange, EDI standardizes documents such as purchase orders, invoices, and shipping documents into an agreed-upon open-coded format. Connectivity to VANs was available only for large organizations that relied mostly on mailbox services. VANs were considered too expensive to implement, and smaller suppliers were pressured to adopt EDI (Langfield-Smith & Greenwood, 1998). Furthermore, recent research reflects reluctance on the part of traditional EDI trading partners to adopt the Internet due to the newness of the Internet technology, potential Internet legislations, the lack of Internet standards, and the lack of reliability and security of data transmission within the Internet environment.

Internet-Based EDI

Alternatively, Internet-based EDI, with significantly fewer implementation constraints, plays an important role in extending EDI benefits to a wider spectrum of businesses. Internet-based EDI differs from traditional EDI as it uses proprietary flat files in HTML (hypertext markup language) formats and it establishes two types of connections. The first is a direct connection that requires front-end translation software to transmit and display documents or interfaces with existing in-house application systems. Second is through a third-party Internet VAN (IVAN) that sets up a Web page to perform translations and exchanges among trading partners.

What was once cost effective for only large corporations conducting e-commerce in EDI format is today feasible for all organizations through Internet commerce applications (using Internet-based EDI, intranets, extranets, e-marketplaces, and Web services). E-technologies promote accessibility, availability, and universality, thereby allowing trading partners to interact with one another easily. Furthermore, the Internet provides smaller suppliers with an easy, inexpensive method of accessing data in addition to providing a ubiquitous reach and real-time access to information.

Extranets

Extranets are Internet-based applications that use standard protocols, middleware, and browser software to fulfill functional requirements and support supply-chain operations. Extranets serve as information communication technologies that integrate internal and external communications along the supply chain. The applications improve firm competitiveness by increasing the efficiency of internal and external communications and organizations, and by facilitating new and improved products and services. Furthermore, it is used to support information sharing among registered trading partners. For example, when orders come into an extranet system, the lead time for delivering the products is composed of order-processing times, material lead times, assembly lead times, distribution lead times, transportation times, and installation times.

E-Marketplaces

White and Daniel (2003) describe e-marketplaces as Web-based systems that enable automated transactions, trading, or collaboration between business partners. An electronic marketplace is an interorganizational system that allows participating buyers and sellers to exchange information about processes, products, and services in the supply chain. Furthermore, Bakos (1998) suggests that the key tasks of e-marketplaces are matching buyers and sellers, aggregating and facilitating buyers' demands and sellers' products, and acting as agents of trust.

Web Services

Web services are modular Internet-based business functions that perform specific business tasks to facilitate business interactions within and beyond the organization. They are flexible, decentralized, open, unmonitored, shared Internet-based applications that allow firms to create new products and services faster than existing methods that consist of the dynamic assembly of loosely coupled components (e-services, legacy data; Fieldman, 2002; Fonseca, 2002). Web services bring requesters, providers, and brokers together, thereby connecting people, applications, and data (Fieldman). They are primarily technical, enabling e-collaborations among value-chain partners. Web services promise to increase flexibility, agility, and competitiveness as well as opportunities to reduce development cost and time. Early adopters of Web services include high-velocity industries, such as insurance, financial services, and high-technology industries. These industries are viewed as a set of diverse trading partners (including suppliers and customers) working closely together in a highly competitive market that requires continuous innovation to maintain competitive advantage (Paratech International, 2001). In the next section, we discuss how e-technologies impact supply chain management.

The Role of E-Technologies in Supply Chain Management

SCM is a network of facilities that procures raw materials, transforms them into intermediate subassemblies and final products, and then delivers the products to customers through a distribution system. The Internet provides a platform for electronic inventory management, production planning, purchasing, distribution management, and payment systems (Anderson & Lee, 2003). For example, in the automotive industry, SCM involves balancing reliable customer delivery with manufacturing and inventory-management costs in order to effectively perform the order-fulfillment cycle time, inventory level, and cost. The main activities include material processing such as blanking, stamping, and information processing to forecast and plan production for each supplier, manufacturer, and assembler. Coordination among trading partners is critical due to interdependencies that include the shipment of steel sheets to the stamping plant and the shipment of doors, roofs, hoods, and minor parts. The overall objective is to minimize the inventory levels necessary to maintain reasonable order-fulfillment cycle times, taking into consideration the demand, process, and supply uncertainties across the supply chain. E-technologies also offer several secondary services including integrating the purchasing, distribution, and inventory processes, thereby streamlining the entire transaction process and allowing better inventory management, quality control, and supply chain management. Buyers experience effective e-procurement collaborative activities through better and more informed decisions in selecting suppliers and products, through superior planning and forecasting, and by obtaining more competitive pricing, better delivery terms, and higher product quality in the supply chain. Information on products, prices, businesses, and services in electronic databases are available to registered trading partners anytime from anywhere in the world. Furthermore, firms are using Web-based tools to make decisions and validate their trading partners (Domke-Damonte & Lensen, 2002). For example, Freightquote.com, a Lenexa provider of online freight management services, is using The Dun & Bradstreet Corporation in Murray Hill, NJ, to access the Global Decision Maker Web site for real-time recommendations on whether to grant credit. Therefore, both the internal and external integration of e-technologies is important for effective SCM. While internal integration involves interconnection with a variety of applications such as order entry, invoicing, billing, and payment transfers, external integration facilitates e-commerce transactions with trading partners such as suppliers, customers, government units, and financial institutions (Claycomb & Frankwick, 2004). Effective SCM and competition in the global economy demands trustworthy trading partners. In the next section, we discuss the role of trust in using e-technologies.

The Role of Trust in Using E-Technologies

The extant literature on relationship marketing defines trust as being that the partner's word is reliable and that a party will fulfill its obligations. Economists and sociologists have been interested in how institutions are created to reduce the anxiety and uncertainty associated with transactions (e.g., Zucker, 1986). Trust in general involves uncertainty and dependency, as online transactions and exchange relationships are not only characterized by uncertainties, but also by anonymity, lack of control, and potential opportunism, making risk and trust crucial elements of e-commerce. Relational marketing includes activities directed toward establishing, developing, and maintaining successful relational exchanges. Relational exchanges include supplier partnerships (goods suppliers, just in time, and total quality management), lateral partnerships (competitors, technology alliances, nonprofit organizations, government), buyer partnerships (ultimate customers and intermediate customers), and internal partnerships (functional departments, employees, and business units).

Institutionally based trust production uses formal mechanisms and does not rest on personal characteristics or on past history of exchange (Zucker, 1986). Similarly, Grabner-Krauter and Kaluscha (2003) suggest that one important reason for the importance of trust in e-commerce is the fact that in a virtual environment, the degree of uncertainty of economic transactions can bring about several risks caused by the implicit uncertainty of using open technological infrastructures for the exchange of information (system-dependent uncertainty), or can be explained by the conduct or behavior of actors who are involved in the online transaction (transaction-specific uncertainty).

We propose that in B2B e-commerce relationships, technical solutions and security services provide impersonal assurances that contribute to expectations, intentions, and behaviors. Behaviors and intentions (i.e., intentions to continue in the e-commerce relationship) is a predictor of actual behavior (i.e., relationship continuity). This is consistent with Zucker (1986): Technology trust can be viewed as a form of institution-based trust. It is created in an impersonal economic environment (without familiarity) with similarity (communality). Trust forms not because people know each other personally, but because institutional structures that are akin to policies, auditing, and recourse are embedded in the e-commerce technology. Hence, we propose two types of trust—technology trust and relationship trust—discussed in the next section followed by types of communications.

Technology Trust

We refer to this impersonal form of system trust as technology trust. Technology trust is derived from the security mechanisms and standardized, routine business processes embedded in e-commerce technologies. The foundations of technology trust are the technical safeguards, protective measures, and control governance mechanisms that aim to provide reliable transactions through standardized, routine processes and detective mechanisms embedded in the e-commerce technology. We define technology trust as the subjective probability by which organizations believe that the underlying technology infrastructure is capable of facilitating transactions according to their confident expectations.

Relationship Trust

Relationship trust refers to the conduct and behaviors of actors involved in online transactions. Relationship trust is defined as the subjective probability with which organizational members collectively assess that a particular transaction will occur according to their confident expectations. It is derived from the interpersonal component of e-commerce relationships. Behaviors reflect reliability, integrity, and dependability as well as knowledge and understanding of the e-commerce system. Unique to e-commerce relationships, relationship trust is evidenced when a partner makes available real-time information. Trading partners have access to supply-chain databases containing information such as demand forecasts, sales data, inventory data, production data, and distribution data.

What is Communications?

Morgan and Hunt (1994) suggest that a major precursor of relationship trust is communication, which is defined as "the formal as well as informal sharing of meaningful timely information between firms" (Anderson & Narus, 1990, p. 44). Previous research suggests that quality communication is related to satisfaction with the partner, intentions to continue a relationship, and a willingness to provide referrals (Morgan & Hunt; Sawhney & Zabin, 2002). MacNeil (1981) acknowledges that honest and open lines of communications encourage continued growth and close ties between partners. Furthermore, Doney and Cannon (1997) suggest that a focal firm may confer trustworthiness upon a partner through the provision of positive statements about its experience with the partner. Likewise, Anderson and Narus (p. 45) suggest a positive link between trust and communication, and noted that the "accumulation of trust leads to better communication." Morgan and Hunt suggest that effective communication leads to relationship commitment, defined as an exchange partner believing that an ongoing relationship with another is so important as to warrant maximum efforts at maintaining it.

Types of Communications

There are two forms of communication in e-commerce relationships, namely the transactional and relational components of communication. The transactional component of communication is reflected in the more formal and precise reporting of outcomes and results. Transactional attributes of communication include the accuracy, timeliness, adequacy, correctness, and credibility of information exchanged between the partners (Mohr & Spekman, 1994). We suggest that technology trust sets the stage for initial trust. From a transactional perspective, trust in the technology contributes to satisfaction, commitment, and intentions to continue.

In contrast, the relational component of communication is reflected in the bargaining and negotiation between the partners. Similar to the information-sharing and participation aspects of communication identified by Mohr and Spekman (1994), trading partners share information and engage in joint planning and goal setting. The intent is to engage in conversations that become increasingly revealing to set the stage for the reciprocal sharing of information and increased risk taking. The higher the trust the buyers have in their suppliers, the more they will be inclined to exhibit positive behaviors, keep promises, and show care and concern. We argue that the role of relationship trust supports a positive relationship evidenced by cooperation, information sharing, satisfaction, and commitment leading to relationship continuity. Similarly, previous research suggests that there is a positive relationship between trust and commitment (Doney & Cannon, 1997; Ganesan, 1994). Table 1 presents the different types of e-technologies applied in B2B e-commerce and links their impact on the role of management and trust.

CONCLUSION

This study explored the role of e-technologies in supply chain management and its impact on the role of communication for management and trust. The study contributes to theory by extending the existing literature on e-commerce and trust. Furthermore, the study also contributes to practice as e-commerce practitioners will be made aware of the evolving nature of technology, management, and the role of trust. Future research should aim to examine each type of e-technology in greater depth as multiple case studies in order to derive a generic model showing the link between the evolution of different types of e-technologies and trust.

Table 1. Evolution of e-technologies and trust

E-Technologies	**Role of Management**	**Impact on Trust**
Traditional EDI via VANs from 1970s onward	Focus on structural arrangements in the form of trading agreements, policies, and procedures for the governance of standardized, structured transactions. The focus is on implementing the transactional component of communication so that EDI messages can be transmitted in an orderly fashion.	Buyers are likely to experience high technology trust as the focus is on implementing compatible IT infrastructures to facilitate suppliers to send EDI transactions. Low relationship trust was experienced when the smaller suppliers were coerced to adopt EDI (particularly in the automotive industry) even though EDI was expensive and inflexible.
Internet-based EDI from mid-'90s onward	Focus is on implementing the Internet IT infrastructure that facilitates the integration of Internet-based EDI. The focus is on both the transactional and relational components of communications as trading partners need to be trained to use the Internet-based EDI application, in addition to formulating uniform standards of operations.	Buyers are likely to experience high technology trust as the focus is on implementing EDI with proprietary systems in HTML formats. Furthermore, buyers also make an effort to build their relationships, and they experience medium relationship trust as trading partners experienced a cost-effective manner of engaging in e-commerce.
Extranets in mid-'90s	Focus on training their registered trading partners on their product characteristics including asset specificity and complexity, in addition to building relationships. The emphasis here is on the relational component of communication as the buyer would like to lock its supplier for long-term relationships.	Buyers are likely to experience high technology trust as the focus is on implementing compatible technologies and training trading partners to use the system correctly. Furthermore, they are likely to experience high relationship trust as the supplier wants to retain the buyers by providing high-quality service. Buyers had to register in order to have access to the buyer extranet system.
E-marketplaces at turn of the 21st century	Focus on building relationships and implementing compatible systems in order to expand their market's situational characteristics such as bargaining power, liquidity, product availability, uncertainty, and trust. The focus is on the relational component of communication as buyers would like to retain their suppliers.	Trading partners are likely to experience high technology trust as the focus is in maintaining a compatible system to interact. Likewise, trading partners are likely to experience medium relationship trust due to the global reach in which trading partners have access to multiple buyers and suppliers.
Web services in the 21st century	Focus on providing quality services and relationship building in addition to the firm's characteristics that include e-procurement activities such as switching costs, and purchase formalization and centralization. The focus is on both the transactional and relational components of communication.	Trading partners are likely to experience high technology trust as the focus is on implementing compatible systems in order to facilitate online transactions. Likewise, they are likely to experience high relationship trust as service providers want to maintain and retain their trading partners for long-term investments.

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KEY TERMS

Electronic Data Interchange (EDI): The computer-to-computer exchange of intercompany business documents and information through standard interfaces, which requires hardware, software, and communications technology that permit those computers to transfer the data electronically (such as purchase orders, invoices, medical claims, and price lists).

E-Marketplaces: Web-based systems that enable automated transactions, trading, or collaboration between business partners. It is an interorganizational information system that allows the participating buyers and sellers to exchange information about prices and product offerings.

Extranets: Internet-based applications that use standard protocols, middleware, and browser software that fulfill functional requirements to support supply-chain operations.

Internet-Based EDI: An alternative to traditional EDI that uses proprietary systems in HTML format.

Relationship Trust: The subjective probability with which organizational members collectively assess that a particular transaction will occur according to their confident expectations.

Technology Trust: The subjective probability by which organizations believe that the underlying technology infrastructure is capable of facilitating transactions according to their confident expectations.

Web Services: Modular Internet-based business functions that perform specific business tasks to facilitate business interactions within and beyond the organization.

Category: Concepts, Trends, and Challenges

Evolution Stages in Web Applications

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INTRODUCTION

Among the many important contributions that information technology (IT) applications provide to organizations, Internet based applications may be considered the most important for strategic purposes, according to different authors like Porter (2001).

Initially, companies tried many different alternatives for using the great potential of the Web and a great number of completely new businesses that were enabled by the new technology. However, there were many failures (not only successes) and the situation has changed since the late 1990s. Thus, the time of experimentation is over and a business-oriented approach is required (Chen & Tan, 2004; Souitaris & Cohen, 2003). The Internet has indeed represented an opportunity, if properly used, for small and for big enterprises anywhere in the world (Drew, 2003; Kula & Tatoglu, 2003; Wresch, 2003).

This article describes the initial steps of an ongoing research that intends to compare the phases of Web dissemination in organizations with the adoption stages of traditional computer systems, based on Nolan's six stage model (Nolan, 1979). This approach could help describe and predict the integration of WWW into the work of organizations as well as provide a basis for improving management policies and decisions (Laurindo, Carvalho, & Shimizu, 2003).

Nolan's model (Nolan, 1979) is still an important and widespread known reference. In 1977, ARPANet (the network that gave origin to the Internet) had only 107 hosts (Ruthfield, 1995). This number increased to 317 million of hosts in January of 2005 (ISC, 2005).

This article is based in secondary data collection, some interviews with professionals from companies present on the Web, research on Web sites, in addition to a bibliography about the issue.

BACKGROUND

Nolan's Four Stages Theory

Gibson and Nolan (1974) presented a theory where the evolution of computer utilization was divided in four stages:

1. **Initiation:** New concept, exploring the possibilities of technology use.
2. **Expansion:** Some applications are developed. People are required for developments.
3. **Formalization:** Costs begin to be considered. Some effective controls are developed.
4. **Maturity:** The technology is being well integrated and managed.

The Six Stages of a Reviewed Theory

Nolan (1979) reviewed his pioneering theory and published a new study, showing the evolution of computer implementation in an organization as happening in six stages, and that is known as stages theory:

1. **Initiation:** When the first computers are purchased for labor reduction and reduce paper handling.
2. **Contagion:** When IT is expanded to other functions like invoice, inventories, and checks emission. There isn't, however, the concept of information integration.
3. **Control:** The growth of the use of information systems in the organization is explosive. IT department is professionally administered.
4. **Integration:** The restructuring demanded by the previous stage is completed in response to the pressure for better administration; information sys-

tems are guided to support needs of different managerial levels. Information has better quality as a direct result of centralization of the IT department under a single administrative structure and as a consequence of the use of databases management systems.

5. **Data Administration:** Is dominated by database technology. IT department recognizes that information is a very valuable resource that should be accessible by all users along the organization.
6. **Maturity:** Information is considered as patrimony of the organization. Users are active and responsible, and IT growth is planned and organized. Applications portfolio is complete and its structure reflects the organization and their information flow.

WEAVING THE STAGES

The introduction of the Web in companies has followed, in some way, a similar pattern established on Nolan's stage theory. As it is usually possible to take advantage of the structure and resources of preexisting IT applications, the first initial elementary steps are generally soon overcome. Web applications implementation usually begins when the company already can be classified in the integration stage of computer implementation (Anghern, 1997).

Seybold and Marshak (1998) establish that there are five stages for e-business initiatives: enterprise information (*brochureware*); customer support and interaction; electronic transactions support; customer's personalized interactions; and community promotion. Galliers and Sutherland (1994) defined six stages: *ad hocery*; starting the foundation; centralized dictatorship; democratic dialectic and cooperation; entrepreneurial opportunity; and integrated harmonious relationships. Anghern (1997) proposed the idea of four virtual spaces that companies would successively pass in the Internet: information, communication, distribution, and transaction. McKay, Marshal, and Prananto (2000) suggested a model named SOG-e (stages of growth for e-business), where the stages are defined as: no presence, static online presence; interactive online presence; Internet commerce; internal integration; and external integration.

This article proposes a classification that follows the same evolutionary classification, integrated with Nolan's stages.

Beginning the Weaving

The Internet's first use in companies is usually e-mail, a demand of personal and inter-organizational communication. Initially, own domains are not used, but access provider domains. However, as soon as own domain is registered, initiation in the Web begins, what usually happens timidly from isolated initiatives. Commonly it is made by IT professionals, since they know how to deal with the Web, and they can easily learn HTML.

Web pages are designed by professionals with technical, but no "artistic" skills. Thus, pages are usually visually poor, with graphic elements collected from other sites and with animation usually generating visual conflicts that are not always coherent when coupled with the presented content.

It is not just the form that doesn't adhere to company business. Also content often reflects the taste of the person that made the pages, with links to sites that are unrelated to company objectives and concerns.

Publication is usually made with several "under construction" areas awaiting information of other departments, which are never received, since executives of the company still do not clearly visualize or understand Internet potential (Evans & Wurster, 1999).

An example is the site of a small electronic manufacturer, which produces switching power supplies. This company sells as an OEM manufacturer and does not have final user customers. Many products are developed under customer specification and main clients are in the electronic products industry. This manufacturer has several product families, and its site (an own domain site) is a collection of static pages showing these products. There are no search engine or database queries to find specific characteristics. The page design can be considered adequate, with some appeal, although there are some "under construction" pages. The site is disconnected from the business: it is only a "show room". There are no private pages for specific customers and the only way to contact the company is by e-mail or phone.

Contamination

With the intensification of domestic and professional Internet use, companies and managers pay attention to the need for better site structure and for more accurate information. IT professionals are demanded for these requirements; however, they are not prepared to cope with these desires while simultaneously performing their habitual activities.

Each executive has his or her own idea of how to use the Internet. They start to understand the Web as a resource to generate financial incomes; although, it is not clear to them how it can be done. However, due to lack of coordination, no project really is able to achieve expressive results.

In order to implement the Web in a company, Internet training is provided to IT personnel; although, this, by itself, doesn't represent an effective site evolution for the lack of specific coordination. WYSIWYG software is adopted by IT professionals, which makes possible the visualization of pages independently of HTML knowledge.

One example is a nonprofit organization and partner of a university. It works in the industrial engineering field and has the following activities: specialization courses, consulting services, and quality certification. The site is a collection of several static pages with almost no user interaction. These pages work like an organization's services catalog, and it is hard to find what one is looking for. There is an electronic bulletin that is a Web copy of the paper bulletin published every three months. The only dynamic activity is student registration for the courses, but it is not connected with the internal ERP system.

Controlled Net

The recruiting of a Web master marks the beginning of a more professional approach of Net utilization. This professional is still subordinate to the IT department, but begins to work as an interface between the IT department and other business areas, particularly the marketing department, which identifies the Web as not just an information vehicle, but also a sales channel. By the first time, there is an effective interest with site's design. Sites development turned out to be considered a cost center and to be made by contracted companies as advertisement and/or design agencies. Meanwhile, the development of intranets is analyzed. It is still a turbulent stage, but objectives begin to be more clearly delineated. Some companies started to create their first visual identity and proceedings handbooks.

A possible example is the site of a producer of paper goods, as envelopes and letter papers. Its first site was developed in 1998 and just showed the address and an icon "talk with us". Its second generation was developed by an advertisement company, which defined a visual identity and created a user-friendly and visually elaborate portal providing news related to paper goods and also showing its products and specifications. Although the company sells only to re-sellers, the site is still not used as a B2B solution. However, the marketing department is pressuring the Web master to finish the development of one solution to sell using the Internet.

Net Business Integration

Company objectives are better defined. The site is developed and managed by professionals (Anghern, 1997). Many companies structured their own Internet department with Web designers, although developments are in agreement with advertisement agencies in order to establish a corporate communication identity. Coordination of this department is usually done by the marketing department. Flash technology use is intensified, with elaborate animations and programming resources integrated, in addition to dynamic pages, which makes interactive sessions possible. Depending on the company's activities, e-business sites are developed, such as virtual stores and Web EDI.

Intranets are more carefully developed, containing diversified information using resources of databases, such as procedures and manuals, product catalogs, documents relative to ISO 9000 series, as well as, according to company activity, some pages with internal news, like announcements of employee birthdays and trips or the arrival of new employees.

The next example is a large international power tools manufacturer, which makes products like chainsaws, line trimmers, and brush cutters. It has a well-structured site that is easy to navigate, with a full online catalog. There is general information like company history, customer services (as a safety manual), and other product orientation. A "tips and tricks" section has several interesting comments for final users like "tip of the month: the right way to plant fruit trees", showing that the company wants to "*capture*" clients' attention by publishing issues of interest to them, although there is no direct retail sale. It is possible to find dealers around the world. Some countries have a dealer of private communication for B2B (business to business) operation.

Web Data Administration

All Internet resources are already assimilated. Depending on the company activity, firms adopt B2C (business to consumer) and/or B2B (business to business).

In B2C, the most frequent utilization is virtual stores, which use complex procedures to guarantee that sales are securely made (Belanger, Janine, Hiller, & Smith, 2002). Stock availability and respective and continuous updating are included in these procedures; validation of credit cards; the "basket"; etc. Different technologies compete: internally developed, acquired, or obtained through alliances. Electronic auction is another form of B2C, where buyers can obtain desired products in specific sites. In B2B, there are several forms of relationships with members of a supply chain. Since the traditional EDI (electronic data interchange) based on Internet's resources and capillarity, until extranets, where business partners can be linked for orders emission; stocks inquiry; Web EDI; etc. There is an intensive dissemination of the use of data bases and XML language, what makes possible to share information and documents through the Web. Intranets are increasingly used in collaborative activities. Vertical portals, also known as e-hubs (Kaplan & Sawhney, 2000), allow wider relationships in the supply chain. They are vertical virtual markets, providing information and services for a specific industry (Christiaanse, Diepen, & Damsgaard, 2004).

Big B2C companies are representative examples. Many of them were born during the Internet boom. All these companies are working in a similar way. The graphical interface is absolutely friendly, and usually, it is very easy to find the desired product. The customer can choose a product from a catalog where he or she can also see the stock quantity, put it in a "basket" together with other products, and the system calculates the final price, including freight. The system is able to notify the customer when the goods will be delivered and provides the customer with step-by-step e-mail notifications of what is happening with his or her purchase order (like credit approved, stock picking, in dispatch, etc.). Some similar sites do it so automatically that there is no tneed to show options for asking questions. The system manages everything.

Web Maturity

The slogan of Web maturity could be "everything by Internet, from any place, at any moment." It is not just for allowing database access, or for purchasing orders emission, but for truly managing via the Web. Applications are totally based in application service provider (ASP), which are organizations that host those applications, making possible their use for several companies that pay a fee for the time used. They are accessed through the Internet, mainly by the use of VPN (virtual private network), a kind of virtual net. Applications are based on Web technology. XML language and .NET technology (from Microsoft) are widely used. This resource allows systems like ERP to be shared, not just inside of organizations, but also selectively, by partners of the value system.

An example is the site of one of the biggest hospitals in Brazil. The site was launched in 2004 with the goal of offering services to hospital users and providing support for its doctors. It is easy to navigate, with good flash animations. Using it as a service for hospital users, he or she can obtain exam results using a password defined when he or she goes to the laboratory. The doctor can read the results at any time from any place to provide more efficient care.

On the subject of preventive care, users can learn which steps to follow in order to be prepared for exams, like the length of a fasting period or the duration of a urine collection, for example. Regarding materning, there is e-learning for pregnant women in order to prepare them for childbirth. It is possible to access a Web TV with movies, which uses a laical language where the user can not only learn about diseases and their corresponding treatments, but also see interviews with leaders and other personalities. The intranet is a good complement for the site. From the intranet it is possible to control in real-time the beds on hospital rooms. It is possible to know if a bed is occupied or not and if the patient is being fed, etc. Also by intranet, doctors have access to a phone book and e-mail addresses of colleagues with information including whether he or she is working in the hospital and his or her position in the building.

All administrative controls are ERP based and on the intranet. Besides, they can be accessed by authorized people. Intranet is not only accessed on LAN, but also by hospital employees from any where using the Internet.

FUTURE TRENDS

Mobility is the key word. Wi-Fi solutions are disseminating, with hotspots covering wide areas and technological convergence of equipments that combine all kind of communication resources. They provide access to the Internet not only from any place, at any moment, but also by any kind of wired or wireless connections (Mennecke & Strader, 2003).

The growth of the Internet makes possible knowledge accumulation in an almost limitless way. No other media can do that. Thus, this will be the Web's greatest role: to serve as a constant and permanent knowledge accumulator.

Meanwhile, another important front for Internet expansion will be e-government, which encompasses income tax declaration, filling in documents, registration, online reverse auctions, among many other different and increasingly available applications. The Internet has enabled a more service-oriented approach to government activities. In addition, in the near future, other possibilities, like elections via the Web can even assist citizens in participating in political activities (Steyaert, 2004; Tapscott, 2001).

CONCLUSION

The Internet, according to Porter (2001), is the most important IT platform to emphasize a distinctive strategy. The different phases of its use in organizations can help one to understand how to use it successfully. However some authors, like Tapscott (2001), understand that the Internet revolutionized the way business is performed.

This article discussed of the idea of a stage model for Internet use.

Nolan's stage model faces some criticisms, like Smithson and Hirscheim (1998), which consider this model to be poorly action oriented and classify it as only a diagnosis tool. But in a turbulent environment like that of modern markets, an analytic tool that can quickly provide good insight into and understanding of a company's situation can be a powerful aid to correct both operations and strategy orientation. This is the potential of the application of the stage model in Web utilization.

The model proposed in this article should be further observed in future empirical studies, which would allow for its enhancement and refinement.

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KEY TERMS

B2B (Business-to-Business): Business made electronically (mainly by Internet) between companies by the selling or purchasing of goods or services. It includes the data interchange.

B2C (Business-to-Consumer): Is the retail selling made via the Internet.

E-Business: "Electronic business", or a business made via the Internet, not only selling or buying, but also supporting customers and connecting the supply chain.

E-Commerce: "Electronic commerce" means selling and buying of products and services via the Internet.

EDI: "Electronic data interchange". A standard message layout used on computer-to-computer commercial data interchange. Traditional EDI uses an electronic method called VAN (value added network). However, it is increasingly adopting Internet protocol.

E-Hubs: Virtual markets among companies (B2B marketplaces or B2B information brokers).

Information Technology (IT): Is the comprehensive and diversified set of technologies for information processing, as software, hardware, and telecommunications.

Web EDI: Is the "electronic data interchange" made through Internet Web pages.

Web TV: Are movies, interviews, or shows transmitted via the Internet.

Category: Concepts, Trends, and Challenges

Exploiting Public Sector Information through Innovative E-Government Policies

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INTRODUCTION

The digital, knowledge-based economy (European Commission, 2003a) has a strong impact on the life of all citizens at the global level. Under suitable terms and/or appropriate conditions, it can be a powerful "engine" for growth, competitiveness, and jobs, while at the same time it improves living standards.

The multiplicity of innovative Information Society (Dutta, Paua, & Lanvin, 2004) tools has led to unprecedented possibilities to combine data taken from different and various sources into added-value products and services. To this perspective, public sector information can be an important "prime" material for relevant applications.

For the specific framework of the European Union (EU), the public sector information (European Commission, 1998) plays a very important role in its social and economic models by supporting high levels of welfare for citizens, ensuring socioeconomic cohesion, and sustaining the functioning of a competitive and fully liberalized market environment. In particular, the public sector engages in a wide range of activities, varying from education, healthcare, and social security, to protecting consumers and strengthening the environment. Consequently, financial and business information is collected by a number of ministries and other appropriate organizations.

Company registers, usually required by law in many Member States, are also maintained by the public sector. Legal information (in particular concerning legislation and jurisprudence) and administrative information constitute another example, while patent offices are usually public sector bodies. Scientific, technical, cultural, and medical information is extensively collected by public research institutions and public archives. Geographical information relevant to transport and tourism (e.g., maps, road traffic situation) is also available in corresponding public agencies. Furthermore, tourist information is gathered and published by public sector bodies at different levels of government.

Learning how to manage and to exploit all relevant information produced and stored could create a very high level of public value (and this is probably an unavoidable step towards a future user-centered government). Even greater potential benefits can result if governments, authorities, and/or organizations actively participate in the development of the knowledge-based society, in the true sense to create public-shared spaces for the creation and the delivery of various forms of "knowledge."

However, today there are still some "barriers" preventing the full "exploitation" of public sector information at the European level. These may originate from diversities either in language or in pricing issues, or in (administrative) rules and/or practices, such as differences in replying time, the refusal to transmit the information in digital format, the need to prove that the information is not limited by data-protection rules, and exclusive deals that already exist between public and private firms.

In fact, Europe's public sector (Cap Gemini Ernst & Young, 2004) is today at a crossroads, in front of numerous global challenging conditions, institutional change, and the profound impact of new technologies in a background which evolves very rapidly. Expectation is growing that, as it is a major economic performer for boosting growth and innovation, the public sector can (and will) play a strong role in realizing the Lisbon strategy (European Commission, 2000; European Council, 2003) for economic, social, and environmental renewal. It should be expected that the public sector would become more productive, cut the "red tape," eliminate queues, and offer services of improved quality.

Simultaneously, the European public sector will, over the next decade, undergo a number of transitions (such as increasing cultural and religious diversity, aging of the population, and changing living, working, and consumption patterns) that will require new services as well as innovative ways of delivering the existing ones. In particular, the public sector should "close" the demographic deficit, restore democratic ownership, and cope with demographic change (e.g., aging, immigration, etc.). Other perspectives may be relevant to safeguard liberty, justice, and security. The public administrations are now facing (with a medium- to long-term time horizon) very power-fully the challenge (DG Information Society of the European Commission, 2001) of improving the efficiency, productivity, and quality of their offerings, to respond to all the forthcoming needs and demands. This may result in new ways of delivering services to citizens and businesses while coping with various domains, especially if considering initiatives to extend the internal market and to deepen convergence in enlargement (OECD, 2003; IDA eGovernment Observatory, 2002; Chochliouros & Spiliopoulou-Chochliourou, 2003a). This option also implicates special perspectives such as identity management, advanced public electronic services, deployment of dynamic and personalized services, and exploitation of innovation in technology.

BACKGROUND

The initial concept of electronic government (e-government) took off a few years ago, mostly as the "*mirror image*" of electronic commerce (e-commerce) in the public sector. However, the e-government has now become an explicit component of public sector reform as a fundamental instrument to increase efficiency, strengthen competitiveness, and enhance modernization.

In particular, e-government can be now estimated (European Commission, 2003c) as: "…the use of information and communication technologies (ICTs) in public administrations combined with organizational change and new skills in order to improve public services and democratic processes and strengthen support to public policies."

Experiences and up-to-date practices have very clearly demonstrated that relevant activities can refer to a great diversity of functions (European Institute of Public Administration, 2003), including, *inter-alia*:

- Electronic public services (e-services) to end-users, either citizens or corporate businesses; these could include applications, facilities, and/or additional electronic features related to government *online* presence/access and the provision of *online* services, customs' services, value-added taxes, *online* job search, *online* requests for personal documents, *online* book search in public libraries, and so forth.
- Electronic procurement (e-procurement)—that is, the means for the realization of *online purchases*. The adoption of electronic public procurement systems is driven by the need to reduce costs and favor purchases in large volumes, thus limiting the number of contracts. Although such an option can be occasionally included in e-services (as a specific modular component), it may follow completely different implementation dynamics. In fact, it is currently promoted by higher-level administrations and typically requires considerable internal government reorganization. Early experiences seem to suggest extra benefits in terms of cost savings and improvement of transparency, however there are still strong "resistances" by local stakeholders, threatened by the concentration of purchase activities and other constituencies.
- Electronic democracy (e-democracy), in a way to support the genuine participation of citizens in politics. Although still in its "infancy" and at elementary levels (with some pioneer experiences especially in northern Europe), e-democracy formulates a very promising expectation for the future.

E-GOVERNMENT AS THE "VEHICLE" FOR EXPLOITING "PUBLIC VALUE"

In fact, e-government implicates the use of emerging technologies to transform public administrations and to improve radically the way they work with their customers, be they citizens, enterprises, or other administrations. The e-government is now a key vehicle for the implementation and achievement of "higher policy" objectives. It is unlikely that relevant objectives on the single market freedoms, industrial policy, liberalization and competition, sustainable development, and security across the EU can be achieved (Chochliouros & Spiliopoulou-Chochliourou, 2003a) unless such interoperable services are swiftly implemented.

This places e-government at the "core" of public management renovation and reform, where technology is used as a strategic tool to modernize structures, processes, the regulatory framework (Chochliouros & Spiliopoulou-Chochliourou, 2003b), human resources, and the culture of public administrations to provide better government and, ultimately, increased "public value."

The creation of public value is a broad term that includes a multiplicity of democratic, social, economic, environmental, and governance roles. Some quite indicative but concrete examples may refer to: (a) the provision of public administration and public services (such as health, education, and social care); (b) the development and the implementation of policies, accompanied by an appropriate regulatory framework to reflect real market needs; (c) the supervision and the management of public finances; (d) the guarantee of democratic political processes, gender equality, social inclusion, and personal security; and (e) the management of environmental sustainability and development.

The target for the provision of better government depends on a variety of factors including, but not limited to, existing and developing governmental structures and processes, cost benefits and reductions, effectiveness, improved quality of services, accountability, transparency and openness, and greater participative governance and adequate accessibility, especially to avoid "digital divide" events (Department of Economic and Social Affairs of the UN, 2003).

In particular, present challenges are focused on opportunities to design, apply, and exploit methods, means, and/or other "tools" essential for new public management activities, especially focusing on the centrality of users' needs. Core drivers of such a revolutionary process could be: (a) the need to improve efficiency, productivity, and quality of public services without increasing budgets; and (b) the need to satisfy citizens' expectations of new standards of service provision allowing flexibility, personalization, and full availability, as in the private sector.

It becomes evident that e-government can be a "catalyst" to realize a more efficient administration, transforming the "balance of power" between government levels (supranational, national, regional, local) and functions. So it improves the development and implementation of public policies and helps the public sector to cope with the conflicting demands of delivering more and better services with fewer resources. While technology cannot transform "bad" procedures into good "ones," e-government creates the *choice* for the public sector to do its tasks differently. Therefore, electronic government marks "the most dramatic shift in governance in generations and offers a fundamental restructuring of the way government operates and interacts with citizens" (Holmes, 2001).

OPTIONS FOR STRUCTURING THE NECESSARY UNDERLYING PREREQUISITES

All fundamental related activities are currently built on two main but interrelated developments. The first can be estimated as the business models adopted in the recent past by the (private) enterprise sector. These were largely concerned with obtaining competitive advantage by diverse activities such as continuous process improvement, a focus on core competencies, and the reorganization of internal processes. The public and their political representatives now expect public administration to be as efficient, fast, and effective in achieving its goal, as is the private enterprise sector.

The second domain of activities is related to the effective use (Wauters, 2003) of a wide range of information and communications technologies, of which the Internet is the most "visible." The combination of advanced ICTs in the support of new ways of working in public administration, together with the "enhanced" provision of information and interactive services, accessible over different "channels" and infrastructures, is the foundation of e-government. This vision is very exciting as it progresses beyond the "simplistic" image of communication technologies, considered as "tools" for an additional delivery channel of public services. On the contrary, it constitutes a new vision of the role of government, which exploits the potential of technical innovation, without falling in the trap of any particular technological determinism. Modernizing government through ICTs is not the only driver of change in the public administration. The whole socio-political system is shifting, to incorporate new and innovative options of the evolution performed. This "variable geometry of power" scenario lends credibility to the perspective of an increasingly networked government.

In essence, interoperability between infrastructures, facilities, applications, and equipment is a fundamental requirement (European Commission, 2003b), from both the economic and technical perspectives, for the development of efficient and effective services at both the pan-European and national levels (also including the regional and local ones). Interoperability is not simply a technical issue concerned with linking up various systems; it goes beyond, to include the sharing of information between networks and the reorganization of administrative processes to support the seamless delivery of e-government services. Such a framework, which can be defined as the "wider" set of policies, standards, and guidelines describing the way in which organizations have agreed, or should agree, to do business with each other, is to provide the specifications and the guiding principles for joining together the information systems of public administrations across the EU.

FUTURE TRENDS

Apart from intergovernmental relationships (also including the local, regional, national, and EU dimensions), all principal applications currently refer to government-to-citizens (G2C) and government-to-businesses (G2B) relationships. Citizens and enterprises can greatly benefit from a sophisticated provision of various forms of public sector information on Internet-based platforms and infrastructures.

Making public sector information online available for reuse (where allowed and always under the specific requirements imposed by a proper legal framework) enables businesses (also including small and medium-sized enterprises (SMEs)) to develop attractive and competitive offers. Meanwhile, a minimum "set" of common rules could take away investment failures and most part of any probable uncertainty, to enhance the offering of suitable products.

Current trends (IDA eGovernment Observatory, 2002) promote the need to incorporate, in the delivery chain, a growing number of "intermediaries," which will play an increasing role in the delivery of public services and will ensure openness and competitiveness. Services, however, should be addressed to the citizen-centric, especially in terms of availability, usability, flexibility, and pricing.

Citizens are becoming accustomed to ever-faster response times and ever-higher quality of products-services from the private sector (OECD, 2003). Consequently, they expect to have the same (or similar) levels of performance from the public administrations. Obscure procedures, long queues, having to re-enter information that is already held by the administration, and "one-size-fits-all" approaches are all practices that are increasingly criticized. In order to face the appearing challenges (Millard, Iversen, Kubicek, Westholm, & Cimander, 2004), public service provision should be expected to become more user friendly and personalized, adapted to the specific needs of the individuals. Moreover, it needs to be "inclusive," and all citizens have to be adequately served, independently of their skills and capabilities, income, or geographical location. The public sector cannot "choose" its clients, contrary to the private sector (nor can the public usually choose whether or not to be clients of the public sector).

The e-government evolution should also address the needs of enterprises for reducing cost transactions, supporting competition in a global economic environment, and increasing speed, simplicity, and scalability. Meanwhile, the promotion of fair-trading and appropriate pricing schemes in the market(s), in order to guarantee a minimum of certainty and transparency, will be a principal factor to forward an efficient penetration of e-government. In order to respond, *properly,* to the forthcoming challenges, the enterprise sector should, with appropriate support from the EU authorities, develop fully interoperable e-business solutions.

Interoperability, therefore, for both public and enterprise sectors, will be at the heart of all the suggested policies. This implicates combined considerations at various levels, such as: (a) the technical level, which is concerned with technical issues of linking "Internet-type" technologies and systems, the definition of "open" interfaces (with appropriate standards and specifications), and realizing communications; (b) the organizational level, which deals with modeling business processes, aligning information architectures to organizational goals, and helping business processes to cooperate, to extend their activities, and to include suppliers, (business) partners, and customers; and (c) the semantics level, which is concerned with ensuring that the precise meaning of exchanged information is understandable by any other relevant application; this also entails agreement on, for example, ways to discover, represent, and give context to information, and it will allow automated tools to share and process data, even when they have been designed independently.

Citizens and businesses expect authorities to become more accountable for the management of their financial contributions and taxes to the state. They also demand more transparency of decision making (especially in the fight against corruption and fraud) and democratic involvement in all phases of policy development. More specifically, through online forums, virtual discussion rooms, and electronic voting, citizens can be able to express their views, directly question the decision makers, and so contribute with an informed opinion to the democratic process.

This constitutes an improvement towards more transparent, accountable, and open public institutions.

To ensure creation, development, and implementation of appropriate e-government- based services (Millard, 2003), the latter should be accompanied by joint actions to build up experience and validate advanced solutions for profitable collaborations. This concerns common approaches to key aspects of seamless pan-European service provision such as accessibility, user identification, security, interoperability, also including data definitions and procedures. As far as appropriate, pan-European e-government services should be integrated and interactive.

CONCLUSION

Public sector information covers a great variety of activities, while its improved use could turn all relevant resources into a valuable asset for European citizens, businesses, and administrations alike. In particular, with the advent of the Internet, governments have started exploring how they can maximize the value of their information resources.

Consequently, numerous recent European initiatives have been focused on stimulating services, applications, and content that can create new markets, reduce costs, and eventually increase productivity throughout the economy. In such a complex environment, electronic government can be a significant factor, mainly to promote solutions for an effective exploitation of the disposed information. The expected development encompasses the provision of better public administration; more efficient, transparent, open, and participative governance; and the implementation of more democratic political processes.

E-government has emerged as a means for improving government, and ultimately, for increasing public value (Centeno, van Bavel, & Burgelman, 2004). However, clearer understanding on how, and in what areas, can efficiently contribute to maintain and strengthen good governance in the knowledge society. In particular, recent development is now entering a new phase, fully characterized by the "re-engineering" of governmental processes, at all possible levels of administration, for better treatment of information.

E-government should have a strategic focus: the complete achievement of the "Lisbon goals" for realizing an appropriate "electronic Europe" capable of sustainable economic growth, and ensuring that businesses and citizens derive the maximum benefit from any progress in ICTs (European Commission, 2000; European Council, 2003). This will also contribute to the reduction of barriers to the internal market for services and mobility, effective implementation of national policies, and broader regional or local development.

Moreover, e-government should be oriented to satisfy user needs in two parallel options: (a) for living, working, and doing business; and (b) as "users" of administrative services, as taxpayers, and as interactive participants in democracy.

Public administrations can provide major key contributions to improve Europe's competitiveness, growth, innovation, and employment rates, as well as social cohesion (European Commission, 2001b).

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KEY TERMS

E-Democracy: The utilization of electronic communications technologies, such as the Internet, in enhancing democratic processes within a democratic republic or a representative democracy. It is a political development still in its infancy, as well as the subject of much debate and activity within government, civic-oriented groups, and societies around the world. E-democracy also includes within its scope electronic voting.

E-Government: The use of information and communication technologies in public administrations, combined with organizational change and new skills in order to improve public services and democratic processes, and strengthen support to public policies.

E-Procurement: The means for the realization of *online purchases*, by using appropriate electronic communications services and infrastructures.

Information and Communication Technology (ICT): A sector including a great variety of technologies such as desktop and laptop computers, software, peripherals, and connections to the Internet that are intended to fulfill information processing and communications functions.

Interoperability Framework: Not simply a purely technical issue concerned with linking up various systems, but the "wider" set of policies, measures, standards, practices, and guidelines describing the way in which various organizations have agreed, or should agree, to do business with each other.

Knowledge-Based Economy: A form of modern economy referring to a specific structural transformation, where the fast creation of new knowledge and the improvement of access to various knowledge bases increasingly constitute the main resource for greater efficiency, novelty, and competitiveness.

Public Value: Any form of value created by governments though the provision of services, the passing of laws and regulations, and other actions. It also involves all the short-term and long-term contributions made by public administrations to society and the economy. Furthermore, it includes efficiency gains by better internal performance and, most importantly, the multiplier social and economic effects such as: (1) social development and inclusion, (2) enabling companies to lower their administrative costs and become more competitive, and (3) strengthening innovation across the economy.

Failure of Furniture.com

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INTRODUCTION

The growing U.S. furniture and home furnishing market is highly segmented (Bransten, 2000). Although many large manufactures and retailers have 100 years or longer history in this industry, none of them dominate the market.

In the e-commerce boom starting from mid 1990s, many companies began to use the Internet as a new channel selling furniture to customers. Among those new online furniture businesses, some were traditional furniture retailers setting up a Web site as an additional channel reaching customers, and others were pure-play e-tailers, owning only online presences but no physical stores.

This article traces the history of furniture.com, a once-famous pure-play retailer in the furniture retail industry, and analyzes the reasons of its failure theoretically. We believe that the narrative and the analysis will provide valuable insights for pure-play e-tailer managers from many aspects, including product selection, online and offline services, and management of relationships with suppliers, etc.

THE HISTORY OF FURNITURE.COM

A Start-Up Backed by High-Profile Financial Institutions

In June 1998, Steve Rothschild launched furnituresite.com. In November 1998, Andrew Brooks replaced Steve Rothschild as CEO and changed the name of the company to furniture.com in January 1999. Furniture.com funded $13 million in the first round of financing in June 1998 (Sandoval, 2000). In the following year, the company successfully carried out its second and third round of financing, which brought the total capital raised to more than $50 million (Cox, 1999B).

Products and Services

Furniture.com was a pure-play furniture e-tailer, owning only online store but no physical stores. According to SEC filing, furniture.com offered furnishings for every room, as well as outdoor furniture, mattresses and accessories. It offered products from over 200 manufacturers. Furniture.com had no inventory or warehouses and its products were delivered to customers directly from manufacturers.

Furniture.com was one of the leaders of online service revolution. It attempted to use Internet-related technologies to improve customers' online experiences. It provided an excellent cyber magazine about decorating that is comparable with print offerings such as Home. Furniture.com Web site also offered customers with personalized newsletters and personalized Web pages. Another feature on furniture.com was instant messenger. When customers shopping online had any questions about furniture or decoration, they could reach an online expert design consultant and ask specific questions (Mullaney 1999, 2001). The Web site enabled customers to create a drawing of a room and then drop furniture into it to visualize how well the furniture will work. Offline, furniture.com provided free delivery and set-up through a Red-Carpet Program.

However, some of these online features were not implemented as promised. Customers complained that the consultants behind instant messenger often could not give feedback instantly, and sometimes gave answers that seemed like they did not read and understand the questions entirely, likely due to dealing with too many customers simultaneously (Mullaney, 1999). As far as offline operations went, furniture.com got many complaints about late delivery and missing merchandise. In April 2000, it canceled its free shipping and charged a flat $95 shipping fee for all purchases (Iovine, 2000).

National Brand Name Campaign

In spring 1999, furniture.com launched a $5 million-plus national brand name advertising campaign inviting customers "to love their rooms" with help from "the best way to shop for furniture" (Cox, 1999A). The campaign consisted of three ads airing on radio stations and in daily newspapers in over a dozen of the largest metro markets in the U.S. (Cox, 1999A). The ad launch was the first element in a major brand building program, which furniture.com planned to invest "tens of millions of dollars" in offline and online adverting, strategic partnership, and other marketing initiatives (Cox, 1999A).

In the national brand name building campaign, furniture.com signed marketing alliances with AOL, Yahoo!, GO Network, and affiliated marketer Be Free Inc (Cox, 1999D). In July 1999, it signed advertising agreements with Lycos and MSN, in which it secured presence on the MSN Shopping site and placed banner advertisements on MSN Home Advisor and Women Central. It gained presence in the Real Estate, Home, Business, and Arts and Entertainment areas on Lycos. Under the agreement, furniture.com also gained a significant presence on HotBot, as well as other Tripod communities (Cox, 1999E).

In August 1999, furniture.com appointed the New York office of British advertising agency Bartle Bogle Hegarty to handle its U.S. brand building advertising account. This time the spending "easily eclipsed" the $5 million radio and print campaign it ran that spring (Cox, 1999C). In October 1999, furniture.com introduced George the cat, "the world's toughest furniture critic" as the icon of a $20 million integrated national branding campaign (Cox, 1999F). Furniture.com's advertisements aired on NBC, CBS, and ABC as well as HGTV, E! Entertainment Television, and other cable stations. In print, the ads appeared in shelter, lifestyle, and weekly magazines; and in national and general market newspapers (Cox, 1999F).

The Failure of IPO and the Bankruptcy of Furniture.com

In January 2000, furniture.com filed with Securities and Exchange Commission for an initial public offering (IPO). The offering was initially led by Goldman, Sach & Co. Although furniture.com had a loss of $43.7 million on sales; $10.9 million in 1999, the company expected to raise a maximum of $50 million according to its SEC filing.

In March 2000, Goldman Sachs dropped out of the IPO. Due to the unfavorable market situation, furniture.com withdrew its planned IPO in June. Three days later after the withdrawal, furniture.com slashed its work force by 41%. A spokesman said 80 employees lost their jobs and the layoffs were "part of an overall program to reduce costs and accelerate furniture.com to profitability" (Enos, 2000).

After it canceled the original planned IPO, furniture.com turned to a new round of private financing and got $27 million from CMGI. In CNET news in July 2000 (Sandoval, 2000), a former employee in furniture.com described the situation at that time: "In a desperate attempt to impress potential investors, the e-tail company staged an elaborate show in May for two Idealab executives taking a tour of its headquarter in Framingham, Mass. Accountants, human resources workers, and engineers were ordered to sit in the company's call center and "look busy" helping imaginary customers while speaking into dead phone lines." Such theatrics paid off temporarily. A month later, furniture.com managed to stave off bankruptcy by the narrowest of margins after receiving $27 million from CMGI, Bessemer Venture Partners, and other investment companies (Sandoval, 2000).

Despite the success of private financing, the company ceased operations and entered Chapter 11 bankruptcy because of lack of funding and a harsh market only three months later in November 2000 (Enos, 2000).

The Businesses of Other Furniture E-Tailers

The collapse of furniture.com was not solitary. Its other two strongest competitors HomePortfolio.com and Living.com shut down before furniture.com did so.

In an article in Home Office Computing in March 2001 (Syarto, 2001), five online furniture Web sites were recommended as stable furniture sites. Three of them were running on the bricks-and-clicks model. Those surviving pure-play furniture e-tailers are mentioned as having a "well thought-out customer service model." While most pure-play furniture e-tailers dropped out, traditional furniture retailers began to take a phased approach to the Internet. They first provided product information and gathered customer data, and later began to sell products online. One of the successful cases has been Ethan Allen.

Failures of Furniture.com in the Press

The failure of furniture.com received a lot of attention in the press. Some articles were about complaints from furnitures.com customers. The customers complained that design consultants supporting the Web site could not answer messages as quickly as they promised. More importantly, customers experienced painful problems such as late delivery and missing parts when making purchases from furniture.com (Mullaney, 2001). From the industry perspective, some commentators felt that furniture and home furnishing e-tailer chose wrong items to sell online since furniture purchase is infrequent and high-priced, and most furniture is too big to be delivered through UPS. Moreover, a Web site cannot be touchy-feely and so customers cannot bounce on a mattress, for instance, when they make a purchase decision. Weak back-end office and a flawed business model are also causes for the failures. Another reason mentioned was too much spending on marketing and information infrastructure (Sandoval, 2000).

Rebirth of Furniture.com

At the time this article is written, five years have passed since the bankruptcy of furniture.com. During this period, furniture.com has been reincarnated and back to business. A group of former employees bought the domain name in October, 2001 (Sandoval, 2002). Carl Prindle, a senior vice president for the former furniture.com, assumed the president of the new company (Cox, 2000G). Furniture.com was re-launched in April, 2002 with a new business model (Regan, 2002). The company planned to form alliances with experienced furniture stores and its first two partners were Seaman's Furniture and Levitz Home Furnishings, two of the largest furniture retailers in U.S. The new furniture.com attempted to take advantage of their partners' marketing support, production, and distribution capabilities. The company also turned to click-and-mortar from pure-play business model. Customers of the new site can enter their zip code and then only products available in the near area will be shown on the Web site, ensuring fast furniture delivery. The descriptions and analysis in this article are restricted to the furniture.com that went bankruptcy in 2000.

THEORETICAL ANALYSIS OF FAILURE OF FURNITURE.COM

First of all, furniture.com failed because it entered an unattractive industry. The $60 billion-a-year U.S. furniture retailer industry is fragmented and difficult to manage (Bransten, 2000). Michael Porter provided a five forces framework that can be used to analyze an industry's relative attractiveness from five different dimensions, including the bargaining power of customers, the bargaining power of suppliers, the potential new entrants, the substitute products or services, and the intra-industry rivalry (Porter, 1980). Analyzing the pure-play retailer furniture industry based on the five forces model, we find that it is not an attractive industry (see Figure 1, Porter's Five Forces Model for furniture.com). First, the bargaining power of customers is high. Most people buy furniture infrequently and they have many choices. Second, the bargaining power of suppliers is high. Most furniture manufacturers have their own distribution systems in place and do not have the desire to incorporate new online e-tailers into their established distribution chain. Third, although there are no substitute products for furniture from the product stand point, there are substitute services that allow customers to shop for furniture in different ways. If customers are not happy with pure-play furniture e-tailers, they can easily turn to traditional furniture stores or click-and-mortar furniture retailers. Fourth, the entry barrier is low and the potential new entrants are numerous. At the time of e-commerce boom, both traditional and new start-up e-commerce furniture retailers were trying to enter the online furniture market. Fifth, the intra-industry rivalry is severe both in terms of the online furniture retailer industry or the general furniture industry. During the time that furniture.com was in business, there were several other high-profile furniture e-tailers running with the same business model, including living.com and HomePortfolio.com. These two companies also filed for bankruptcy in late 2000 (Enos, 2000). Even some established traditional furniture retailers had difficult time. Bransten (2000) reported, "Heilig-Meyers Co., a big furniture retailer, filed for bankruptcy-court protection from creditors in August 2000. Restoration Hardware, Inc. a home furnishings chain based in Corte Madera, Calif., slumped in September 2000."

Figure 1. Porter's "Five Forces Model" for funiture.com

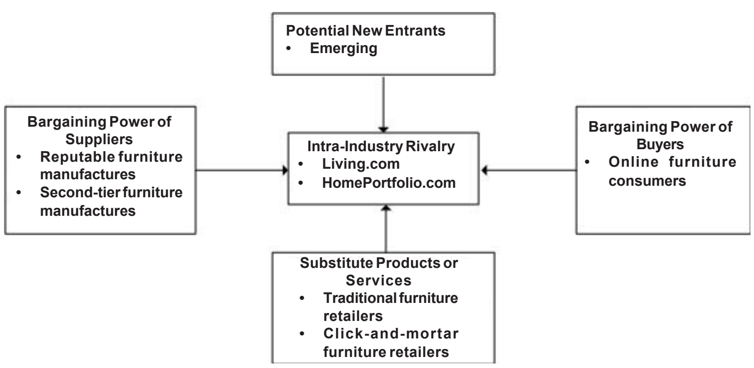
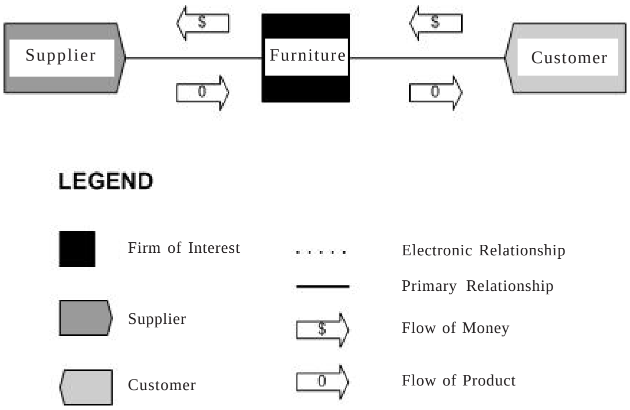


Figure 2. Direct-to-customer model—Furniture.com (Adapted from Perter Weill and Michael R. Vitale, Place to Space, Migrating to Ebusiness Models. Boston: Harvard Business School Press, p. 109, 2001.)



Second, furniture.com failed because it did not succeed in teaming up with reputable furniture manufactures. Afuah and Tucci (2001) proposed a framework for strategies of building business models for e-commerce. According to their framework, when the technology for running business is imitable and the complementary assets are held tightly and important, the suitable strategy is "team up." In the case of furniture.com, the technology to build a Web site selling furniture is highly imitable, evidenced by the large number of emerging furniture e-tailers during the 1999-2000 period. The complementary assets, such as brand name, alliances with good suppliers, and excellent customer services, were critical to the success of business and difficult to acquire. Therefore, forming a solid alliance with reputable furniture manufacturers possessing complementary assets is the appropriate business strategy.

What was troublesome, however, was that reputable traditional furniture manufacturers were not only pure-play e-tailers' potential upstream suppliers, but some of them were also e-tailers' direct competitors. Meanwhile, the traditional retailers in the furniture industry restricted their manufacturers from teaming up with pure-play e-tailers. For example, Iovine (2000) reported, "Stanley, a leading manufacturer, agreed to put its furniture on living.com but pulled it off less than two weeks later after complaints from retailers who felt they were being betrayed. They said that they had to invest in floor samples and advertising, then watch while customers stopped by, kicked the tires, and went and ordered the items on the Web."

The third reason causing furniture.com's failure is that it did not focus on building good back-end office and high-quality customer services. According to the categorization of e-commerce business models by Weill and Vitale (2001), furniture.com was running on "direct to customer" model. One of the core competencies of this business model is managing and integrating online and offline business processes to assure customer value because customer of direct-to-customer firms want fast service and instant gratification (Weill & Vitale 2001). Focusing and spending too much on marketing campaign, furniture.com had poor performance on customer services. It was a good idea to set up instant messenger and make design consultants available online to customers, but the results of implementation were not satisfying. Customers often waited for 15 minutes or more to get an answer to an "instant message" (Mullaney, 1999). Late delivery, missing shipments, damaged merchandise, and botched assembly efforts happened frequently offline (Sandoval, 2000).

The fourth reason why furniture.com failed is that it overspent on brand name building. From resource-based view of the firm, resources that can contribute to creating and sustaining competitive advantages must have three characteristics: (1) the resource is heterogeneously distributed among firms, (2) imperfectly mobile, and (3) hard to be imitated, acquired, or stolen (Mata & Fuerst, 1995). Brand name has the three above characteristics and therefore is a valuable asset for pure-play e-tailers to create and sustain the competitive advantage. However, brand name should be gained at a reasonable cost. According to Securities and Exchange Commission documents, furniture.com pulled in revenues of \$10.9 million in 1999 but lost \$46 million. One possible reason is that it spent \$33.9 million on marketing. This number was triple its sales and almost triple what it spent on product development and general administrative costs combined. Advertisement spending should generally be no greater that 20% of sales according to expert opinion (Kemp, 2000).

PRACTICAL IMPLICATIONS FOR MANAGERS OF E-TAILERS

The experiences of furniture.com are a good lesson for e-tailers, especially pure play e-tailers.

First, choosing the right items to sell plays an important role in online retail industry. A big difference exists between a \$50 book and \$1500 furniture. An in-depth survey on the market and the consumer behaviors should be conducted before making decisions on the choice of products. Furniture may not always be suitable for selling online for several obvious reasons. A Web site is not a good medium for providing customers with a touchy-feely experience. People hesitate to purchase high-priced items without seeing them beforehand. In addition, most furniture is so large that they cannot easily be delivered via UPS or other shipment carriers, leaving delivery a problem to be solved by the e-tailer itself (Sandoval, 2000).

CarMax and others have shown that high ticket items can be marketed on the Web, but it is equally true that physical sites help to leverage the Web for this firm. Furniture.com had none of these advantages.

Second, e-tailer managers need to select the appropriate schematics to evaluate the success of their business. In the years 1999 and 2000, most of the e-tailers evaluated their business success with the number of visitors of the Web site. For example, it was reported that 772,000 unique visitors stopped by furniture.com in September 1999 and this was considered a sign of success of the business. However, it was unknown how many visitors made a purchase and how much they bought. Using "eyeball" tallies to evaluate or predict business success is not reliable. Other factors to appraise business are needed. Good sets of such measures are profitability, profitability predictor, and component attributes (Afuah & Tucci, 2001).

Third, acquiring brand name awareness and other complementary assets should be conducted at a reasonable cost. Furniture.com and its competitor living.com both spent huge amounts of money on marketing campaigns to acquire customers and build their brand names. In August 1999, furniture.com named an advertising agency to handle its U.S. brand-building advertising account and while spending specifics were not disclosed, the retailer said it will "easily eclipse" a $5 million radio and print campaign it ran in the spring (Cox, 1999C). At the end of 1999, furniture.com planned to increase ad spending in 2000, though at that time it only had $31.4 million in cash on hand (Kemp, 2000).

The fourth lesson for e-tailer managers is that excellent services and good back-end offices are still critical success factors in the retail industry, and it is no exception for online retailers. A killer Web site is not the sole factor leading to success. Providing products and services in high quality and effectively managing distribution are also important.

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KEY TERMS

Click-and-Mortar: An e-commerce company that has both online presence and physical store.

Direct-to-Customer: An e-commerce business model that connects manufacturers with customers directly by bypassing intermediaries with Internet-related technology.

E-Tailer: An online retail store.

Five Forces Model: A theoretical framework proposed by Michael Porter that can be used to analyze the relative attractiveness of an industry from five different dimensions.

Instant Messenger: An information technology that enable people to send real-time text messages.

Online Services: Services that are provided online, such as personalized newsletter, instant messenger, etc.

Pure-Play: An e-commerce company that only has online presence but no physical store.

Category: Applications of E-Technologies

Forecasting the Stock Market with ANNs and Autonomous Agents

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INTRODUCTION AND BACKGROUND OF ORGANIZATION

Investment strategies usually aim at achieving maximum profitability what, according to current management theory (Refenes, Burgess, & Bentz, 1997), can be obtained by the construction of well balanced investment portfolios that seek to maximum return and minimum risks.

In order to provide users with information to plan a good investment portfolio, we present an e-commerce Web site solution that enables users to estimate in advance investments return and risks. The application, which is based on computational intelligence techniques, aims at forecasting and divulging the share prices of the main companies listed in the stock market.

Artificial neural networks (ANNs) (Haykin, 1999) that have been used successfully in many other financial time series applications (Braga, Carvalho, Lurdemir, Almeida, & Lacerda, 2002; Refenes, et al., 1997; Zhang, 2003) were used as the main forecasting engine of the system. Autonomous agents (Paolucci, Sycara, & Kawamura, 2003; Russel & Norvig, 1995) are responsible for collecting, on a daily basis, information regarding sale and purchase of shares. The information collected is then used by the ANN to forecast future stock market trends and closing values. The Web site offers free of charge services, such as access to forecasting charts, simulation of investments and general guidelines for buying and selling shares.

DESCRIPTION OF E-COMMERCE, E-GOVERNMENT, AND/OR MOBILE COMMERCE

The application consists of an intelligent system capable of anticipating share prices of the main companies listed in the stock market. This task entails daily collection of market information for calculation time series future values. The data collected is used as exogenous variables of the neural model.

Autonomous agents are responsible for collecting data, divulging forecast indexes on the Web site and generating dynamic Web pages that interact with the data repository. Since they are activated daily, the agents behave as an autonomous intelligent system capable of operating without the intervention of the user or programmer. The *Sections* that follow describe the main techniques that form the structure of the e-commerce application: Artificial Neural Networks and Autonomous Agents.

Artificial Neural Networks

Artificial neural networks (ANNs) (Bishop, 1995; Haykin, 1999) have been widely used to forecast financial time series in the last few years (Berardi & Zhang, 2003; Cao & Tay, 2003; Zhang, 2003). Characteristics inherent to neural models such as learning and generalization based on a set of data and universality in the approximation of linear and non-linear multi-variable continuous functions (Cybenko, 1988) make ANNs a very attractive tool for modeling and forecasting non-stationary time series, such as stock market values.

The forecasting models were based on multi layer perceptron (MLP) feed-forward networks (Haykin, 1999) that consist of a set of sensorial input units, one or two hidden (intermediate) layers and an output layer of computational elements (neurons). The entry signal propagates from the inputs to the outputs through each network layer. Figure 1 illustrates a MLP with two hidden layers.

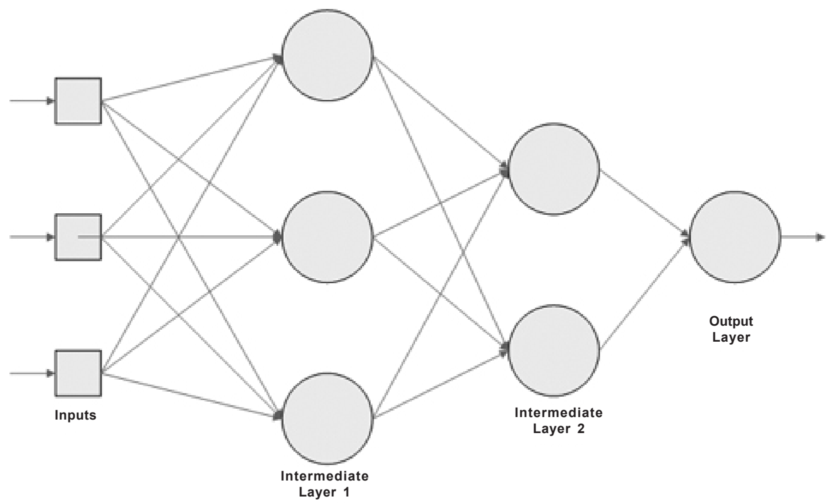
In forecasting financial time series, the inputs of the MLP network are the independent or exogenous variables. The functional relationship estimated by an MLP network can be defined by the *equation* (Zhang, Patuwo, & Hu, 1998):

$$y = f(x_1, x_2, ..., x_p),$$

where $x_1, x_2, ..., x_p$ are the independent variables p and y is the dependent variable. In this sense, this feed-forward neural model is functionally equivalent to a nonlinear regression model.

F

Figure 1. Typical MLP network with two hidden layers



Usually, in time series forecasting models, the inputs correspond to the exogenous variables delayed in time and the output to the future value predicted. This input-output functional mapping implemented by the neural network can be described by the *equation* (Zhang et al., 1998):

$$yt_1 = f(x_{1t}, x_{1t-1}, \ldots, x_{1t-\mathrm{m}}, x_{2t}, x_{2t-1}, \ldots, x_{2t-n}, \ldots y_t, y_{t-1}, \ldots, y_{t-p})$$

where the indexes *t, t-1, ..., t–p* represent the delays of time in relation to *t*; x_1 and x_2 are exogenous variables. Therefore, the MLP network can be seen as a nonlinear regression model for time series forecasting (Brockwell & Davis, 1996). The neural models developed use past values of the series as well as explanatory exogenous variables collected from Internet sites in order to predict future values.

The training process of an MLP network consists of defining the adequate values of the synaptic weights *w* and bias *b* present in the acyclic arcs that provide the links between the units (sensorial or computational) of the adjacent layers (Haykin, 1999). The knowledge acquired by the network during training is stored in these elements. Training of MLPs is supervised (Haykin, 1999) and each desired response (target) for each input pattern (example) is available in the training data. A training algorithm is used to search the values of the weights *w* and bias *b*, by minimizing an error measure such as the sum of square errors (SSE) or the sum of mean square errors (MSE) (Zhang et al., 1998). As a result, the training problem of an MLP network can be seen as a problem of non-linear minimization of a cost function (Bishop, 1995). Typically, an objective function (SSE) to be minimized during the training process is described by the equation:

$$E = \frac{1}{2}\sum_{i=1}^{N}\left(y_i - a_i\right)^2,$$

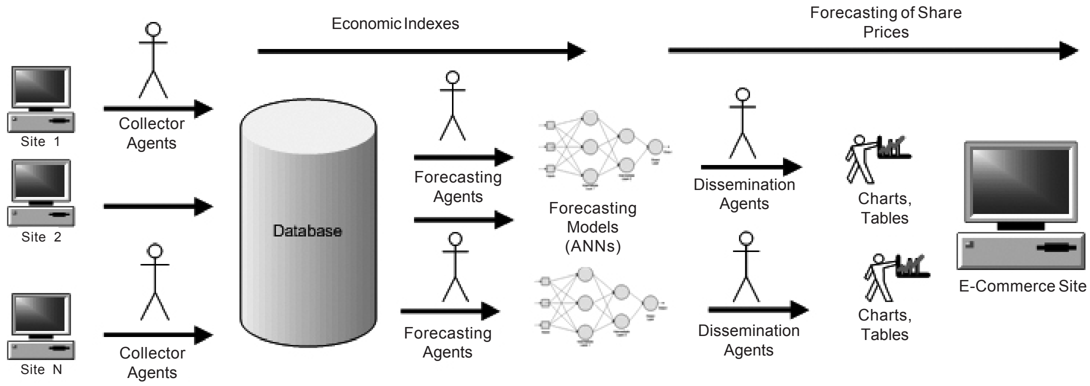
where a_i is the current output of the network, y_i is the desired output and N corresponds to the number of samples in the training set. There are a number of algorithms based on optimization methods for training MLPs, such as, for example, the Backpropagation algorithm (Rumelhart, Hinton, & Willians, 1986), the Levenberg Marquardt algorithm (Hagan & Menhaj, 1994), the GRG2 algorithm (Lasdon & Waren, 1986) and the MOBJ algorithm (Teixeira, Braga, Takahashi, & Saldanha, 1999).

Autonomous Agents

According to Russel and Norvig (1995) "an agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators" (p. 32). An autonomous agent is a software component capable of working for the performance of tasks to the benefit of its users (Paolucci et al., 2003).

The ideal architecture of an agent will directly depend on the type of task it performs and on the environment it is in (Nilsson, 1998). The autonomous agents forming the intelligent system can be classified as information or Internet agents introduced following a demand for tools capable of helping managing the boom of information on the Internet. They manage and collect information from a wide variety of sources. They are programs capable of retrieving information from remote Web sites by means of Internet protocols (Paolucci et al., 2003), storing it in a data

Figure 2. Detailed structure of the intelligent system



repository and using it for executing specific tasks. The following Section offers a detailed description of how the e-commerce solution proposed by our organization works.

How the E-Commerce Web Site Works

Figure 2 presents a schematic overview of the intelligent system illustrating the activities of autonomous agents.

The collector agents are responsible for collecting the information from the Web and for its storage in a database, thus putting together a repository of the time series. This is carried out by monitoring economic Web sites with the aim of collecting economic indexes. The function of the agents that retrieve information is to navigate the Internet searching for pages and extract the desired information from them.

Based on the data stored in the repository of the time series, the forecasting agents are responsible for pre-processing the data so that they can be used in the ANN forecasting models. The agents provide each forecasting neural model with the required input variables in order to predict future values. Finally, the predicted values are also stored in the data repository.

In the last stage, dissemination agents generate dynamic pages from the information stored in the database. These agents are activated upon the action of the forecasting agents.

The pages generated by the dissemination agents provide the user with a forecast of the share prices of the main companies listed in the stock market, in the form of charts and tables. Apart from that, they divulge the variation trends of the quote in relation to previous values.

The agents are capable of calculating the percentile error of the forecasting and to generate illustrative forecasting charts containing real and predicted values. The agents also generate a table comparing the values along with the percentile of errors in the form of a histogram. All this guarantees that the user has a means to evaluate the reliability of the forecasting yielded by the intelligent system.

Each of the stages described previously are under the responsibility of specialized agents that interact with the forecasting models. These agents work independently, that is, their tasks are performed without the intervention of the user or the programmer.

IMPACT OF E-COMMERCE IN THE ORGANIZATION

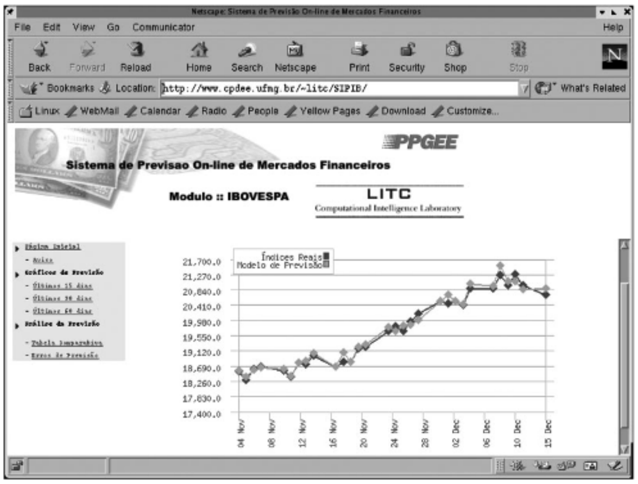
The use of computational intelligence (artificial neural networks and autonomous agents) tools in the development of the e-commerce application led to the construction of a Web site that offers its users a wide range of free-of-charge services:

1. Visual access to dynamic charts and tables containing the predicted values of the share prices.
2. Simulation of investments by means of the construction of a virtual portfolio.
3. Help in making decisions when trading with shares.
4. Statistical analysis of system performance by means of reliability tests, tables and histograms showing the results.
5. Following the news and values of the main economic indicators.
6. Following stock market trends.

Figure 3 illustrates the dynamic chart comparing the forecast values and the real values produced by the Web site.

The inclusion of the intelligent system to the organization's Web site is a differential in itself. More than just an informative Web site, the application devel-

Figure 3. Interface of the Web site with forecasting chart



oped makes it possible for advanced estimates of share prices to be made. In accordance with current theories for planning investment portfolios, the Web site offers support to the planning of high-profit and low-risk investments.

The reliability test offered on the Web site guarantees its trustworthiness, which makes it a reference for banking institutions, investors, economists and financial advisors.

CONCLUSION

The article described an e-commerce application that makes use of an intelligent system capable of forecasting and divulging the quote of the main companies listed in the stock market.

The structure of the intelligent system comprises the interaction between the Autonomous Agents and forecasting models based on artificial neural networks (ANNs). This Web site owes its success to the wide range of resources offered by this intelligent system.

The application described demonstrated that companies can use computational intelligence techniques to offer e-commerce solutions, while making their sites even more attractive to their users with the expansion of services offered.

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KEY TERMS

Artificial Neural Networks (ANNs): Parallel distributed processor formed by single processing units that has a natural capacity of storing experimental knowledge and to make it available for use. Artificial neural networks are designed to model complex problems such as time series forecasting, pattern recognition, etc.

Autonomous Agents: Software components capable of working for the performance of tasks to the benefit of its users. An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.

Forecasting Models: Computational and/or mathematical models that simulate time series behavior with the purpose of forecasting their future values.

Information Agents: Programs capable of retrieving information from remote Web sites by means of Internet protocols, storing it in a data repository and using it for executing specific tasks.

Investment Portfolio: Set of investments (sale and purchase of shares) in a determined period of time. The portfolio keeps a history of operations in the stock market. The construction of an optimal portfolio requires a priori estimates of asset returns and risk.

Multi-Layer Perceptron Feed-Forward Networks: Type of neural networks topology. Set of sensorial input units, one or more hidden (intermediate) layers and an output layer of computational elements (neurons). The entry signal propagates from the inputs to the outputs through each network layer.

Supervised Training: Learning process of artificial neural networks where each desired response (target) for each input pattern (example) is available in the training data.

Training Algorithm: Learning process of artificial neural networks whose function consists on defining the adequate values of the synaptic weights w and bias b, by minimizing an error measure such as the sum of square errors (SSE) or the sum of mean square errors (MSE).

Gambling Over the Internet

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INTRODUCTION

Gambling providers have begun to exploit the Internet as a vehicle for marketing their products and services. This article discusses the increase in *Internet gambling* and how the gambling industry has exploited technology to make market gains. Gambling on the Internet is a billion-dollar industry, with online lotteries and pools generating more than half of the total market value (i.e., $1.66 billion). There is a plethora of gambling opportunities, such as casino games and online games, and horse and event betting, although inevitably some of the rules of the games have had to be adapted to operate via the new medium. The home-based nature of *interactive* gambling means that consumers are no longer restricted by opening hours, social status, or membership requirements, and are able to choose from a wide selection of gambling sites. The nature of the response by gambling organizations to the changes in consumer behavior has depended on the willingness of providers to become online providers, domestic and/or international *legislation*, and of course Internet service provision, all of which will differ depending on the gambling products offered.

BACKGROUND

Recently, van't Veer (1998, p. 4) provided a definition of interactive gaming that encapsulates its attributes:

…the player can participate at any time and at any pace without the intervention of a third party, not completely free of charge, which are provided with the aid of information technology and means of telecommunication beyond the scope of the traditional supply structure and which give the player, at the discretion of the provider, the opportunity to perform all actions necessary for participation such that he [or she] is able to win prizes.

A recent report suggests a surge in online gambling, mostly in the form of electronic sales of lottery and pool tickets. Forrester Research (as cited in Wall, 2000) estimated that more than 1 million Internet users visit gambling sites. Datamonitor estimates that Europeans gamble $55 million a year via the Internet (http://www.e-web.com). In global terms, Balestra (2004) estimated that by the end of 2004, the Internet gambling industry would be a $7.4 billion industry.

Cyber gambling is possible via two technologies: the Internet and digital television. Interactive services are possible because of digital television's utilization of a new bandwidth that allows interactive services. It is anticipated that digital TV will create between 120 and 200 new channels, allowing target marketing to become more directed. Further developments in the use of *WAP* (wireless application protocol) technology create opportunities for gambling via the telephone. Indeed, Eurobet in the Summer of 2000 gave away WAP phones on its UK Web site (http://www.eurobet.co.uk) after identifying a synergy between betting and WAP (Revolution, 2000). Such technological innovations will increase the penetration of access to the Internet, and thus the development of gambling sites becomes a potentially more lucrative opportunity. As the National Gambling Impact Study Commission (1999, p. 5.3) reported, "the rapid increase in sites is likely the result of the financial success of existing operations." Technological capability coupled with credible gambling sites appearing in more regulated environments will rapidly increase the proportion of gambling transacted over the Internet (Michener, Gregory, & Swatman, 1999).

Interactive Gaming and Communications (USA) was the first company to accept a wager over the Net on May 11, 1995, with 18 different casino games, online access to the National Indian Lottery, and plans to launch an Internet sports book. The Yahoo! search engine in January 2005 revealed 100 casino categories, containing 9.46 million casino sites (http://yahoo.com). The Internet Gaming Commission identifies 850 Internet gaming establishments operating in more than 30 countries, 125 of which are not licensed (http://www.internet.commission.com). Rolling Good Times (http://www.rgtonline.com) offers links to approximately 1,000 Internet sites that offer some sort of betting. These varying estimates of the number of online gambling sites supports the National Gambling Impact Study Commission (1999) finding that the lack of a central register of Internet gambling sites makes calculating the number of sites virtually impossible.

Gambling via interactive technology is underpinned by two recent changes in consumer behavior. First, access to and familiarity with interactive technology is becoming increasingly commonplace, for example, through the use of ATMs (automated teller machines) and telephone bank transactions, and the growth of Internet service providers (ISPs). The National Gambling Impact Study Commission (1999) argued that the increasing use of the Internet and growing consumer confidence in conducting online financial transactions have led to a greater number of people willing to engage in Internet gambling.

THE IMPACT OF INTERACTIVE GAMBLING

The ease of use of the technology and pathways through the sites are important. Providers need to recognize that an extensive effort on education is likely to be required. The National Gambling Impact Study Commission (1999, p. 53) found that "the design and pace of the online games have advanced dramatically over the past few years, as has the ease of use. Gambling sites now feature interactive games…and walk customers through a virtual tour of the site…" This finding supports the view that the effective delivery of the service will depend on participants acquiring and displaying appropriate skills (Mudie & Cottam, 1993). For example, to enhance the adoption of ATMs, "it was necessary to familiarize customers with the new technology properly, as well as aid them in overcoming the depersonalization of a formerly personal service" (Grove, Fisk, & Bitner as cited in Gabbott & Hogg, 1997, p. 139). This lack of personal contact may affect players' confidence and trust in the service. Hence, the Interactive Entertainment Group's online casino site (http://www.geishalounge.com) uses a geisha as a guide through the site to mirror the service aspects of a typical casino. The organization argues that a high level of customer service supports the customers' need for instant feedback, given the adrenaline buzz of gambling ("Casino Puts Focus on Sophistication," 1999).

The marketing of interactive gambling appears to be a classic marketing case study. The new medium of the Internet has offered providers with a different marketing channel for their gaming products. Rather than the development of new games, the familiar gambling activities of casinos, lotteries, and sports betting have been adapted to operate on this new medium. Moreover, the nature of the technology means that the providers have readily accessible databases of customer information that will enhance future product developments and aid the retention of customers by relationships with their target groups.

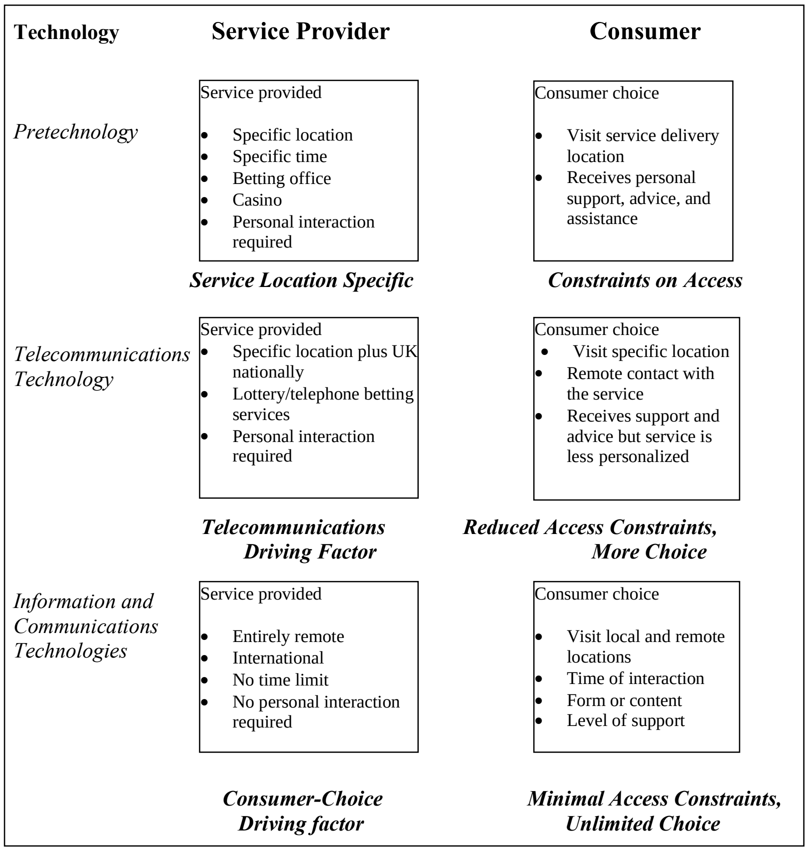
Internet gambling is currently largely unregulated and uncontrolled. The potential of gambling on credit, persons under 18 gambling, and criminal involvement are all areas of concern (Gaming Board for Great Britain, 1997). Under UK law (1968 Gaming Act), there is no problem with Internet betting; however, establishing an Internet casino host in the United Kingdom is illegal (http://www.gbgb.org.uk/faq). In Australia, legislation on Internet gambling (The Queensland Interactive Gambling Player Protection Act 1998) has been introduced (Michener et al., 1999). The U.S. response has been to make Internet gambling illegal under the auspices of the 1961 Federal Wire Act, which prohibits the use of the telephone to place sports betting. Indeed, the co-owner of an Antigua-based sports-betting operation has recently been found guilty in New York under the 1961 act and was sentenced to a 2-year jail term (Daneshku & Garrahan, 2000). However, the 1961 statute does not specifically deal with the Internet; hence, the Internet Gambling Prohibition Act successfully passed through the Senate in November 1999. The act was proposed by an Arizona senator, who argued:

Gambling is either heavily regulated or expressly prohibited in the States. On the Internet it is neither. Given the tremendous potential abuse, addiction and access by minors, on-line gambling should be prohibited. My bill will protect children from logging on to the family computer, "borrowing" the family credit card and losing the family home, all before their parents get home. (http://www.senate.gov/kyl)

The lack of a regulatory framework means that interactive services have the potential of supporting criminal activity through games or money laundering (Carruthers, 2004). This harks back to Ploscowe (1963, p. 654) who argued that "gambling gold" underpinned organized crime ventures and "hoodlums" had a prominent role in many forms of gambling, for example, slots, lotteries, casinos, bingo, and numbers. The Internet offers a return to criminal involvement in the gambling market.

Endler and Davis (1999), McMillan and Grabosky (1998), Michener et al. (1999), and the National Gambling Impact Study Commission (1999) have all discussed the negative criminal impacts of Internet gambling, particularly in regard to money laundering. Indeed, the need for regulatory control is important to McMillan and Grabosky because they argue that cyber gambling eclipses the notion of community control that characterized traditional gambling. For Watson, Liddell, Moore, and Eshee (2004), the legalization and regulation of Internet gambling should be through existing land-based casinos. Endler and Davis suggest that legal redress must be at an international level, and they argue for regulation based on perception and trust, with trust to be exemplified by a mechanism to distinguish reputable games. This argument provides an interesting dimension to the relationship between provider and player.

Figure 1. The impact of ICTs on the gambling supply chain



The Internet Gaming Commission, an independent body launched by an American, offers the online gambler a categorization of sites based on bet sizes and odds, and offers a bulletin board and dispute-resolution section (http://www.Internet.commission.com). The industry is involved in a similar labeling exercise through the use of the GamCare symbol on registered sites. GamCare, the National Association for Gambling Care, is a registered charity whose aim is to promote responsible attitudes to gambling (http://www.gamcare.org.uk). For example, http://www.premier5.com/game, the URL of an Internet sports-betting site, points to a document that incorporates information regarding GamCare, including a help-line number and useful tips for those who access its site and believe that their gambling is a problem.

In summary, there are concerns in regard to money laundering, underage gambling, problem gambling, the abuse of databases, the hacking of credit-card details, and the retrieval of gambling debts and payouts of winnings. Coupled with this is the view that the Internet is a democratic medium that should not be subject to legislation. However, existing statutes do not appear to be entirely applicable to the Internet. Van't Veer (1998) identified three approaches to regulation, which he termed the American, the European, and the Australian approaches. The European approach is to utilize domestic legislation. The American approach could be seen as punitive in that its basis appears to be that online gaming is bad. The Australian approach has been to introduce legislation to protect the player and to provide tax revenues. Thus, the approaches range from strict control to laissez-faire (McMillan & Grabosky, 1998).

Traditionally, to participate in gambling, customers had to visit a particular venue (e.g., a casino, racetrack, betting shop, bingo hall). They were restricted by tangible barriers, such as opening times and membership rules, and the intangible barriers of societal taboos and unspoken rules of the game that made it difficult for the uninitiated to participate. ICT developments mean that gambling can be supplied online to a purchaser at home, at work, while traveling, or at leisure venues. Through access to the Internet, gamblers can readily access a number of gambling sites, provided by different organizations, and can play a variety of games. The supplier-buyer relationship, while being distant, can also be personalized through the format of the technology, for example, by "welcome back" messages that address the user by name. Promotions can be personally targeted to the individual gambler.

The impact of ICTs on the gambling supply chain is shown in a diagrammatic format in Figure 1. The consumer can choose from a number of providers, decide what and when to play, and have play tailored to his or her specific needs.

FUTURE TRENDS

It is perhaps inevitable that future innovations in gambling will take advantage of the opportunities provided by technological developments and the consequent change in purchase behavior. The rapid development of technologies, such as mobile devices with more user-friendly screens and keyboards, will aid the market penetration of interactive gambling. Provider databases contain appropriate marketing information that will support the increased personalization of gambling opportunities. For example, if a customer already receives text alerts about his or her favorite team's soccer results, then the customer could also be encouraged to place wagers on the outcome of particular soccer matches involving that team.

To retain consumers as gamblers, gambling organizations will have to develop relationships with them. Gaining access to players will in turn involve gambling sites engaging with others in the supply chain, for example, platform providers, complementary service-product providers, and so forth. The nature of the transactions (i.e., money transfers potentially between partners who do not know for sure the locations of each other) suggests that trust will be a key aspect of the relationship.

CONCLUSION

The potential for gaming to drive the widespread usage of the Internet has been likened to pornography's role in popularizing the home ownership of videocassette recorders. Data shows that gaming attracts lower income people more than it does the wealthy. Thus, gaming might be the application that drives online usage from the economic and academic elite to all levels of society (Rose, 1998). Online gaming might be one of the few services that can directly generate the billions of dollars in revenue that will be needed to finance the cost of developing the information superhighway infrastructure (Mermigas as cited in Janower, 1996).

When home-based access to the Internet becomes the norm, the perception of interactive gambling as a popular leisure activity is also likely to become the norm. There is an obvious synergy between gambling products and experiences, and technology.

Internet gambling sites have achieved success by providing access using a number of different platforms and easy links around the sites. Perception barriers surrounding the term gambling or betting have been recognized, and there is an emphasis on fun, flutter, and sweepstakes. Access and perception barriers have been overcome by the development of games based on the target market's interests, for example, particular sports, television programs, and so forth. The promotion of Internet sites utilizes a company's established brand presence, prize funds, and affiliate marketing schemes.

Participants in the gambling industry have demonstrated their recognition of the need to adapt supply-chain arrangements to meet the needs of existing and new market segments. Changes in customer and consumer attitudes and purchasing behavior provide the opportunities for such adaptation, while ICTs provide the catalyst and the conduit.

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KEY TERMS

Affiliate Marketing: When companies use third parties to provide services on their behalf. The affiliates may deliver customer lists or customers to the main company in return for a commission payment or cross-selling opportunity.

Brand Presence: The presence of a product offering that is distinguished from its competitors through the use of a symbol, design, or characteristic, or a combination of these.

Cyber Gambling: Gambling that takes place using an interactive technology such as the Internet or digital television.

Gambling: A leisure activity in which money is staked with the anticipation of making a gain and/or winning a prize.

Information and Communication Technologies (ICTs): Used to describe the diverse range of technological developments (e.g., computer storage and retrieval, computing capacity, wired communications, wireless communications, portable technologies) that have enhanced the internal and external activities of organizations.

Supply Chain: A network of organizations that provide goods or services to each other.

Trust: The reliance and confidence in the behavior between one or more partners involved in a trading relationship.

Category: Concepts, Trends, and Challenges

Global Marketing on the Internet

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INTRODUCTION

One of the most differential characteristics between the Internet and other traditional media relates to the relatively easier "global market reach" enabled on this new medium. Internet technologies foster direct, fast, and flexible communication between producers, suppliers, and final customers across countries (Bridges, Goldsmith, & Hofacker, 2005).

The Internet global reach is likely to have relevant implications for both business-to-consumer (B2C) and business-to-business (B2B) markets. Internet-related technologies are also argued to have "equalizing effects" (Cavusgil, 2002; Hamill, 1997; Samiee, 1998a), as skills and information assets tend to be more critical factors than financial resources or firm size in order to achieve success in global e-markets. Nevertheless, companies will necessarily have to face important challenges and risks in this new global business environment.

Global marketing practices are especially likely to be changed by the introduction of Internet technologies, owing to the differential characteristics of the Internet medium—speed, ubiquity, interactivity, and two-way communication. This article examines the impact of Internet technologies on global marketing activities: global e-marketing.

BACKGROUND

Global E-Markets

Internet markets have special characteristics that will change significantly the way products and services are marketed and distributed through traditional domestic and international distribution channels.

Internet-Based Technologies and Traditional Media for Cross-Border Communications

Although Internet uptake among businesses and consumers has not yet reached the penetration levels of more traditional communication channels (e.g., telephone or fax), the usefulness of online services is expected to increase substantially in the near future (Leek, Turnbull, & Naudé, 2003).

Diverse technologies are available to develop global Internet marketing strategies:

- Among current technologies, the Web and related services, such as e-mail, online forums, newsletters, or chat services, are powerful vehicles for global marketing communications. E-mail is currently the world's most widely used online service among businesses and consumers (Hamill, 1997), and it is expected to become the most useful method for global business communication (Leek et al., 2003).
- Other technological solutions also offer great potential for global e-marketing communications, such as electronic data interchange (EDI), work flow and groupware systems, intranets, extranets, peer-to-peer (P2P) technologies, and other data transfer systems (Cavusgil, 2002).

The relevance of the Internet as a global marketing channel will depend on the added value that it provides compared to traditional media. While certain communication methods will be gradually replaced by more efficient online ones, online and off-line communication systems are expected to coexist in the future.

Global Market Reach

On the Internet, both consumers and businesses can benefit from the access and exchange of information across national and regional boundaries. Diverse authors explicitly recognize the relevance of the Internet global market reach, arguing that the Internet will become an essential element of global marketing strategies (Lazer & Shaw, 2000; Samiee, 1998b).

The Internet and Web promise an easier and cheaper global market presence, "regardless of company size" (Bennett, 1997). Less time and financial resources are required to market goods and services to worldwide customers over the Internet, compared to other distribution channels. The Internet global reach has the potential to increase the variety of products available in different national markets (Deshpandé, 2000).

Quelch and Klein (1996) argue that companies with an online presence become automatically multinationals. However, certain companies, especially SMCs, which have traditionally served only their domestic markets, may have extended their potential customer base on the Internet, but not deliberately. Such companies may not be aware of the Internet's suitability for building international relationships (Hornby, Goulding, & Poon, 2002; Melewar, Hunt, & Bridgewater, 2001; Samiee, 1998b).

Adoption of Internet-Related Technologies: Growth Trends in Different Countries

The term "digital divide" (Ngini, Furnell, & Ghita, 2002) is currently used to refer to national and regional differences in the Internet adoption levels of consumers and companies. Such differences limit significantly the potential benefits to be obtained in Internet markets by international companies and consumers.

Although regional differences are being progressively reduced, Internet adoption and the development of digital infrastructures are still higher in the United States. It must also be noted that Internet markets are developing in uneven patterns around the world—that is, lower Internet penetration and lower availability of broadband Internet access in certain regions (Crosby & Johnson, 2002).

The following regional trends can be observed, with regard to the development of Internet markets (Javalgi & Ramsey, 2001): The United States is still leading, with regard to the number of Internet users and online transactions. Europe is around 10-15 months behind the United States in terms of Internet use, but is the worldwide leader in the use of mobile devices. China is the fastest growing Internet market in Asia, and will account for a large share of the global Internet market.

According to market estimations by Forrester Research for the year 2004, the regional distribution of worldwide e-commerce will be as follows: the U.S. will account for 47% of worldwide e-commerce, Asia/Pacific-countries 24.3%, Europe 22.6%, and Latin America 1.2%.

GLOBAL E-MARKETING

Challenges and Risks

More challenges and risks are involved in global markets than in domestic markets. Diverse issues have been identified in previous research as barriers for the success of global e-marketing communications (Cavusgil, 2002; Eid & Trueman, 2002; Melewar et al., 2001; Samiee, 1998a):

Infrastructural Issues in Foreign Markets

Infrastructural constraints limit the potential success of global e-commerce and e-marketing communications. Global e-marketers should assess the availability and requirements of both technological and commercial infrastructures in the target markets.

Technological Infrastructures in Target Markets

It is critical for companies to evaluate the development of technological and telecommunication infrastructures in countries targeted through the Internet. The suitability of the Internet channel for marketing communications will be lower in those countries with less developed telecommunications infrastructure or unaffordable prices for Internet access.

Firms' Own Technological Infrastructures

Managers need to make the right decisions on the development of their own technological infrastructures, such as setting up their own Web servers or contracting with an ISP, necessary bandwidth, and so forth (Javalgi & Ramsey, 2001).

Commercial and Support Infrastructures

Two main factors are likely to influence success in this regard:

- Availability of local offices and representation (Bennett, 1997; Samiee, 1998a). Setting up local offices can be a costly strategy. Other solutions include contracting the services of local distributors.
- Sophistication of foreign markets' commercial infrastructure—for example, local availability of banks and financial institutions, and providers of computer and Internet services (Javalgi & Ramsey, 2001).

Structural Issues

Consumer Resources

- **PC Ownership:** The international availability and adoption of computer equipment enabling Internet access is required to support the development of e-commerce on a global scale (Javalgi & Ramsey, 2001; Samiee, 1998a). While personal computers are widely available in developed countries, the purchase of PCs is less affordable for consumers in less developed countries.

- **Staff and Consumers' Skills:** The effective use of Internet technologies for global e-commerce demands threshold levels of skills by both companies' staff and consumers. Educational and technological skills (e.g., familiarity with PCs and Internet technologies) and a proper understanding of foreign markets (e.g., linguistic and specific skills to deal with foreign customers and partners) are required in order to fully benefit from the use of the Internet for global marketing communications (Javalgi & Ramsey, 2001).

Geographic Location

Location and geographic constraints are less relevant to commercial success on the Internet, because of the Internet potential for building an integrated worldwide network of people and organizations, regardless of where they are situated (Angelides, 1997; Bennett, 1997; Cavusgil, 2002; Lazer & Shaw, 2000; Samiee, 1998a). Nevertheless, the Internet does not alleviate certain difficulties involved in foreign markets, such as perceived market risk or distribution and logistic complexities.

Government Regulations

Because of cross-border information flows on the Internet, governments will play a key role in the development of Internet markets. On the Internet, global marketers will have to deal with diverse national regulations, and bilateral and multilateral agreements (Tran & Atkinson, 2002; Zugelder, Flaherty, & Johnson, 2000). There is little international homogenization on such issues as consumer protection, intellectual property issues, taxation and pricing, product regulations, limitations to global information flows, restrictions to imports and exports, security and privacy regulations, or censorship.

Payment Systems

There are significant differences in the commonly used payment systems in different countries: while certain payment methods are preferred by consumers from some countries, such payment systems may not be even available or safe enough in other regions (Guillén, 2002). For example, more recently developed payment methods such as e-cash have only been introduced into certain local markets, and few consumers already use these systems (Hornby et al., 2002).

The decision on the acceptable payment methods is crucial for companies conducting transactions over the Internet. E-sellers should be flexible with regard to the accepted payment systems in different national markets.

Cultural Factors

A key decision in global marketing relates to the extent to which marketing communications should be standardized or localized across countries. The global information flows on the Internet have been argued to contribute to an increasing globalization and homogenization of consumers' preferences (Bennett, 1997). Other authors conversely argue that, along with opportunities, the Internet global markets involve significant complexities associated with the diversity of cultures (Samiee, 1998b).

Fully standardized marketing communications are very difficult to apply. Depending on the product and the sector, varying degrees of local responsiveness may be necessary (Guillén, 2002). Owing to the easy global market access through the Internet, there is a risk that global e-marketers overlook the potential implications of regional and cultural differences for effectiveness of their global e-marketing communications (Quelch & Klein, 1996).

Organizational Barriers

Organizational barriers arise from the difficulties and resources required to engage in global marketing. The application of Internet technologies to commercial activities involves the integration and adaptation of the firm's technology, business processes, and staff, according to the characteristics of the online environment and the target markets.

Information Management

Another challenge for online companies may be the effective management of the sheer amount of diverse data available on the Internet (e.g., information on customers' preferences and online behavior or diverse reports and market analyses).

Web Sites' Development and Maintenance Costs

Though the Internet significantly reduces the financial requirements for global marketing communications, the costs involved in effective Web site development and maintenance are not negligible, ranging from $300,000 for promotional sites to $3.4 million for shopping sites (Samiee, 1998a, 1998b).

The maintenance of effective Web sites is an ongoing process, and depending on the purposes and the degree of Web site localization, the total costs of global marketing on the Web may be too high for smaller companies with limited financial resources.

Operational and Procedural Problems

Further problems posed by the global implications of Internet markets relate to dealing with operational and procedural problems (Samiee, 1998a). Such problems are largely transaction specific and include such practical problems as dealing with documentation and paperwork, international logistics, and managing payments in different currencies.

Global E-Marketing Strategies

This section reviews the most significant changes introduced by Internet technologies into the development of global marketing activities. The authors strive to offer a thorough analysis of the potential effects of global online information flows on marketing practices.

Global E-Market Segmentation

Market segmentation on the Internet will differ significantly from traditional consumer and business segmentation. On the Internet, potential customers are easier to target and reach on a global scale. The peculiarities of the Internet for market segmentation have been referred to as "mass customization" or "personalization" (Goldsmith, 1999; Lazer & Shaw, 2000): it incorporates the best of mass markets (e.g., global market reach), together with huge possibilities for individual customization (identification of "segments of one").

Internet technological capabilities allow marketers to identify the individual customer's preferences and accordingly customize marketing communications. On the Web, it is easier for marketers to analyze and track consumers' shopping behavior than in off-line markets. Diverse online services help companies gain an overview of the needs and preferences of people from different cultures (Melewar et al., 2001).

The Global E-Marketing Mix

Global Online Promotion

The decision on the degree of standardization vs. localization is critical for the effectiveness of global online advertising. Online marketers should not underestimate the need for advertising localization on the Internet, depending on the target market characteristics (e.g., developing multilingual Web sites).

Samiee (1998b) points out that the Internet global nature may promote standardized advertising approaches, which may reduce the effectiveness of online advertising campaigns in different countries. Recent research shows that there are no universal values to which standardized advertising can appeal (De Mooij, 2003).

Global Branding on the Web

The Internet offers great opportunities for branding and image building, previously unavailable in offline business environments. The information transparency and international reach, facilitated by Internet technologies, enable companies to build a worldwide identity much faster than in off-line settings (Cavusgil, 2002).

Reputation and branding-related issues are expected to be as relevant on the Internet as in physical markets (Guillén, 2002). Image building is critical for international customers to be aware of a company's existence. Furthermore, "trust" is one of the most decisive factors for online shopping adoption, so companies should not expect international Internet users to purchase "unfamiliar brands through unknown vendors in the foreseeable future" (Samiee, 1998b).

White (1997) argues that consumers should not be expected to purchase from international Web sites if they do not perceive unique benefits in the products offered on those Web sites, compared to the products available through local Web sites.

Branding through Web Sites

The management of a global brand and corporate logo on the Internet is an important challenge to be managed by e-companies. As in traditional markets, companies may decide to use a single brand or multiple brands. On the Internet, Web sites are the most powerful branding medium, and various approaches to Web site development are available, according to the desired degree of identification between (1) product or services brands, (2) global Web sites, and (3) corporate identity (Quelch & Klein, 1996):

- Centralization of all product lines on a single Web site.
- Multiple local Web sites for a single brand.
- Different Web sites for each brand.
- Development of local Web sites by independent sellers or intermediaries.

Pricing Strategies

Effective pricing on the Internet represents a great challenge for companies operating on a global basis. The Web increases consumer power to acquire information and compare prices between domestic and international service providers (Deshpandé, 2000; Lazer & Shaw, 2000).

Diverse possibilities are available for online sellers to track online buyers' behavior (e.g., cookies, IP tracking, or data mining), which can significantly contribute to price discrimination attempts, based not only on traditionally used criteria, such as geographic location of customers and prospects, but on the individual consumer's behavior (Guillén, 2002). Price discrimination strategies involve certain risks that may arise if consumers become aware of price differences between countries.

Among others, challenges to global e-pricing strategies include: (1) global standardization of promotions (e.g., Mother's Day is celebrated on different dates internationally); (2) national differences in price sensitivity; (3) customer dissatisfaction because of price discrimination; (4) faster competitors' reactions to online pricing strategies; (5) pricing regulations; (6) currencies to quote prices; and (7) information related to applicable shipping charges and local taxes.

Distribution

In both domestic and global markets, distribution is a critical determinant of customer satisfaction with online shopping services. Based on the production country and the served markets, companies will have to develop an appropriate distribution channel (Samiee, 1998b): for example, online sellers may decide to keep their own product inventory, or make arrangements with suppliers that ship the products directly to the customers.

Online Disintermediation

Certain authors suggest that companies accessing foreign markets through the Internet will not need to rely on local intermediaries, because customers from those markets can find information about a wider variety of products on the Internet than in local markets (Javalgi & Ramsey, 2001; Quelch & Klein, 1996). The Internet channel, though, does not solve logistic problems associated with the distribution of tangible products to international markets. Because of these restrictions, companies will need to carefully manage logistics and transport issues in foreign markets.

Distribution Fulfillment

The fulfillment of international orders is one of the most important challenges faced by global e-sellers. Most of the problems related to international order fulfillment are associated with the required logistics to distribute tangible goods in foreign markets. Conversely, the Internet is a very suitable medium for the distribution of information and "digitizable" products.

International customers not receiving or receiving late the products they have ordered and paid for online will surely not consider those companies for future purchases. The attitudes toward online purchasing could also be damaged, owing to such unsatisfactory online shopping experiences. Global e-sellers should find logistical solutions, which ensure a smooth and cost-effective distribution to foreign customers.

Product

Global online marketers should assess and emphasize the unique advantages of their own products and services in local markets, compared to those available through traditional channels (Quelch & Klein, 1996; White, 1997).

On the Internet, international customers will benefit from a wider product variety. Some products, not distributed in certain local markets, will usually be available for purchase online. Consumers from such markets can access foreign Web sites for purchases.

Niche Products

Smaller companies with limited financial resources can gain easier access to international markets through the Internet. Quelch and Klein (1996) suggest that companies with specialized offerings, thanks to the Internet, will be able to gather the necessary number of customers.

Product Development and Product Design

The benefits provided by the Internet for product development include easier identification of customer needs, individual product customization, and global and faster product testing (Eid & Trueman, 2002). The Internet helps in the design of products that match customers' preferences by incorporating the views and tastes of global customers into the product design and product development phases. Product design and product development processes can be improved by forming virtual teams, which integrate knowledge from different countries (Cavusgil, 2002).

FUTURE TRENDS

Because of the relatively recent development of Internet technologies, further research is needed to clarify the challenges and most suitable global e-marketing strategies in different countries (e.g., standardization vs. localization approaches). Country-specific studies should provide useful insights into the preferred characteristics of e-marketing communications in different regions.

Researchers should emphasize the global implications of the e-marketing research topics, such as those referring to the elements of the e-marketing mix.

CONCLUSION

The Internet provides great opportunities for global market access to companies of different sizes. Lower access costs to foreign markets, as well as better knowledge of global consumers' preferences, are two of the main improvements offered by Internet technologies, compared to traditional distribution channels.

Nevertheless, online companies will have to deal with complex market conditions related to the existence of national and regional differences in the target markets' economic, infrastructural, cultural, legal, and political characteristics. Diverse structural issues, such as current regional differences in Internet usage, should also be taken into account by online marketers in their global e-marketing strategies (Mahajan, Pratini De Moraes, & Wind, 2000). Other challenges to be carefully managed by online marketers relate to organizational issues, such as ensuring a smooth distribution, integrating the Internet into the companies' global marketing strategies, coordinating online and off-line distribution channels, or evaluating the need for local representation in the local market (Samiee, 1998b). The most suitable strategies to cope with structural and organizational problems will be highly dependent on both the characteristics of the target market and the offered products or services.

Internet technologies provide great improvements in global market segmentation and market selection, which is likely to increase the effectiveness of online companies' global e-marketing efforts. The Internet channel will also have a significant impact on the diverse elements of the companies' global marketing (e-marketing) mix. Internet technologies will introduce significant changes into the pricing, promotion, distribution, and product elements of the marketing mix. Most of the improvements provided by Internet technologies relate to higher possibilities for adaptation, according to the preferences of the individual customer.

It seems clear that the Internet should not be regarded as a panacea for global market access. According to diverse recent investigations, localization of marketing communications is expected to be further necessary on the Internet in order to account for local markets' differential characteristics. The improved possibilities for global market research offered by the Internet should help companies find a balance between standardization vs. localization approaches, according to the target market's specific characteristics. Global e-marketers should prove their skills in finding a balance between the higher effectiveness of localization approaches and cost advantages provided by standardization strategies.

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KEY TERMS

Global E-Market Segmentation: Process leading to the identification of homogeneous consumer groups in the global Internet markets.

Global E-Marketing: Marketing efforts undertaken by companies outside their domestic market.

Global E-Marketing Mix: Combination of elements (promotion, price, place, and product) used by online companies to market their products/services on a global scale.

Internet: Global communications network consisting of thousands of interconnected networks.

Online Shopping: Purchases carried out through the Internet channel.

Niche Product: Specialized offering with a limited customer base.

Web: World Wide Web, or resources on the Internet that are using the hypertext transfer protocol (HTTP).

Governing Health Care with IT

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INTRODUCTION

The pressures for the health care industry are well known and very similar in all developed countries: altering populations, shortage of resources as it comes to staff and financial resources from the taxpayers, higher sensitivity of the population for health issues, new and emerging diseases, just to name a few. Underdeveloped countries have different problems, but they also have the advantage of being able to learn from the lessons and actions the developed countries made already, maybe decades ago. On the other hand, many solutions also exist, but they all make the environment even more difficult to manage: possibilities of networking, booming medical and health-related research and knowledge produced by it, alternative care-taking solutions, new and expensive treats and medicines, and promises of the biotechnology.

From the public authorities point of view, the solution might be easy: outsource as much as you can out of this mess. Usually, the first ones to go are marginal operational activities, such as laundry, cleaning, and catering services. It is easy to add information systems to this list, but we believe this is often done without a careful enough consideration. Outsourcing is often seen as a trendy, obvious, and easy solution, which has been supported by financial facts on the short run. Many examples show that even in the case of operational information systems outsourcing can become a costly option, not to speak of lost possibilities for organizational learning and competitive positioning through mastering of information technology.

In this article, we discuss how information technology and health care industry work together. Information technology is a valuable resource that must be managed within the health care industry. At the same time, information technology has the potential to renew the whole industry. Good practices in both must be supported by good IT governance.

Health care is a big resource user in every country. In Table 1 we have percentages of health care expenditures in relation to gross domestic product in selected countries, where the percentage is very high (WHO, 2004). As one can see, the cost explosion phenomenon hits both rich and poor countries, even though the wealthiest countries are well presented in the list.

Table 1. Top 20 percentages of health care expenditure in relation to gross domestic product in 2001 in selected countries (WHO, 2004)

USA	13.9
Lebanon	12.2
Cambodia	11.8
Switzerland	11.0
Uruguay	10.9
Germany	10.8
Timor-Leste	9.8
Marshall Islands	9.8
France	9.6
Jordan	9.5
Argentina	9.5
Canada	9.5
Greece	9.4
Surimare	9.4
Australia	9.2
Palau	9.2
Portugal	9.2
Iceland	9.2
Croatia	9.0
Belgium	8.9

Health care costs can be born by different parties within a national economy. Shares of different potential cost carriers vary from national economy to economy:

- The national government, directly or through different indirect arrangements such as separate funds or public insurance institutions
- Municipalities or other local public actors
- Private insurance institutions
- Employers
- The patients themselves

For example, in the United States, the raising costs of health care born by the employers have been a topic of much academic and industry discussion (Berry, Mirabito, & Berwick, 2004). Sadly enough, there is controversial evidence whether information technology can lower the total costs of running health services (Ammenwerth, Gräber, Herrmann, Bürkle, & König, 2003; Ko & Osei-Bryson, 2004).

There are few other forces than modern information technology that could cut down costs in the health care industry. In addition to cost cutting, information technology can provide extended productivity and is an ingredient in the processes that cumulate towards better care practices. But advantages from information technology are not to be harvested without constant focus on IT governance issues in the industry.

BACKGROUND

We have found the following reasons for the late adoption of modern information technology in the health care sector (Suomi, 2000):

- Fragmented industry structure
- Weak customers
- Strong professional culture of medical care personnel
- Hierarchical organization structures
- Handcrafting traditions
- One-sided education
- Big national differences in processes

We will next discuss each of these issues in greater detail.

Fragmented Industry Structure

Good competitors and customers are a key to success for any company and industry (Porter, 1990). Unfortunately, the health care sector has not been able to enjoy from neither of them. For a long time health care has been considered as a faceless public service, where normal competitive forces are not in effect. Health care organizations have not felt each other as competitors, and neither have they documented productive cooperative behavior. First with penetrating privatization the situation is starting to change.

Weak Customers

As it comes to customers, most often they get into touch with the industry when in a critical and sensitive situation, where bargaining power is very low. Bad service has just to be suffered. First during the last few years the concept "customer" has started to substitute the word "patient." Regulative bodies have become active in this respect, and for example in Finland a special patient-ombudsman has been institutionalized and legislation on patient reclamation and insurance has been introduced. In general, new technology is seen as a method to empower patients (Beun, 2003).

Strong Professional Culture of Medical Care Personnel

Professional cultures can have a profound outcome on organizational outcome. Within the health care sector, there are many strong professional cultures, the strongest of them being those of doctors and those of the nurses. People seeking to these professions usually value human interaction, and are not much up for abstract systems such as computers.

Hierarchical Organization Structures

A part of hospital organization has always been a strong hierarchical, professional and specialized structure. Work on the computers, unfortunately, is low on the hierarchy list, especially of course in the activities of keying in patient data that would be a natural thing to do for the doctors. As EITO (1995, p. 46) put it: "*for many Health Care applications, the most difficult obstacles can be social and cultural.*" It is well known that information system development and application can be very difficult or at least different from less bureaucratic organizations than the health care.

Handcrafting Traditions

Even when we conclude that health care is a very information intensive industry, it has not been considered as such one. A good doctor is valued because of his handcrafting skills, especially in surgery, and it is not being understood that behind the handcraft operations a vast amount of knowledge is needed. Some, anyway, have understood that human body is the most complex entity in the world and of which information and knowledge has been collected over thousands of years.

One-Sided Education

Education of health care personnel has traditionally not focused on computer skills. Even the classical university tradition has kept medical and natural science (and thus computer) faculties apart from each other. Fortunately, during the last years, the drive for deeper cooperation between different science fields has begun to bear fruit.

Big National Differences in Processes

Patient care is very culturally bound, and especially the administrative processes behind vary greatly from one country to another. This, of course, makes standardization very difficult and the industry a bad target for suppliers of standard software and platforms. Neither do we have any dominant players in the field that would behave in the market as strong customers and trend setters.

Currently, however, not even the health care industry can not escape the tsunami of modern IT. IT has to be governed within the industry and IT and governance structures meet in two ways. At one side, IT enables new governance structures for the health care industry. On the other, it is an object needing governing. As both sectors offer a multitude of new possibilities, innovations are called for in the industry.

IT governance thinking matures in organizations as any other discipline. Van Grembergen, De Haes, and Guldentops (2003) defined the following stages in their IT Governance Maturity Model:

- Nonexistent
- Initial/ad-hoc
- Repeatable but Intuitive
- Defined Process
- Managed and Measurable
- Optimized

Needless to say, in the health care industry, IT governance thinking is nonexistent or initial/ad hoc in the best situation.

HEALTH CARE, GOVERNANCE, AND IT

The Meaning of IT Governance Structure in Health Care

IT is an old acronym for information technology. Very often it is now replaced with the term *ICT,* referring to information and communication technology. This is to emphasize the communication services that are developing very fast, such as the Internet and mobile services. The letter "C" is often upgraded to the second dimension—alongside communication it can refer to contents. IT or IT governance is defined (IT Governance Institute, 2001) as follows:

IT governance is the responsibility of the board of directors and executive management. It is an integral part of enterprise governance and consists of the leadership and organizational structures and processes that ensure that the organization's IT sustains and extends the organization's strategies and objectives. (p. 10)

For many there is a temptation to understand governance as just a synonym for *management*. This is an oversimplification. Management is a goal-oriented activity, whereas governance is often given from outside, and organizations just have to live with it. This is not to say, that all governance structures would be beyond management control: most governance structures management can influence—at least on the long run. The long run is a key term in many aspects: When referring to governance structures, we talk about structures that are semipermanent and are not changed very frequently. *Structure* is a term closer to *architecture* than to *infrastructure*: governance structures are architectural terms, and are then implemented into infrastructures through different organizational forms. Therefore, the terms *organization form* and *governance structure* are not synonyms. Organizational forms are more formal and touch upon one organization, whereas governance structures are found in a richer selection of forms and organize themselves over a number of organizations. Table 2 summarizes our discussion here.

Governance structures are present in almost any human decision making situation. In Table 3, we have a collection of key aspects of IT governance structure issues in health care.

IT AS A TOOL TO BE GOVERNED IN HEALTH CARE

Information and communication technology needs management in health care organizations as in any other organization. Yet the issue seems to be very difficult for

Table 2. Comparison of terms management, organizational form, and governance structure

	Management	Organizational Form	Governance Structure
Time perspective	Short	Medium	Long
Focus	Action	Internal organization	Interorganizational structures
Management Control	In action	Easy	Difficult
Metaphor	Communication channels	Infrastructure	Architecture
Character	Concrete	Formal	Abstract

the health care organizations. Morrissey (2003, p. 6) paid attention to the fact that health care organizational culture is often hostile to new information technology: *"The expression 'Culture eats Strategy for lunch' has never been more accurate than with physician order entry."* At the same time he documents the frustrations many hospitals and health care organizations have felt in the case of information technology: "*We have bought enough technology and we're not getting the expected value out of it.*" Haux, Ammenwerth, Herzog, and Knaup (2002, p. 19) have paid attention to the weak management of information technology and systems in health care organizations: "*The health care institutions, especially hospitals, must emphasize professional information management more strongly in their organizations.*"

Ross and Rockart (1996) have defined the following success factors for successful IT management:

- Achieve two-way strategic alignment
- Develop effective relationships with line management
- Deliver and implement new systems
- Build and manage infrastructure
- Reskill the IT organization
- Manage vendor partnerships
- Build high performance
- Redesign and manage the federal IT organization

Next, we discuss these issues in the health care IT context.

Two-way strategic alignment means that the organizational strategy affects the IT strategy, and vice versa. The current tumult of health care IT is partly a result of the fact that the effect of IT on health care processes has been denied for too long.

Effective relationship with line management means that communication is fluent and the parties aim at common goals. Effective communication needs a common language. Unfortunately, medical people and IT professionals do not always speak the same language. The applications the staff members use are the face of the information technology to the whole organization. A deliberate balance with investments to the infrastructure as well is needed. Functional applications can not be built on a flimsy base, but overinvestment in infrastructure is always a danger threatening organizations (Broadbent, 1999). Typical key applications of a hospital are electronic patient records (EPRs) and picture archiving and communication systems (PACSs).

Even in the health care organizational environment, IT professionals are under constant educational and skill renewal pressure. One of the big challenges meeting them is that patient data must move over traditional organizational boundaries and therefore must be able to deliver professional services in networked and often virtual organizational settings. The same issue is central in the management of vendor relationships: health care organization's IT staff must be able to integrate solutions from several vendors or, even better, they must be able to put enough pressure to vendors to self integrate their solutions.

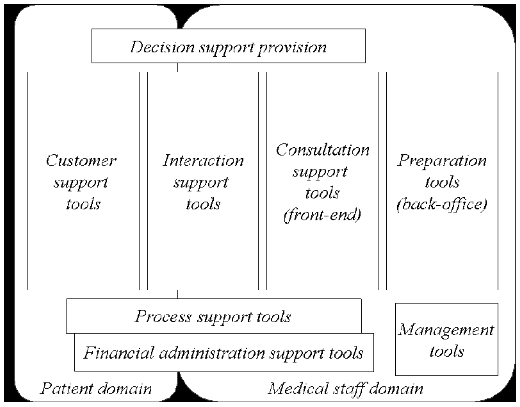
Performance of IT solutions is dependent on many factors. Typical critical resources are time and money. Lack of money can be seen in undersized hardware and software solutions, and lack of IT-professionals time culminates in bad designs for the solutions.

Federal IT organization means that there are both centralized and decentralized IT units in the organizations. Even in big hospitals there is usually just one big IT unit. The federal structure problematic comes more into the foreground in the interorganizational settings of systems.

Table 3. IT governance structure issues in health care

IT as an enabler
Health-related information on the Web
Private-public sector cooperation
Allocation of patients to different levels of care
Customer contacts distribution between electronic and classical means
Ownership, structure and allocation of patient, population-level and other critical data
Electronic forums for patients to interact
Electronic prescription systems
IT as an object to be governed
New legislation needs because of the new data processing possibilities
Data privacy and security
Structure and status of the information resource management in health care units
IT-general management partnership
Sourcing decisions of IT
Charging arrangements on IT-services

Figure 1. Classification of IT tools in health care



IT AS A TOOL FOR GOVERNANCE IN HEALTH CARE

How can information technology help in governing health care? We can approach this issue by taking a look at the application areas of IT in health care organizations. We propose the classification as shown in Figure 1, as adapted from (Suomi, 2000). The classification is a conceptual one, and actual information systems met in health care settings might fit several categories of the framework's systems.

The heart of our classification is in the interaction between the medical personnel and the patient, a kind of basic value-adding chain. In addition to the basic value chain in the middle of the figure, there are certain supporting functions and systems needed.

The figure divides the systems into systems for the use by the patient/customer (patient domain) and by the medical staff (medical staff domain).

We further differentiate between two basic use scenarios of these systems:

1. (patient) self-care scenario
2. (patient-medical staff) interaction scenario

In addition we have the activities of the health care professional or organization, that are not connected to any specific individual patient interaction, but they are of less interest for our analysis here.

SELF-CARE SCENARIO

The self-care scenario means that the patient tries to manage his or her disease or illness without individual professional help. Decision support provision in the self-care scenario helps in self-diagnosis and in deciding whether professional help is needed or not. Internet-provided information is a key component in this category.

Customer support tools help the patient with the daily management of the disease or illness. For example, easy-to-use tools to make different measurements (such as blood pressure) belong to this category. Process support tools are related tools, but focus in the self-care scenario more on the total life cycle of the disease. An example might be computerized tools for keeping track of different measurements. Financial administration tools help in managing the disease or illness condition financially.

INTERACTION SCENARIO

In the patient-medical staff interaction scenario, decision support helps to diagnose the patient and to decide what kind of care he or she needs. Now the decision is made in cooperation between the medical staff and the patient, not just by the patient, as in the self-care scenario.

Customer support tools are used in the same way as in the self-care scenario, but there they also help the patient to prepare for the interaction with the medical professionals.

Interaction support tools are active in the situations where the medical staff and the patient meet. This meeting can take many forms: it can be a physical meeting, a virtual meeting through electronic means, or some combination of these. Doctors often want to keep physical meetings technology free, but technology can help even in these cases, say to facilitate communication in the case of sense disabilities or language problems. In a virtual meeting, different systems such as phone or e-mail services belong to this category as well as those different applications of telemedicine.

Consultation support tools and preparation tools are to be used by the medical staff. Consultation support tools help the medical staff members during an individual customer consultation, whereas preparation tools are active outside the actual customer interaction. An example of consultation support systems might be a system used to support surgery operations.

In our analysis, the information domains are important. Customer support tools contain information for the patient and are used by him or her. Interaction support tools contain joint information and are used by both patients and medical staff. Consultation support tools contain patient-specific information that is targeted just for the medical staff.

To clarify the proposed value chain, take the example of a laboratory test. For the test, the customer might have to prepare himself or herself by not eating anything. The customer might obtain this information the hospital's

Web site or a customer-support tool. An electronic patient card that would help in identifying the patient during the testing would be an interaction support tool. Analyzing the test would be a back-office function for the preparation tools. Analyzing the laboratory results and working out how to tell the results of the test to the customer in a comprehensive way could be facilitated by a consultation support tool.

Process support tools in the interaction scenario help in organizing the interactions between the patient and the medical staff (e.g., different consultation time reservation, queue management systems). Financial administration of the patient-medical staff interaction is one part of this. Electronic systems for handling prescriptions also belong to this category.

Finally, a health care organization has to maintain a lot of management routines that are not connected to any individual patients. Resource planning and management systems and statistics keeping are examples of this domain.

The information in Figure 1 is not to say that the different health care systems would be independent isles of automation. All the systems included in the figure should be integrated by a comprehensive electronic patient record.

FUTURE TRENDS

In Table 4, we list the most dramatic changes we will see in the health care sector because of modern IT and the challenges these changes cast on the IT governance.

One of the biggest changes in the industry is that information related to health, diseases, sickness, and medicines is not scarce. Internet is a rich source of such information, at different levels of expertise, and in different languages. The gap between what information is available and what a health care professional should know is growing fast (Weaver, 2002); similarly, the pressures for laymen to know about medical issues grow. Decision support is needed more than ever in this plentitude of information. Different solutions should be found to differentiate right information from wrong, especially in the case of information targeted for laymen, such as most of the information found on the Internet.

Free information will shift the power balance between health professionals and patients: More often, the patients are the best experts on their disease, and self-care will grow in importance. Systems to support self-care must be developed. Different electronic forums or virtual communities will offer the patients forums to share experiences and peer advice, to the healthy ones as well as to the chronic and acute sick (Utbult, 2000).

If the patients get more empowered, they should too get more responsibility. Health care information systems should not just keep track of medical staff decisions, the decisions taken by the patients should also be recorded to the systems.

Similarly, the interaction between the patients and health care professionals is going to change: Electronic means are going to take share from face-to-face meetings (Cain, Sarasohn-Kahn, & Wayne, 2000; Gilson, 2003). A key survival factor for all the electronic sources of health information and all communication channels to be used by

Table 4. Future changes in the field of health care introduced by modern IT and the challenges to IT governance produced by them

Future changes in the field of health care introduced by modern IT	**Challenges to IT governance**
The amount of free medical information will grow very fast	Mechanisms to rate different information sources have to be developed
Patient self-care will grow in importance	Systems to support self-care must be developed
Patient empowerment will gain in importance	Customer rights and decisions must be tracked in medical information systems
Interaction between patients and medical staff will increasingly turn away from physical meetings to electronic means	Electronic means to facilitate patient-medical staff communication must be developed
Data collected about patients will grow in amount and quality	Data privacy needs even more concern
Medicalization of the society	Medical and other information systems will have to be linked sophistically
Costs of medical care will continue to raise	Cost monitoring will grow in importance
Focus should turn from individual care-taking episodes and consultations to long-term care-taking relationships and processes	Pressures to develop electronic patient records
Resources of the area will not grow as fast as demand	Information systems must be used for process redesign

the patients is how they can build and sustain customer/patient trust (Luo & Najdawi, 2004).

Medicalisation of the society (Conrad, 1992) is a strong trend. Increasingly more issues in human life are seen as belonging to the sphere of medical expertise. If and when we accept this trend, medical decision makers need information about our lives in many aspects. As patient data can be electronically cumulated into huge databases, these databases can be used for different statistical, research, and other purposes. This calls for care and proper legislation giving the ramifications for data usage. For example, often the need of integrating data about one's health and social life arises, if effective care is looked for. Needless to say, we enter a difficult area where data privacy issues gain in importance.

Science and industry will continue to produce increasingly effective cure methods and medicines, but not always without increased costs. It is clear that not everyone can be granted the best possible care with public finances. Systems for keeping track of costs and making cost-informed care-taking decisions will be needed in the future.

For organizing patient flows through the health care system modern IT offers many possibilities. A key issue is to follow the long-term development of the patient, not to focus just on short-term episodes of care. This puts pressures on the electronic patient record systems.

Resources can be saved or wasted through care-taking decisions. It is for sure that in many nations the total share of health care costs is at its top already, so current resources should be used more efficiently. Efficiency, among other things, means that patients are taken care of in the best and most effective places, be they public or private, and of right level of expertise. This all calls for extensive process redesign and system support for that. Should patient data be all the time available anywhere though electronic means, would the Healthcare Supply Chain be much more effective (More & McGrath, 2001).

CONCLUSION

Health is undoubtedly among the most important issues for all people. In a modern society, the threats towards health are changing all the time, but at the same time the possibilities to maintain health and to cure illnesses also grow exponentially. The task is to make needs and solutions to meet in an effective way. This is about information and communication technologies and governance structures.

Modern IT allows health care organizations to structure themselves in new, innovative ways and simultaneously to empower the customers to interact with the organizations, with fellow patients and information sources in revolutionary new ways. In this environment, health care professionals too have to adjust their roles.

Managing and building governance structures for IT in health care organizations is not that much different from other organizations. Even in health care organizations the scope and status of information resource management has to be decided. Issues such as sourcing decisions, charging arrangements and data privacy and security issues all deserve their attention. There are, anyway, certain problems that need to be solved in this area:

- Data privacy and security needs are extremely important and might sometimes conflict with optimal care.
- As the area is new, legislation is often lagging behind.
- The field is a meeting place for two strong professional cultures, that of medical doctors and IT professionals, which might bring along difficulties.

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KEY TERMS

Electronic Patient Record: All health-related information related to a patient in electronic form, assembled as a single entity.

Electronic Prescription: Prescriptions created and handled in electronic form in an integrated information system.

Health Care Supply Chain: A managed set of activities related to the health care activity of a patient organized so that all information needed is all the time available and that the participants in the chain have a complete picture of the total process.

Picture Archiving and Communication System: A system for capturing, storing and distributing medical images. These systems are fast turning from storing analog images to storing digital images.

Sourcing Decision: Whether to buy goods/services from the market or to make them self—alone or in different alliances.

Virtual Community: A social aggregation on the Internet when people interact long enough to form personal relationships.

Graphical Content on Mobile Devices

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INTRODUCTION

The enthusiasm for mobile computing is still unbroken as a year on year increase of 51% in the overall global shipments of mobile devices in the fourth quarter of 2004 has shown (Canalys.com, 2005). With 300 million new subscribers in 2004 alone, 27% of the world's population now has access to mobile communications (Svanberg, 2005). A mobile device is a natural multi-functional device and the opportunity to handle multimedia data is only the first step on a long way. Although the development of mobile devices has already made great progress, handling graphical data is still expensive due to the limited resources in mobile environments. Especially if large graphics must be processed limits are quickly reached. However, it is necessary to provide effective and appealing graphical representations for successful m-commerce.

The aim of this article is to derive major limitations of current mobile hardware and to show how large graphical content can be appropriately processed on such devices. Since visual content can be described either by vector (SVG, Flash) or raster data (Bmp, Gif), both approaches are explained and particular properties are shown. Based on experimental results, this enables us to give guidelines for the appropriate handling of large graphical contents in m-commerce applications.

This contribution is structured as follows: in the section titled "Background", properties of current mobile devices are reviewed and the displaying pipeline together with basic principles of vector and raster images is explained. These statements form the basis for our tests and comparisons in the "Main Discussions" section and statements for future work in the "Future Trends" section. Since there are huge differences in the performance in the handling of vector and raster images, we close our contribution by giving implementation guidelines for applications presenting large graphical content on mobile devices ("Conclusion"). "References" and "Key Terms" serve to provide sources for cited literature and definitions for related terms.

BACKGROUND

Recent Work

Effectively representing information by graphical means is a key issue in m-commerce applications. Many publications describe the processing of graphical content in mobile environments, but they are rather limited to WWW-browsers (Joshi et al., 1996), interaction issues (Rekimoto, 1996) or other specific problems (Rist, 2001; Want et al., 2002; Karstens, Rosenbaum, & Schumann, 2003). Nevertheless, these publications neither describe the actual efforts needed to process the used graphical data, nor do they consider the nature of the content description actually used. Due to limitations of mobile devices, this can be of crucial interest since each kind of data is processed differently, which might even render an accepted approach impossible if provided resources are exceeded. This has been shown in (Rosenbaum & Tominski, 2003) by a comprehensive investigation of the processing and display pipeline of mobile hardware.

Related Limitations of Mobile Devices

Due to fast progression in this research field, properties of mobile devices change quickly. Thus, current limitations regarding the handling of large images are not the same as a few years ago (Rosenbaum & Tominski, 2003). We found, that some constrains still exist (e.g., screen size/resolution, processing power), whereas some have strongly decreased (storage space) or have been overcome (lack of color). To give the reader an impression of current hardware, we compiled a list of important properties of current mobile devices (Table 1). Since classic tablet-PCs or Laptops are more aligned to stationary systems than to light-weight mobile assistants, they have not been considered.

Table 1. Specifications of different mobile devices (03/2005)

Devices	Display	Resolution	Colours	Processing power	RAM
Mobile:					
Siemens SXG75	2.2”	240 × 320	18bit	-	128MB
Hagenuk S200	2.2”	160x220	16bit	Texas Instruments OMAP 310	32MB
Samsung i600	- -	176x220 128 x 32	16bit -	Intel® PXA250 200MHz	32MB
Palm Treo 650	2.5”	320x320	16bit	Intel® PXA270 312MHz	32MB
Asus **MyPal** P505	2.8”	240x320	16bit	Intel® PXA272 520MHz	64MB
Qtek 9090	3.5”	240x320	16bit	Intel® PXA263 400MHz	128MB
Palmsize:					
Palm Zire 72	2.5”	320x320	16bit	Intel® PXA270 312MHz	32MB
BlackBerry 7750	3.0”	240x240	16bit	-	16MB
Palm Tungsten-T5 Premium	3.7”	320x480	16bit	Intel® PXA272 416MHz	256MB
Sony Clié PEG-UX50	4.0”	320x480	16bit	Sony CXD2230GA 123MHz	64MB
Handheld:					
Gizmondo Force	2.8”	240x320	-	Samsung ARM9 S3C2440 400MHz + GPU Nvidia Goforce 3D 4500	64MB
Fujitsu Siemens LOOX 720	3.6”	480x640	16bit	Intel® PXA272 520MHz	128MB
Sharp Zaurus SL-6000	4.0”	480x640	16bit	Intel® PXA255 400MHz	128MB
Toshiba Pocket PC e830	4.0”	480x640	16bit	Intel® PXA272 520MHz	128MB
Dell Axim X50v	3.7”	480x640	16bit	Intel® PXA270 624MHz + GPU Intel® 2700G - 16MB	196MB
HP iPAQ HX4700	4.0”	480x640	16bit	Intel® PXA270 624MHz	128MB
Sony VAIO U71	5”	800x600	24bit	Intel® Pentium® M733 1100MHz + GPU Intel® 855GME – 64MB	512MB
Stationary PC:					
generic	21”	2048x1536	32bit	Intel® P4-570J 3800MHz + GPU Nvidia GeForce 6800 Ultra	1 GB

Screen Dimension

The relatively small screen dimension is one of the major drawbacks of mobile devices if large graphical content is to be presented. The display size of current devices varies dependent on the respective device class and spreads from 2 to 5 inches screen diagonal, which is by far less than what is offered by common stationary devices. Thus, the available space for presenting images is very limited and most parts of the content might be hidden. Interestingly, some mobiles offer a second, smaller display to show additional data.

Screen Resolution

The pixel density of mobile displays is rather high. Some devices offer a resolution of 800×600 by a screen dimension of only 5 inches. This leads to a very detailed presentation of the content. Nevertheless, this property is limited by the human visual system, which can resolve visual content only up to a certain extent (Hubel, 1988; Wandell, 1995). Thus, the provided space to display data is and will be by far lower compared to stationary gadgets.

Processing Power

The appropriate handling of graphical content is heavily affected by the available processing power. Due to the dimensions of mobile devices, it is not possible to include hardware with performance similar to stationary devices. This is mainly due to the limited energy supply. Although the speed of current systems has increased a lot, the performance regarding data processing is innately much slower. An interesting trend is the use of additional GPUs to improve the processing of graphical data. Currently, they are only provided by two devices specialized on gaming (Gizmondo) or highly detailed output (Sony VAIO), but are expected to be supported by other devices too. The advent of such additional peripherals will strongly enhance the handling of visual content in the near future (Rasmusson, Dahlgren, Gustafsson, & Nilsson, 2004).

Other Limitations

As predicted in (Rosenbaum & Tominski, 2003), nowadays mobile devices offer by far more storage space than two years ago (Table 1). Thus, limitations in image handling are mostly overcome and might only occur if many images must be handled or stored at same time. Minor limitations, as user interaction and data transmission, do not influence content presentation and are considered to be out of scope for this article.

Presenting Graphical Content on Mobile Devices

Working with mobile hardware causes a variety of problems due to limited capabilities of such devices. In this section we want to review basic steps of the display pipeline for graphical data together with important properties and requirements which should be fulfilled to allow a convenient and effortless exploration process. This gives us clues for later examinations and statements.

Before graphical content can be shown on screen, it must pass the display pipeline. First, it must be loaded to memory. Here, properties like *file size* and *file format* play an important role. Since the content is often encoded, *loading* can be further split in pure *file reading* and the following *decoding* in memory. Based on this, more detailed statements can be derived about affected properties of the device. After the loading step, the content is stored in an internal memory representation (IMR) forming the basis for the later display. There are different approaches for such internal representations, which can even coexist at the same time. The IMR itself is mainly influenced by the properties *image dimension* and *precision*, but also by image content. The final pipeline step shows the whole or part of the IMR on screen. Here, all current devices make use of a discrete raster display with a certain *screen resolution.* Since there are rather different approaches for the IMR, their demands on the display step vary heavily and are worth being examined.

Arbitrary graphical content can be described by either raster or vector graphics. Due to the fact that each approach uses completely different ways to describe graphical content, they require different resources at the respective pipeline steps.

Raster graphics are used in areas where content is rather complex, (e.g., in digital photography). When using raster graphics, image content is described by pixels arranged on a regular 2D-grid of certain *image dimension* and *precision*. Each pixel is independent from others regarding its color, which causes a quite large *file size* if using spatially extensive graphics at high precision. Thus, raster data is often stored in compressed representation (e.g., in PNG- or JPEG-format), only sometimes uncompressed (e.g., in BMP-format). The used *file format* heavily influences the time to load the content, whereby formats producing a small *file size* need generally more processing power for decoding, but are faster to read. However, the structure of the resulting IMR, mostly a bitmap, is the same, and no conversion is necessary to map the IMR to display. Nevertheless, additional modifications (e.g., for zooming operations) might influence the presentation quality.

Vector graphics use simple geometric primitives and their attributes to describe image content. Due to this principle, it is necessary that the graphical content can be appropriately described by such primitives, (e.g., in technical drawings). Content described by vector primitives is often smaller than raster data. Thus, *file size* is also smaller, and the demand for processing power while loading is little. This might not always be the case, and depends strongly on the *number* and *complexity of primitives*. In contrast to raster graphics, the IMR can be rather different for vector data. The most obvious approach is to store a description of the vector primitives and to render them directly to screen at display time (*direct drawing*). Here, the *number of primitives* and *complexity* are the main properties to consider. To achieve differently zoomed as well as panned views, a transformation matrix is preliminarily applied to primitives. By doing so, no information is lost and the visual appearance is very good. Unfortunately, this is costly in terms of processing power, especially if the *number of primitives* is large, and can be even worse if *primitive complexity* is high. To reduce these needs, it might be useful to render the whole content after decoding to an IMR-bitmap. Thus, similar results as for raster data can be achieved for display time. We refer to this approach as *indirect drawing*. Common *file formats* to store vector graphics in mobile environments are Macromedia Flash (Besley & Bhangal, 2003) and SVG (Scalable Vector Graphics) (W3C, 2001).

It has been proposed that while exploring large raster or vector graphics on mobile devices, two main requirements should be fulfilled (Rosenbaum & Tominski, 2003):

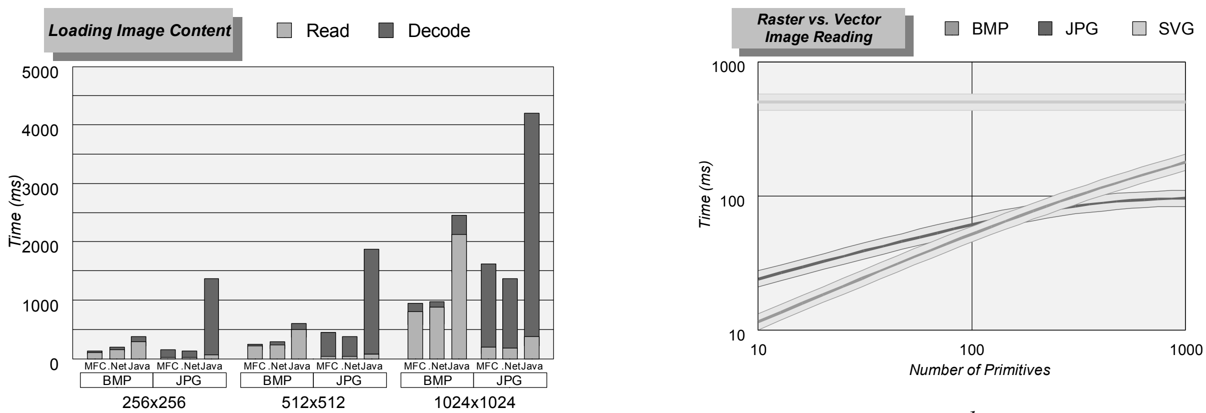
- High presentation quality
- Short presentation and update time

The degree of accomplishment of these requirements varies for raster and vector graphics, hardware capabilities, and user interaction. Regarding interaction, we constrain our statements to the elementary zoom and pan approach since more sophisticated techniques are mostly a combination of the different options offered by this method. Interaction further requires the distinction in *presentation* and *update time*. While presentation time spreads from loading until displaying, update time only considers the time to display the IMR.

MAIN DISCUSSIONS

In this section, we present results derived from our experiments with large graphical contents described by raster and vector images in m-commerce environments. The results are taken by using a modern LOOX 720 running with Pocket PC2003 and providing average performance compared to the devices listed in Table 1. To extent the applicability of the statements, we used different programming environments–MFC (Microsoft Foundation Classes), .Net Compact Framework, and Java to also consider their rather varying performance. *Presentation quality*, *presentation time*, and *update time* are the key points we are focusing on.

Figure 1. (a) Loading time of graphical content using raster images of different dimension and format, and (b) Pure reading time of vector and raster images with varying content.



b.

a.

Presentation Quality

A high presentation quality is mandatory for creating successful m-commerce applications. Such high quality representations can be achieved if the graphical content can be rendered to the display without loss of information.

For raster graphics some loss of information occurs if content must be scaled, (e.g., for zooming). If so, we got the worst results if build-in system functions were used. Especially when downscaling, pixels are simply omitted without regarding their color. Better results can be achieved by using the more complex filtered scaling, which on the other hand strains the computational abilities of the mobile device.

In case of vector graphics, panning and scaling operations are lossless (i.e., do not cause loss of information). However, there is a slight decrease in quality due to the rasterization necessary to map primitives to IMR/screen. This might be reduced by using anti-aliasing techniques, which again come at a computational cost.

Presentation and Update Time

Fast access to graphical information is another issue in m-commerce applications. Before presenting an image it must be loaded and mapped to IMR. To meaningfully compare raster graphics, examples of different *image dimension* were selected. As shown in Figure 1(a), loading time increases linearly with *image dimension*. Since the used *image format* does strongly influence processing time, we measured properties of BMP- and JPEG-images. JPEG-encoded images are much smaller than BMP-images, and can be read more than 10 times faster. While *file size* of BMP-images depends only on *image dimension*, it might vary for JPEG-images. If image content changes, compression ratio and *file size* are influenced, which also affects the time to read the image (Figure 1b).

To evaluate loading time, decoding of image content must also be considered. Since image content in BMP-files is stored uncompressed, no additional efforts are necessary. Not surprisingly, JPEG-images need significantly more time for decompression than for reading. Thus, loading time for JPEG-images increases dramatically and is, in overall, higher than for BMP-images. As shown in Figure 1a the testbed implementations based on MFC and .Net achieve similar results and outperform Java by a factor of about two.

For vector images, it is more difficult to derive statements regarding loading time. While for raster images creating an IMR is straightforward, vector images must be parsed and analyzed. Here, loading time depends even stronger on the used *file format*. If using Macromedia Flash, which is based on an optimized and even compressed binary description, files are fast to read. Contrary, SVG is based on XML grammar, and thus *file size* is bigger and processing the content is more expensive. Hence, loading SVG-files is innately slower than loading Flash. Due to the absence of a freely available SDK for accessing Flash-files, we restricted our measurements to the reading of SVG-files (Figure 1b). As assumed, reading time is highly correlated with the *number of primitives*.

As shown in Figure 1b, the time to load raster graphics is only loosely coupled with the content. Contrary, loading vector graphics depends strongly on the *number of primitives*. Thus, if only a few primitives are processed, vector graphics are faster to read than raster graphics. The break-even in our example is reached by using slightly more than 150 primitives. The concrete value also de-

Figure 2. Direct drawing of vector primitives with different complexity

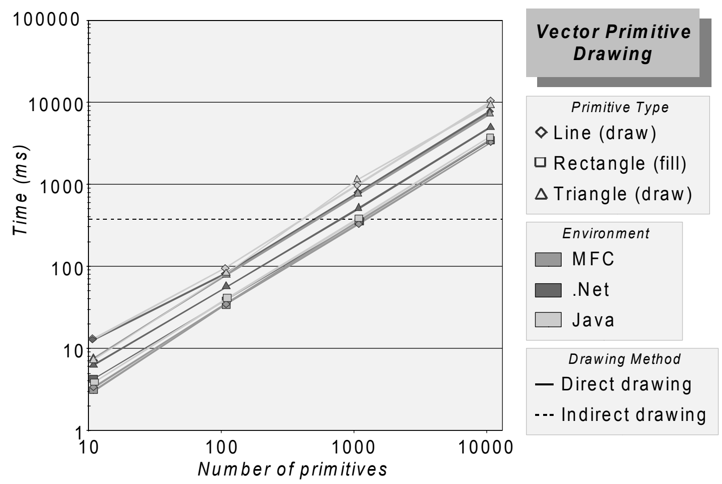
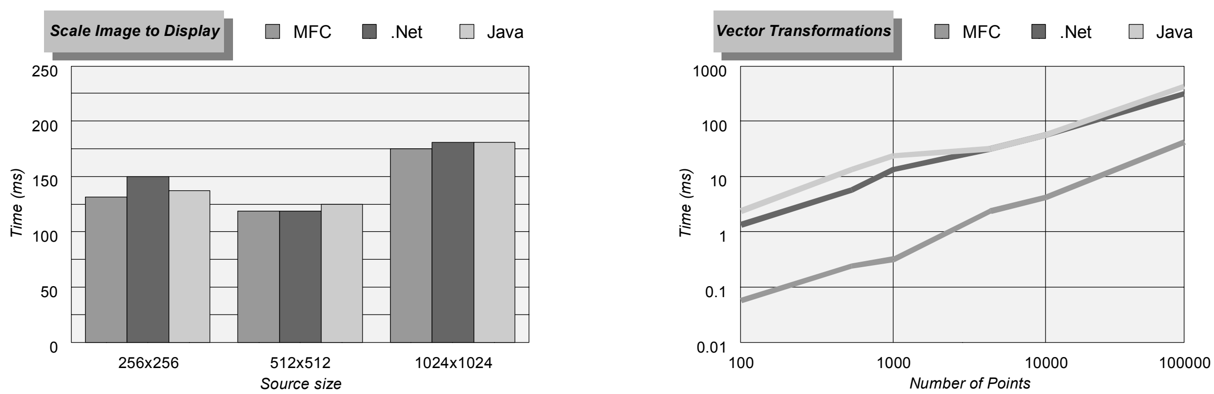


Figure 3. Performance of scaling operations for (a) raster- and (b) vector graphics



a. *b.*

pends on *primitive complexity*. If more or complex primitives are needed to describe the content, (e.g., to build a texture), better results are achieved by using raster data.

When the content is available in IMR, it can be shown on screen. As described above, the IMR of raster data can be rendered directly to display. Thus, update time mainly depends on *screen resolution*. For the handheld used, processing takes approximately 130ms in all tested environments. This update time stays constant even if *image dimension* exceeds *screen resolution*. Obviously, if *image dimension* is lower than *screen resolution*, a faster update time can be achieved. This also applies for *indirect drawing* of vector data, where only the IMR-bitmap must be transferred to screen (Figure 2). Thus, the same fast update times can be achieved. Since all primitives have already been drawn to the IMR-bitmap and been discarded, update time is completely independent from *primitives complexity*.

To simulate common applications for *direct drawing* of vector images, we measured the display time of several types of graphical primitives. As shown in Figure 2, update time increases depending on *primitive number* and *complexity*, whereby drawing triangles takes the most time. There are also differences depending on the used programming environment. Here, MFC performs best in most of the tests, but the advantage over .Net is often marginal. Contrary, Java is up to twice as slow.

Regarding an interactive exploration using zoom and pan, we examined how panning and different scaling operations affect update times. Since for panning simply a different image part is shown, there is no difference regarding update time for raster data. However, zooming is different and time to transform the content depends heavily on *image dimension* and *screen resolution.* To show this, we measured the time required to scale images of different *image dimension* to *screen resolution* (Figure 3a). Surprisingly, all programming environments achieve similar results. Nevertheless, more complex scaling techniques are slower than straightforward approaches.

Panning and zooming for vector primitives is realized by using a transformation matrix. In order to compare scaling, we measured how long such matrix multiplications take. This depends especially on *primitive number*, respectively points. If more points must be transformed, it takes more time to process them. As shown in Figure 3b, integer vector transformations can be computed rather fast on mobile devices. As expected, calculations in double precision are much slower. The fastest transformations are achieved by the MFC-implementation.

FUTURE TRENDS

The mobile sector is subject to rapid development of the belonging hardware. Thus, computational power of mobile devices will also increase and the application area of vector graphics will surely expand. The inclusion of additional GPUs in current devices seems to back this outlook. Furthermore, more sophisticated compression approaches for raster images, as JPEG2000, require more computing power to be processed. Nevertheless, they provide better performance, and even more interesting, many additional features for interactive imaging (Rosenbaum & Schumann, 2005). Thus, our conclusions given in the next section might still be valid for the near future.

CONCLUSION

Summarizing, we stated the properties of current mobile hardware to show still existing limitations of such devices. This gave us the motivation to review the displaying pipeline together with important properties of vector and raster data in order to derive statements for an appropriate handling of graphical content in such environments. Based on this, concrete tests and comparisons have been conducted and lead to the following statements when to use raster or vector data in m-commerce applications:

- **Graphics loading**
  - Loading time depends strongly on the used file format.
  - Loading raster data is generally fast but requires additional computational efforts if content must be decompressed.
  - Loading vector data is fast for up to about 150 primitives.
- **Graphics rendering**
  - Drawing raster data is fast on mobile devices.
  - Rendering vector primitives directly to display is generally slow and depends on primitive number and complexity.
  - Rendering vector primitives indirectly using an IMR-bitmap achieves fast update times.
- **Quality**
  - Simple scaling of raster data is fast but leads to low quality presentations.
  - Scaling vector graphics by integer matrix multiplications is very fast and achieves high quality.
- **Development environment**
  - Implementations based on MFC are fastest.
  - .Net and Java implementations often achieve a similar performance

Our claim was also to answer in which circumstances raster or vector data are more suitable for presentation of large graphical contents on mobile devices. We found that both classes have their eligibility depending on the content and external demands, like quality vs. response time. In case of simple graphics, which can be described by less than 150 primitives, vector graphics performed best. Vector graphics also offer better quality than raster graphics. On the other hand, our measures show that raster graphics are better suited if large and complex graphics must be presented, since their system requirements are content independent. They are simply not as complex as vector graphics, and thus, easier to handle. Due to this, they fit to current mobile hardware, and we favor raster graphics to describe graphical content in such environments.

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KEY TERMS

Displaying Pipeline: Collective term for the different stages which must be passed to show *graphical content* on screen.

Graphical Content: Information represented by an image, perceived via the human visual system.

Image Format: Used to permanently store *graphical content*, based on the use of *raster graphics* or *vector graphics.*

Limitations (of *Mobile Devices*): Hardware restrictions mostly imposed by the application area, main limitations are processing power, screen dimensions and transmission bandwidth.

Mobile Devices: Gadgets not needed to be attached for a certain place, mostly subject to certain *limitations.*

Raster Graphics: Approach for the description of *graphical content* by color points arranged on a regular pixel grid.

Update Time: Time necessary to draw *graphical content* to display, the update step is part of the *displaying pipeline.*

Vector Graphics: Approach for the description of *graphical content* by *vector primitives.*

Vector Primitive: Geometrical object with certain properties, mostly belonging to one of the basic classes: point, line, or triangle.

Category: Concepts, Trends, and Challenges

High Availability and Data Consistency for Three-Tier Enterprise Applications

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INTRODUCTION

Enterprise applications, such as those for e-commerce and e-government, are becoming more and more critical to our economy and society. Such applications need to provide continuous service, 24 hours a day, 7 days a week. Any disruption in service, including both planned and unplanned downtime, can result in negative financial and social effects. Consequently, high availability and data consistency are critically important for enterprise applications.

Enterprise applications are typically implemented as three-tier applications. A three-tier application consists of clients in the front tier, servers that perform the business logic processing in the middle tier, and database systems that store the application data in the backend tier, as shown in Figure 1.

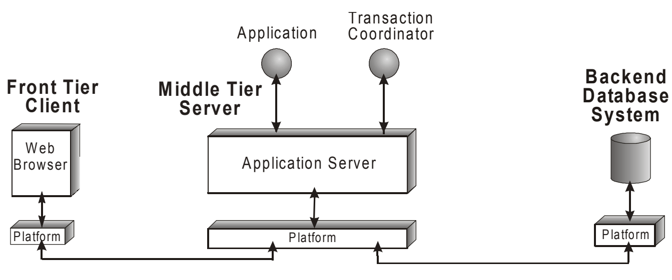
Within the middle tier, a server application typically uses a transaction processing programming model. When a server application receives a client's request, it initiates one or more transactions, which often are distributed transactions. When it finishes processing the request, the server application commits the transaction, stores the resulting state in the backend database, and returns the result to the client.

A fault in the middle tier might cause the abort of a transaction and/or prevent the client from knowing the outcome of the transaction. A fault in the backend tier has similar consequences. In some cases, the problems can be a lot worse. For example, a software design fault, or an inappropriate heuristic decision, might introduce inconsistency in the data stored in the database, which can take a long time to fix.

Two alternative recovery strategies, namely roll-backward and roll-forward, can be employed to tolerate and recover from a fault. In roll-backward recovery, the state of the application that has been modified by a set of unfinished operations is reversed by restoring it to a previous consistent state. This strategy is used in transaction processing systems. In roll-forward recovery, critical components, processes, or objects are replicated on multiple computers so that if one of the replicas fails, the other replicas continue to provide service, which enables the system to advance despite the fault. Many applications that require continuous availability take the roll-forward approach. Replication is commonly employed in the backend tier to increase the reliability of the database system.

There has been intense research (Frolund & Guerraoui, 2002; Zhao, Moser, & Melliar-Smith, 2005a) on the seamless integration of the roll-backward and roll-forward strategies in software infrastructures for three-tier enterprise applications, to achieve high availability and data consistency. *High availability* is a measure of the uptime

Figure 1. A three-tier enterprise application



of a system, and typically means five nines (99.999%) or better, which corresponds to 5.25 minutes of planned and unplanned downtime per year. *Data consistency* means that the application state stored in the database remains consistent after a transaction commits. Both transactions and replication require consistency, as the applications execute operations that change their states. Transactions require data consistency, and replication requires replica consistency.

BACKGROUND

Transaction Processing

A transaction is a set of operations on the application state (Gray & Reuter, 1993) that exhibit the following ACID properties:

- **Atomicity:** Either all the operations succeed in which case the transaction commits, or none of the operations is carried out in which case the transaction aborts.
- **Consistency:** If the application state is consistent at the beginning of a transaction, the application state remains consistent after the transaction commits.
- **Isolation:** One transaction does not read or overwrite intermediate results produced by another transaction—that is, the transactions appear to execute serially.
- **Durability:** The updates to the application state become permanent (or persist) once the transaction is committed, even if a fault occurs.

A transaction processing (TP) system typically consists of a TP monitor, communication channels, database servers, operating systems, and applications. A TP monitor provides tools, mechanisms, and application programming interfaces (APIs) to ease or automate the application programming, execution, and administration of the transactions.

When a transaction involves operations on more than one computer, it is called a *distributed transaction*. In a distributed transaction, an atomic commit protocol is necessary, so that the ACID properties hold for the state at all of the computers involved in the transaction. The most popular atomic commit protocol is the two-phase commit (2PC) protocol.

The 2PC protocol involves a transaction coordinator, which drives the protocol, and one or more transaction participants, which control the application state to be persisted. The 2PC protocol involves two phases of message passing. In the first phase, the coordinator sends a request to *prepare* to all of the participants. If a participant can successfully write its update to persistent storage, so that it can perform the update even in the presence of a fault, the participant responds to the coordinator with a "Yes" vote. At this point, the participant is *prepared*. If the coordinator collects "Yes" votes from all of the participants, it decides to *commit* the transaction. If the coordinator receives even a single "No" vote, or if a participant does not respond and is timed out, the coordinator decides to *abort* the transaction. In the second phase, the coordinator *notifies* the participants of its decision. Each participant then either commits or aborts the transaction locally and sends an acknowledgment to the coordinator. The coordinator can *forget* the transaction once it receives acknowledgments from all of the participants in the second phase.

Because of its simplicity and efficiency under fault-free conditions, the 2PC protocol has been adopted as the atomic commit protocol for many distributed transaction processing specifications, including the XOpen/XA specification (The Open Group, 1992) and the CORBA OTS specification (Object Management Group, 2000). The 2PC protocol is used by essentially every commercial TP monitor and database server for distributed transaction coordination within a single enterprise.

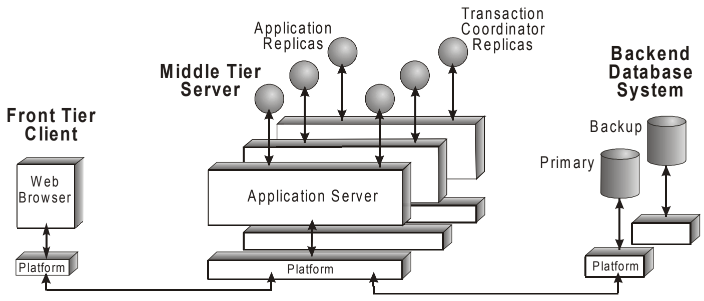
Replication

Component, process, or object replication, based on the virtual synchrony model (Birman & van Renesse, 1994) is often regarded as orthogonal to transaction processing. Critical components of a distributed system are replicated to achieve the required reliability and availability, so that the failure of one of the replicas will not bring down the entire system.

Active replication, passive replication, and semi-active replication are the most common replication strategies, which are defined as follows (Powell, 1991):

- **Active Replication:** All replicas perform exactly the same actions in the same order and output their results.
- **Passive Replication:** Only one replica (the primary) executes in response to the client's requests. Passive replication has two variations: warm passive replication and cold passive replication. In warm passive replication, the primary periodically checkpoints its state at the other executing replicas (the backups). In cold passive replication, the backups are not launched until the primary is detected to have failed.
- **Semi-Active Replication:** Semi-active replication is a hybrid of the active and passive replication strat-

Figure 2. The use of both replication and transaction processing for three-tier enterprise applications



egies. In semi-active replication, both the primary and the backup replicas execute the operations, but the backups follow the directives of the primary, and only the primary outputs the results.

To provide a single copy image to the other components in the distributed system, and to maintain replica consistency, systems that provide replication use a fault tolerance infrastructure to manage the replicated objects. The most challenging aspect of replication-based fault tolerance is maintaining replica consistency (Narasimhan, Moser, & Melliar-Smith, 2002), as methods are invoked on the replicas, as the states of the replicas change, and as faults occur. The basic strategy for maintaining replica consistency is to start the replicas in the same state and to ensure that they perform the same operations in the same order. In such a fault tolerance infrastructure, a multicast group communication system (Melliar-Smith & Moser, 1999) is typically used to provide reliable totally ordered multicasting of messages and group membership services.

THREE-TIER ENTERPRISE APPLICATIONS

To provide high availability and data consistency for three-tier enterprise applications by integrating replication and transaction processing, one must consider the client tier, the middle tier containing the server applications, and the backend tier containing the database system, which are discussed below. The use of both replication and transaction processing for three-tier enterprise applications is shown in Figure 2.

The Client Tier

The client tier of a three-tier enterprise application typically consists of Web browsers and is notoriously unreliable. A Web browser might freeze or crash unexpectedly due to software bugs in the browser or in the operating system on which the browser runs. The user of a Web browser might decide to quit without giving appropriate notice to the server. In addition, the network connection between the client tier and the server in the middle tier might break unexpectedly.

Developers of enterprise applications have been well aware of these problems and have often incorporated specific solutions into their applications. From the server's point of view, there are two concerns. First, valuable server-side resources should not be wasted if the client crashes, or becomes inactive, or quits. Second, service should be provided to the clients, preferably with exactly-once semantics, even if the client fails briefly, as long as it can recover later.

The first concern is typically addressed by creating a session each time a client logs in and by keeping the session open only while the client is active. When the session is closed, all server-side resources, such as database connections, are garbage-collected or reused by other clients' sessions.

The second concern is often addressed by using a technique called "cookies." A cookie is a small string that is generated by a Web server as a byproduct of a client's request, sent with the server's response to the client, and stored at the client's computer, usually in a separate file. Later requests from the same client to the same server carry the cookies created earlier, so that the server can recognize the client. Sometimes, cookies can be used to detect duplicate requests to the server. For example, a cookie can be generated by a Web server immediately before a client initiates an online payment. If for any reason the client retries the online payment, the same cookie would be used by the client's requests. The server can easily recognize this by storing the cookie with the first online payment request and by comparing the cookie in the duplicate request with the one it stored. If the server cannot guarantee exactly-once semantics, the server should provide enough information to the client, so that the client can determine if an earlier attempt succeeded.

The Middle Tier

The middle-tier server applications interact with the clients directly and execute according to predetermined application business logic. Therefore, it is important to provide fault tolerance in the middle tier.

For large enterprise applications, a transaction often spans several database systems, which requires the middle tier to run transaction monitoring middleware to coordinate the commitment of distributed transactions. Typically, the 2PC protocol is used for distributed transaction coordination within a single enterprise. The 2PC protocol is a blocking protocol in that the transaction participants might be blocked for an extended period of time waiting to commit or abort a transaction, if the transaction coordinator is temporarily inaccessible. Although practical implementations of the 2PC protocol allow a participant to make heuristic decisions regarding the outcome of a transaction, continued processing without waiting for the coordinator to recover can compromise the consistency of the data. In principle, such inconsistencies can be addressed by the applications; however, application-specific solutions are usually provided in ad-hoc manners and are expensive to design, implement, and maintain. Several non-blocking commit protocols have been developed (Skeen, 1981). Very few of them, if any, have been incorporated into commercial TP systems because of excessive complexity and high overhead.

An enterprise application can benefit in several ways if replication is incorporated into the middle tier.

- By replicating the application objects, a fault in an application object is masked so that the ongoing transactions in which the object is involved are not aborted, and thus, the probability of committing a transaction is increased.
- By replicating the transaction coordinator, a fault in the transaction coordinator does not roll back or block a transaction, thus avoiding typical problems involved with the use of the 2PC protocol.
- In some cases, such as deadlock avoidance, a transaction must be aborted. A fault tolerance infrastructure, if properly designed, can automatically retry the aborted transaction using message logs, checkpoints, and message replay. This retry further reduces the probability of propagating the effects of an aborted transaction to a client.

There are two aspects that one must address in building a fault tolerance infrastructure that provides both high availability and data consistency, replication, and recovery.

Replication

To ensure replica consistency, it is necessary that incoming messages are delivered to each replica reliably in the same order. This requirement is typically achieved by using a multicast group communication protocol (Melliar-Smith & Moser, 1999) that ensures virtual synchrony (Birman & van Renesse, 1994). Without virtual synchrony, requests might be delivered more than once and, if a fault occurs, some requests might not be delivered at all.

In addition to the message ordering requirement, other sources of replica non-determinism must be masked or sanitized by the fault tolerance infrastructure, particularly for stateful replicas. Examples of other sources of replica non-determinism are multithreading and clock-related operations.

A fault tolerance infrastructure that provides both high availability and data consistency replicates both the application objects and the transaction coordinator of the TP monitor in the middle tier. Protecting the application objects against faults, by replication, reduces the risk that a transaction is aborted if the application objects fail. Similarly, protecting the transaction coordinator against faults, by replication, reduces the risk that a transaction becomes blocked if the coordinator fails.

Even though the application objects can be made largely stateless by recording all important state in the database in the backend tier, the transaction coordinator is intrinsically stateful—that is, it generates unique identifiers for new transactions and it keeps track of the state of ongoing transactions. For each transaction, the transaction coordinator writes its decision to commit or abort a transaction to stable storage when it has received acknowledgments from all of the other coordinator replicas that they have received “Yes” votes from all of the participants. To ensure that the persistent data are not compromised by replication of the transaction coordinator, the disk-write operations carried out by the replicas of the coordinator must be synchronized.

In principle, a uniform reliable totally ordered multicast group communication protocol (Schiper & Sandoz, 1993) should be used for replica synchronization and recovery when there are visible side effects of operations resulting from message delivery, such as disk-write operations. However, a uniform reliable totally ordered multicast significantly impacts the latency of message delivery and, therefore, functionally similar synchronization mechanisms are often used. A drawback of the latter approach is that it is necessary to identify the places where such synchronization mechanisms are needed, and to design and implement those mechanisms.

Recovery

Recovery includes incorporating a new replica into the system and restarting a replica that failed. In a replicated transaction processing system, it is desirable to retry an aborted transaction automatically, as a way to recover the system in a consistent manner using the roll-forward recovery strategy.

The recovery is made possible by periodically checkpointing the state of a replica and logging incoming messages. A checkpoint of a replica can also be taken on demand. When a new or restarted replica is introduced into the system, the infrastructure determines a synchronization point after which new incoming messages are logged at the new or restarted replica. The most recent checkpoint and the logged messages before the synchronization point are transferred to the new or restarted replica. The checkpoint is then applied to the new or restarted replica and the logged messages are replayed to bring the replica up to date.

When the infrastructure becomes aware that a transaction has been aborted, it sends a notification to all of the participants in the transaction (including the initiator). Then the infrastructure resets the states of the application objects involved in the aborted transaction by applying the most recent checkpoints and replaying the logged messages up to, but not including, the message that took the objects into the transaction. It discards the logged messages within the aborted transaction. Finally, the infrastructure replays the message that initiated the transaction at the initiator.

The Backend Tier

Replication has long been used in database systems to improve reliability and availability. Early studies have shown that traditional replication techniques where updates are propagated from the primary to the backups *before* a transaction is committed (often termed *eager replication*) are too expensive and prone to deadlock when used in database systems (Gray & Reuter, 1993).

Consequently, commercial database systems make a tradeoff that compromises correctness and consistency of replication to achieve better performance (Vaysburd, 1999). A typical approach is to commit transactions at the primary without delay and then asynchronously transfer the transaction log from the primary to the backups (often termed *lazy replication*). If the primary fails, a backup will take over (termed *failover*). However, the most recently committed transactions might be lost during the failover. Moreover, the old primary and the new primary might make incompatible decisions. Reconciliation of those committed conflicting transactions typically require manual intervention.

Recent results suggest that eager database replication that uses an efficient reliable totally ordered multicast protocol (Kemme & Alonso, 2000) might be a more promising approach for achieving high availability and data consistency without compromising either consistency or efficiency.

FUTURE TRENDS

Existing transactional database systems are easy to use and very effective within a single enterprise. Many enterprise applications, however, span multiple enterprises. Transaction processing systems include protocols to allow distributed transactions and two-phase commit across multiple enterprises. Those protocols are, however, almost never used, because they impose a risk that a fault in one enterprise can block activities in another enterprise and can render data inaccessible.

Instead, transactions are strictly local, and compensating transactions (Garcia-Molina & Salem, 1987) are created to undo the effects of committed transactions. If a transaction in one enterprise aborts, compensating transactions are invoked to undo corresponding activities in other enterprises. Unfortunately, compensating transactions are highly application specific, and are difficult to program and test.

An alternative strategy for the future (Zhao et al., 2005b) involves strictly local transactions and roll-backward recovery to maintain data consistency, and replication and roll-forward recovery for communication between enterprises to maintain high availability and data consistency. This strategy avoids the use of compensating transactions by employing a reservation-based extended transaction protocol that coordinates business activities. Each task within a business activity involves two steps, where each step executes as a separate traditional short-running transaction. The first step involves an explicit reservation of resources. The second step involves the confirmation or cancellation of the reservation. As distributed applications that span multiple enterprises become more widespread, such strategies will become more important.

CONCLUSION

High availability and data consistency are essential for enterprise applications, particularly for e-commerce and e-government. Such enterprise applications must be continuously available to their clients, and should strive to ensure exactly once invocation semantics. Providing high availability and data consistency involves careful design and programming of the applications, replication of critical components (namely, the transaction coordinator and stateful application objects of the middle-tier servers), and replication of the backend database systems.

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KEY TERMS

Data Consistency: When the application state stored in the database remains consistent after a transaction commits.

Fault Tolerance: The ability to provide continuous service, even in the presence of faults, using replication, or redundancy, to mask faults.

High Availability (HA): A measure of the uptime of a system; typically means five nines (99.999%) or better, which corresponds to 5.25 minutes of planned and unplanned downtime per year.

Multicast Group Communication Protocol: Provides reliable totally ordered delivery of messages that are multicast to all replicas of a component, process, or object.

Recovery (Roll-Backward, Roll-Forward): Recovery includes incorporating a new replica into the system and restarting a replica that failed. With roll-backward recovery, the state of the application that has been modified by a set of unfinished operations is reversed by restoring it to a previous consistent value. With roll-forward recovery, critical components, processes, or objects are replicated on multiple computers so that if one of the replicas fails, the other replicas continue to provide service, which enables the system to advance despite faults.

Replication (Active, Passive, Semi-Active): With replication, multiple copies of an application program execute as multiple components, processes, or objects on different computers. In active replication, all of the replicas execute the operations and output their results. In passive replication, only one replica, the primary replica, executes the operations, and one or more backups stand ready to perform the operations if the primary fails. In semi-active replication, both the primary and the backup replicas execute the operations, but the backups follow the directives of the primary, and only the primary outputs the results.

Three-Tier Application: Consists of clients in the front tier, servers that perform the application business logic processing in the middle tier, and databases that store the application data in the backend tier.

Transaction Processing: An application programming paradigm that is based on the notion of a transaction. A transaction is a set of operations on the application state that exhibit the atomicity, consistency, isolation, and durability (ACID) properties.

Two-Phase Commit (2PC) Protocol: The most popular atomic commit protocol; it is so named because it involves two phases of message passing, a transaction coordinator, which drives the protocol, and one or more transaction participants, which control the application state to be persisted.

History of E-Commerce

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INTRODUCTION

E-commerce or electronic commerce, also known as e-business, refers to the transaction of goods and services through electronic communications. Although the general public has become familiar with e-commerce only in the last decade or so, e-commerce has actually been around for over 30 years. There are two basic types of e-commerce: business-to-business (B2B) and business-to-consumer (B2C). In B2B, companies conduct business with their suppliers, distributors, and other partners through electronic networks. In B2C, companies sell products and services to consumers. Although B2C is the better known to the general public, B2B is the form that actually dominates e-commerce in terms of revenue.[1]

The concept of e-commerce is related to notions of Internet economy and digital economy. All these concepts relate to the use of new information and communication technologies for economic activities, but with different focuses. Internet economy refers to the economic activities that generate revenue from the Internet or Internet-related products or services (Costa, 2001). Therefore, pre-Internet e-commerce, as will be detailed in the following section, cannot be called Internet economy. On the other hand, some activities, such as building Internet connections for commercial purposes, are a part of Internet economy, but they are not necessarily e-commerce. Digital economy is based on digital technologies such as computer, software, and digital networks. In most cases, digital economy is the same as e-commerce. However, not all activities in the digital economy are e-commerce activities. For example, purchasing computer gear from a storefront retailer is not an activity of e-commerce, although it certainly is a key component of the digital economy. Hence, e-commerce, Internet economy, and digital economy are closely related but have different concepts.

E-commerce has been perhaps one of the most prevalent terms in this digital era. Although e-commerce was once looked upon simply as an expressway to wealth, it has actually transformed the way people conduct business. An historical analysis of e-commerce will provide insights into the evolution of the application of information and communication technologies in the commercial arena. Furthermore, an analysis of the evolution of e-commerce in the past as well as its present state will enable us to project future trends in e-commerce.

THE INFANCY OF E-COMMERCE: BEFORE 1995

E-commerce was made possible by the development of electronic data interchange (EDI), the exchange of business documents from one computer to another in a standard format. EDI originated in the mid-1960s, when companies in transportation and some retail industries were attempting to create "paperless" offices. In the mid-1970s, EDI was formalized by the Accredited Standards Committee of industry representatives, and more varied companies began to adopt EDI through the 1970s and 1980s. As the first generation of e-commerce, EDI allowed companies to exchange information, place orders, and conduct electronic funds transfer through computers (Sawanibi, 2001). However, the diffusion of EDI was slow. By the late 1990s, less than one percent of companies in Europe and in the United States had adopted EDI (Timmers, 1999). The huge expense for getting connected to an EDI network and some technical problems limited the diffusion of EDI.

The second generation of e-commerce is characterized by the transaction of goods and services through the Internet, which started as a research tool, but has generally evolved into a commercial tool. The inception of the Internet can be traced back to the 1960s, when the Advanced Research Projects Agency Computer Network (ARPANET), the precursor to the Internet, was established for research in high technology areas. The nodes of ARPANET increased from 4 in 1969 to 15 in 1971. The term *Internet* actually did not come into use until 1982, when the number of hosts on the ARPANET rose to 213. Then, in 1983, the Internet Protocol (IP) became the only approved way to transmit data on the Net, enabling all computers to exchange information equally. In 1986, the National Science Foundation (NSF), a government agency, launched the NSFNET, with the purpose of providing high-speed communication links between major supercomputer centers across the United States. The backbone of the NSFNET then became the cornerstone of the TCP/IP-based Internet (Anthes, 1994).

By the end of the 1980s, the Internet had still maintained its noncommercial nature, and all of its networks were based on the free use of the NSFNET backbone, directly or indirectly. The primary users were still scientists and engineers working for the government or for universities. As a matter of fact, academics or researchers were the only ones capable of using the Internet, because a sophisticated understanding of computer science and a high level of computer skills were necessary for Internet use at that time (Eccleson, 1999).

It was the development of a graphical user interface (GUI) and the navigability of the World Wide Web (WWW) that changed the nature of Internet use. In the early 1990s, the creation of the hypertext markup language (HTML), with specifications for uniform resource locators (URLs) enabled the Web to evolve into the environment that we know today. The Internet was therefore taken "out of the realm of technical mystique and into common usage" as it became usable for ordinary people without sophisticated understanding of computer science and techniques (Eccleson, 1999, p. 70). Hence, with the increasing number of Internet users, the Internet became attractive to the business world.

Perhaps the most significant milestone, however, came in 1991, when NSFNET decided to lift commercial restrictions on the use of the network, and thereby opened up opportunities for e-commerce. Advanced Network & Services (ANS), established by IBM, MCI Communications Corp., and Merit Network, Inc., provided Internet connection to commercial users without government restrictions on commercial traffic online. In addition, a portion of the money from these commercial applications was used to upgrade the network infrastructure. In 1993, Mosaic, one of the first Internet browsers, was released, and with Mosaic's graphical interface and rapid proliferation, the Internet became more user-friendly and visually appealing. One year later, Netscape released its Navigator browser, hand in so doing ushered in the golden age of e-commerce.

THE "GOLDEN AGE" OF E-COMMERCE: FROM 1995 TO 1999

In 1995, ANS was sold to America Online, which marked "a transition of backbone infrastructure from federal funding to full private commercialization operation of the Internet" (Kim, 1998, p. 283). With NSF's subsidy removed, private companies took a leading role on the Internet (Kim, 1998). Commercial use of the Internet gradually became the dominant pattern of Internet use in the mid-1990s. The term *e-commerce* came into popular use in 1995, signifying the rapid development of commercial applications of the Internet.

Also in 1995, Amazon.com, the world's largest online bookstore, was launched. Just 1 year later, it became a multimillion dollar business with a database of 1.1 million books searchable by title, author, subject, or keyword, and favored by both publishers and customers. Two months after Amazon's debut, eBay, the world's first online auction site, was launched. In 1996, Dell began to sell personal computers directly to consumers on the Internet and, in 1997, the commercial domain (.com) replaced the educational domain (.edu) as the largest in use (Kim, 1998). The Internet became the fastest growing technology in economic history. Investors, businesses, and consumers alike were attracted by e-commerce during that period.

From 1995 to 1999, many companies built their Web presence and began to conduct transactions online. In 1996, e-commerce transactions in the United States resulted in $707 million in revenue, which increased to $2.6 billion in 1997, and $5.8 billion in 1998 (Fellenstein & Wood, pp. 9-10). From October 1998 to April 2000, more than 300 Internet companies made initial public offerings (IPOs; Cassidy, 2002, p. 192). There were approximately 600,000 e-commerce sites in the United States by the end of 2000 (Dholakia et al., 2002, p. 5). Advertising on the Internet also increased from $267 million in 1996 to $907 million in 1997 and to $3 billion in 1999. The sales of Amazon increased from less than $16 million in 1996 to $1.6 billion in 1999, and the daily sales of Dell increased from under $1 million to $40 million in less than 3 years (Costa, 2001, p. 34).

The growth of e-commerce coincided with the changes in the regulation of the Internet. Throughout the mid-1980s to 1995, the Internet's main backbone was comprised by the NSFnet, a wide-area network developed under the auspices of the National Science Foundation (NSF). NSFnet replaced ARPANET as the main government network linking universities and research facilities. In 1995, however, the NSF dismantled NSFnet and replaced it with a commercial Internet backbone. In that process, the National Science Foundation (NSF) decided to award a monopoly contract to a partnership between the Information Sciences Institute (ISI) and Network Solutions, Inc., to operate IP numbers and domain registration services from 1992 to 1997. At the same time, the NSF implemented a new backbone called very high-speed Backbone Network Service (vBNS), which served as a testing ground for the next generation of Internet technologies.

In 1996, a blue ribbon international panel formed by the Internet Society (ISOC) took over the root server, which is a domain name system (DNS) name server that points to all the top-level domains, and the International Ad Hoc Committee (IAHC) was charted with a plan to form a monopoly registry administration of the DNS on a nonprofit basis. While DNS was looked at as "public resource" by some researchers then (Par, 2003, p. 131), others believed that multiple, competing groups co-owned this resource (Mueller, 1999). In 1997, as the NSF decided to terminate its contract with Network Solutions, the IAHC collapsed.

With the increasing pressure of commercial interests over trademark "squatting," (Par, 2003, p. 131), the U.S. Department of Commerce issued the White Paper in 1997 to transfer the management of the DNS to a new private, not-for-profit corporation. In 1998 the Internet Corporation for Assigned Names and Numbers (ICANN) was formed, which represented a "substantial shift in power to control the Internet from government to private industry" (Fuller, 2001). ICANN made decisions such as allowing more competition among registrars and instituting mandatory arbitration for trademark claims during its first two years of life, which had a significant impact on the development of e-commerce during that period.

THE BURST OF THE DOT-COM BUBBLE: 2000 AND 2001

The "gold rush" of the late 1990s came to be known as the "dot-com bubble," and 2000 and 2001 saw the bursting of that bubble. From March 10 to April 14, 2000, the NASDAQ, the high-tech stock exchange, dropped 34.2%, and the Dow Jones Composite Internet Index dropped 53.6%. The stock price for all the 20 leading Internet stocks dropped, including Amazon.com by 29.9%, eBay by 27.9%, Internet Capital by 72.1%, and VeriSign by 59.2% (Cassidy, 2002, pp. 292-293). This crash quickly cooled the e-commerce frenzy. Many Internet companies were forced to cancel their IPOs, and companies such as Boo.com and Value America had to file for bankruptcy (Cassidy, 2002). According to the *Fortune* magazine, 384 dot-coms "passed on" in 2001 (Adams, 2004, p. 105). In the San Francisco Bay Area, 80% of dot-coms went out of business in 2000 and 2001, which led to a loss of 30,000 jobs directly related to the Internet (Nevaer, 2002, p. xii).

The dot-com crash in 2000 and 2001 has been attributed to the unrealistic expectations for e-commerce and Internet companies. The stocks for Internet companies were overvalued. Exaggerated projections by Silicon Valley, Wall Street, journalists, and government officers all contributed to the inflation of the dot-com bubble. The bubble finally burst, which meant decreases in investment, a slow-down in economic and productivity growth, and decreasing corporate revenues (Cassidy, 2002).

Ironically, despite the bankruptcy of many Internet companies, e-commerce sales actually increased in the year 2000 and 2001. According to the Department of Commerce (2001), estimated retail e-commerce sales in the fourth quarter of 1999 were $5.27 billion, increasing to $8.88 billion in the fourth quarter of 2000 and to $10.04 billion in the fourth quarter of 2001. The estimated total e-commerce sales for 2001 were $32.6 billion, a 19.3% increase compared with the total e-commerce sales for 2000. The increase of e-commerce sales during the dot-com crash suggests that although e-commerce and Internet companies may have been overvalued in the 1990s, e-commerce itself was still viable and growing.

THE RESURGENCE OF E-COMMERCE: 2002 TO THE PRESENT

E-commerce continued to grow after the burst of the dot-com bubble. Some Internet companies that survived the 2000 and 2001 crash have become very successful. For example, Amazon.com has won some of highest customer satisfaction scores in the history of retail industry. eBay has significant sales in second-hand cars, which were once looked upon as inappropriate commodities for online transactions. Wal-Mart, the world's largest storefront retailer, conducts all the business with suppliers through a B2B network (*The Economist,* 2004). Estimated total e-commerce sales reached $45.6 million for 2002 and $54.9 billion for 2003 (Department of Commerce, 2002, 2003). This trend continued in 2004, with e-commerce sales for the third quarter of 2004 estimated to have increased 21.5% from the same period in 2003 (Department of Commerce, 2004).

However, e-commerce still does not represent a large proportion of the economy. E-commerce sales are less than 2% of the total sales in the United States (Department of Commerce, 2004). Although there is plenty of opportunity for growth, the development of e-commerce is limited by factors such as universal access, privacy and security concerns, and Internet fraud. These limitations must be adequately addressed to ensure strong growth in e-commerce.

With the resurgence of e-commerce, regulation of e-commerce deserves special attention. Consumer protection, user agreements, contracts, and privacy in e-commerce all present new concerns regarding regulation of commercial activities (Füstös & López, 2004), particularly as e-commerce contributes to the globalization of economic activity. For example, whereas the European

Union emphasizes consumer's rights, the United States is more focused on protecting freedom of expression and intellectual property (Füstös & López, 2004). Nevertheless, laws such as the U.S. Anticybersquatting Consumer Protection Act (ACPA) and the Electronic Signature in Global and National Commerce Act have been passed to protect the flow of commerce in cyberspace (Füstös & López, 2004; Schneider, 2004). To protect intellectual property in e-commerce, the World Intellectual Property Association (WIPO) developed the Uniform Domain Name Dispute Resolution (UNDR) polity to help settle disputes regarding domain names. In addition, organizations such as the Secure Digital Music Initiative (SDMI), with members of companies related to the information technology industry and music recording industry, are working on protecting intellectual property of digital products (Schneider, 2004).

Controversy has also emerged regarding the collection of sales-tax revenue in this new business environment. E-commerce is believed to contribute to the loss of revenue of state and local government, because states cannot effectively collect sales and use taxes on transactions through the Internet. Organizations such as the National Governors Association and National Conference of State Legislatures have been working under the Streamlined Sales and Use Tax Agreement to create a uniform system to administer and collect remote sales taxes (Government Finance Review, 2004). All of these examples illustrate the array of issues for the regulation of e-commerce. However, with the challenges e-commerce presents to traditional legal jurisdiction, privacy and security of transactions, tariffs, and taxation (Cordy, 2003), careful examination of laws and policies will be needed to assure the growth of e-commerce.

FUTURE TRENDS IN E-COMMERCE

M-commerce, or mobile commerce, is an important growth area for e-commerce. M-commerce refers to the process of using mobile devices such as mobile phones or wireless PDAs to conduct business transactions. With 1.5 billion mobile users in the world, and 140 million in the United States (Cellular Online, 2004), m-commerce is becoming a significant aspect of e-commerce. With m-commerce, the nature of mobile devices changes from pure communication tools to transactional tools. M-commerce has already found important applications in industries such as financial management, travel services, and entertainment (Schone, 2004). M-commerce will be adopted by an increasing number of industries, given its capacity to facilitate interactions between companies and consumers, create mobile virtual malls, and tailor products and services according to customers' purchasing habits in real time. It is estimated by ARC Group that approximately 546 million mobile device users will spend approximately $40 billion on m-commerce by 2007 (Schone, 2004).

The globalizing economy presents additional opportunities for e-commerce. The global Internet population is more diversified than ever before. With the rapid increase of Internet population in countries other than the United States, e-commerce on a global scale becomes necessary as well as feasible. Leading companies in e-commerce have realized this. EBay, for example, built a Chinese service, which has become the biggest e-commerce site in China (*The Economist,* 2004). Another example is Amazon.com, which hired ThinkAmerican, a "cultural portal," to translate and customize its Japanese Web pages to comport with the Japanese culture. As leading e-commerce companies in the United States are extending their business to overseas markets, e-commerce is thriving in many countries around the world. According to Forrester Research, global e-commerce would reach $6.8 trillion by 2004, with North America representing 50.9% (the United States, 47%), Asia/Pacific representing 24.3%, Europe representing 22.6%, and Latin America representing 1.2% (Global Reach, 2004). Forrester also predicted that, although the United States and North America are currently leading in online transactions, Asia and European nations would become more active in e-commerce in the coming years. With the Internet's inherent "globality," global e-commerce pushes e-commerce into its next phase.

As one of the most influential economic forms in our age, significant research will continue to focus on e-commerce. Historical and economic studies will examine the impact of the evolution of the infrastructures, technologies, strategies, and regulation of e-commerce. With the rapid development of m-commerce and global e-commerce, future research will consider implications of advancements in global telecommunications, mobile communications as well as the influence of cross-cultural content and practices.

CONCLUSION

Despite the dramatic rise and fall of Internet companies, e-commerce has demonstrated continuous growth in sales. E-commerce has significant implications for the companies and customers involved as well as society at large. For companies, e-commerce can improve efficiency and productivity. Furthermore, e-commerce allows employees to have more access to information and services, which can help to maintain a healthy corporate culture. For customers, e-commerce provides a very convenient way to transact many kinds of business 24 hours a day, 7 days a week. For society, e-commerce can help to accelerate their economic growth and opportunities, but at the same time may pose challenges and concerns in terms of surveillance and privacy.

The burst of the dot-com bubble may actually have brought about a more rational and sustainable approach to e-commerce. However, as e-commerce grows, we will continue to witness changes in the way people conceive of organizations, transactions, and communications with a dramatic rethinking of time and space considerations in economic activities.

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KEY TERMS

Digital Economy: Economy based on digital technologies such as computer, software, and digital networks.

Dot-Com Bubble: The exaggerated enthusiasm in Internet companies with the overvaluation of high-technology stocks in the late 1990s.

Dot-Com Company: A company that conducts its primary business on the Internet. It is called dot-com company because the company's URL ends with ".com."

Dot-Com Crash: The stock market crash of Internet companies in 2000 and 2001, many of which failed during the crash. Those companies were overvalued before the crash.

E-Commerce (Electronic Commerce): The transaction of goods and services through electronic communications. E-commerce has two primary forms: B2B (business to business) and B2C (business to consumer).

EDI (Electronic Data Interchange): Exchange of business documents through computer networks in a standard format. It was the first generation of e-commerce, applied in B2B transactions before the availability of the Internet in its present form.

Internet Economy: Economy with revenues from the Internet or Internet-related products or services.

M-Commerce (Mobile Electronic Commerce): Using mobile devices (e.g., cell phones and PDAs) to conduct business transactions.

ENDNOTE

1 Most studies classify e-commerce into two categories: B2B and B2C. However, some researchers use a four-type categorization of e-commerce: B2B, B2C, C2B (e.g., guru.com), and C2C (e.g., eBay). See Dholakia, Fritz, Dholakia, and Mundorf (2002, p. 4).

Hypermedia and Associated Concepts

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INTRODUCTION

There has been considerable speculation of late that the design of hypermedia and Web-based systems warrants new methods different from those used in conventional software design (Kautz & Nørbjerg, 2003). However, much confusion abounds within this debate because fundamental concepts such as hypermedia, multimedia, and Web-based systems are rarely explicitly defined and it is often unclear what is actually meant. This article explains the following interrelated terms: multimedia, interactive multimedia, digital multimedia, interactive digital multimedia, hypertext, hypermedia, and Web-based systems. Such clarification is important because for research results to be comparable and scholarly discourse to be logical, there must be a common language.

BACKGROUND

The conceptual origins of hypermedia may be traced to a seminal postwar paper by Vannevar Bush (1945) titled "As We May Think" in which he set forth his vision of an information-management device called Memex. Inspired by Bush's ideas, Douglas Engelbart (1962/1991) wrote him a letter in 1962 about the concept of "an integrated man-machine working relationship, where close, continuous interaction with a computer avails the human of radically changed information-handling and -portrayal skills" (p. 237). This concept was realised as the Augment/NLS (online system) system, famously demonstrated in San Francisco in 1968. Featuring hypertext, split-screen windows, mouse-based input, and interactive, cooperative work using voice and video connections, it was a major milestone in the evolution of computing. Meanwhile, Ted Nelson (1965) was working at Xanadu on a computer-based file system "that would have every feature a novelist or absent-minded professor could want, holding everything he wanted in just the complicated way he wanted it held" (p. 85). Like Engelbart, Nelson (1987) was concerned not just with the support of individual work, but also collaborative information sharing. His vision was of a system in which "any user should be able to follow origins and links of material across boundaries of documents, servers, networks, and individual implementations" (p. 243).

Although there were notable advances in hypermedia technologies during the 1980s, it was not until 1991 when Tim Berners-Lee of CERN (European Centre for Nuclear Research) released his World Wide Web project into the public domain that a universal, unified environment such as envisaged by Nelson (1965) came into being. The Web is a global hypertext system founded upon the hypertext markup language (HTML), hypertext transfer protocol (HTTP), and uniform resource locators (URLs). In its earlier forms, the Web had basic architectural limitations and could only be properly regarded as a primitive, constrained hypermedia implementation. Through the emergence in recent years of standards such as the extensible markup language (XML), XML linking language (XLink), document object model (DOM), synchronized multimedia integration language (SMIL), and Web distributed authoring and versioning (WebDAV), as well as additional functionality provided by the common gateway interface (CGI), Java, plug-ins, and middleware applications, the Web is now moving closer to an idealized hypermedia environment (Bulterman & Rutledge, 2004; W3C, 2001, 2004).

EXPLANATION OF TERMS AND CONCEPTS

Multimedia

Hypermedia is formed by the convergence of two traditionally separate streams of research, namely, multimedia and hypertext. In order to better explain the concept of hypermedia, one must consider both of these streams. This section deals with multimedia; the next deals with hypertext.

Multimedia desktop computing is a relatively new concept, having only been around for a decade or so. The lack of a clear, consistent, commonly agreed-upon definition of multimedia is oft lamented. Simplistic definitions refer to the blending of sound, music, images, and other media into a synchronized whole. However, according to such a definition, the origins of multimedia would extend back to prehistorical cave ceremonies. More recently, the composer Wagner integrated various media into his Gesamtkünstwerk (Total Art Work) performances in the

1870s. By the 1960s, the term multimedia, alternatively known as cross-media, was being used to refer to live demonstrations by human speakers supported by combinations of slide projectors, motion-picture projectors, and audio-tape players.

To distinguish from artistic works, audiovisual presentations, theatre, and other noncomputer-based multimedia, one may use the term digital multimedia, meaning that the application is fully controlled by digital computers (Fluckiger, 1995). A further refinement of the definition of multimedia is the notion of interactive multimedia. Interactive multimedia systems enable end users to choose the information they see and receive by actively engaging with the system. In contrast, traditional television and comparable technologies such as videotape are passive because the end user has no control over the timing, sequence, or content and is not able or intended to interact (Dustdar & Angelides, 1998). However, interactivity is not unique to digital media. It has long been a feature of traditional media such as newspapers where readers must scan a page and decide what articles to read and in what sequence. For the sake of precision, the term interactive digital multimedia is therefore preferable to multimedia or interactive multimedia.

Another related and much misused term that warrants clarification is new media, defined by Williams, Strover, and Grant (1994) as applications of microelectronics, computers, and telecommunications that offer new services or enhancements of old ones. Considered thus, it is a broad term that comprises technologies such as videophones, electronic bulletin boards, and interactive television, though narrow interpretations often treat new media as synonymous with the World Wide Web (McMillan, 2002).

Figure 1 shows a simple diagrammatic representation of the overlapping relationships between multimedia, interactive media, digital media or new media, and interactive digital multimedia. Not all digital media can be regarded as multimedia; for example, SMS (short messaging service) messaging is digital but uses text only, unlike digital television that uses a combination of media (i.e., digital multimedia). Likewise, some applications of interactive media cannot be classified as multimedia.

Hypertext and Hypermedia

The term hypertext was coined by Nelson (1965), meaning "a body of written or pictorial material interconnected in such a complex way that it could not conveniently be presented or represented on paper" (p. 96). In technical parlance, Smith and Weiss (1988) define hypertext as "an approach to information management in which data is stored in a network of nodes connected by links" (p. 816). These nodes can contain text, graphics, audio, and video as well as source code or other forms of data. Hyperlinks, sometimes called hotspots or buttons, may take the form of one or more contiguous words in a passage of text, a picture or diagram or segment thereof, an interface object such as a button, or a segment of a media object. The point at which a hyperlink is located within a node is referred to as an anchor. The destination point of a hyperlink is also known as an anchor. Nodes are sometimes alternatively referred to as targets, pages, documents, cards, or frames. These technical terms are illustrated in Figure 2.

Figure 3 depicts the relationships between hypertext, hypermedia, interactive digital multimedia, and Web-based systems. In keeping with other authors (Vaughan, 2001), hypermedia is treated as a subset of interactive digital multimedia. Here, as elsewhere (Conklin, 1987; Fluckiger, 1995), hypermedia is also regarded as a specialized extension of the more general class of hypertext in the sense that hypermedia incorporates information of any type or format as opposed to just textual data. There is, however, some difference of opinion on this distinction, and the terms hypertext and hypermedia are often used interchangeably as though equivalent. This is understandable given that Nelson's (1965) definition of hypertext as earlier mentioned clearly does not preclude the use of multimedia data types. Indeed, Nelson alluded to the possibility of arranging nontextual media such as films and sound recordings into nonlinear sequences, but referred to such objects as hypermedia.

Figure 1. Associations in multimedia terminology

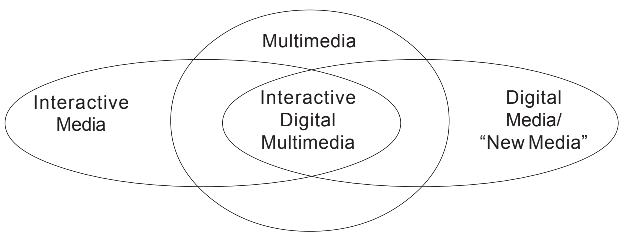


Figure 2. Nodes, anchors, and hyperlinks

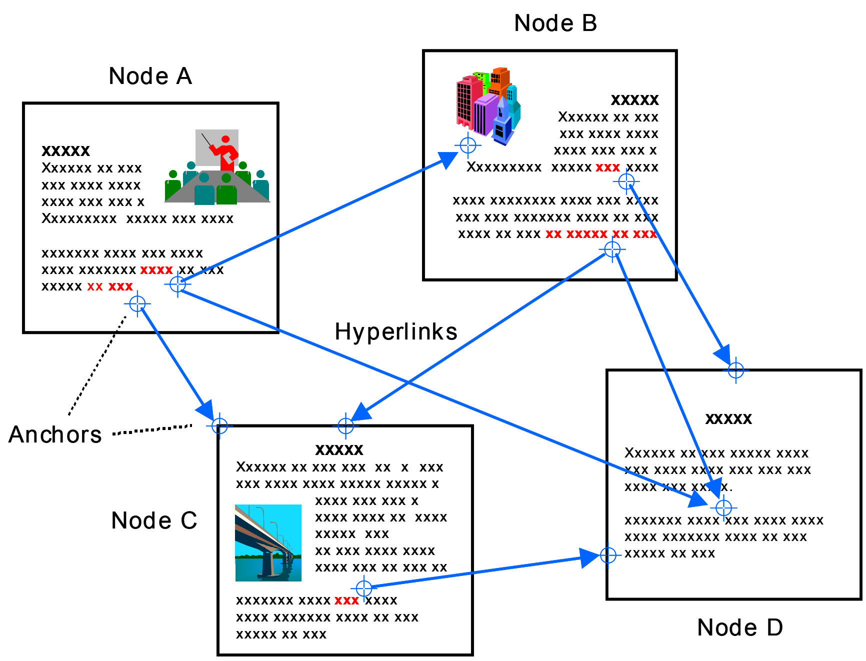
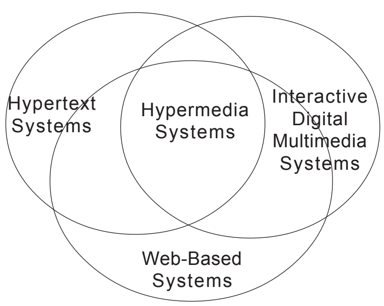


Figure 3. Associations between hypermedia and related concepts



Descriptions of hypermedia generally agree upon the following principal definitive aspects:

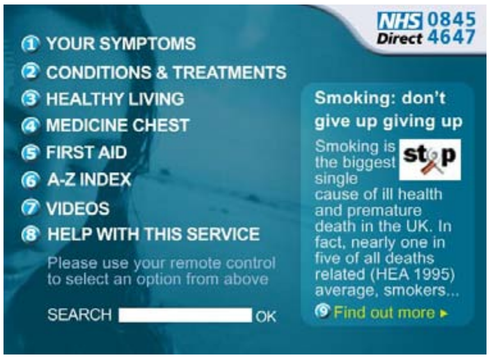
- information structures comprising a set of associated nodes in which the end user requires only a single node at a time;
- nonlinear navigation mechanisms, based upon these associative information structures, that support both casual browsing and purposeful self-directed navigation;
- support for multiple media types and formats; and
- interactive, visual, media-rich user interfaces.

Narrower, more rigorous definitions of hypermedia emphasize additional aspects such as support for end-user annotations, a tailored presentation, the synchronization of time-based media (e.g., audio, video, animation), explicit representations of the network structure within the user interface, scalability, extensibility, interoperability and openness, independence from proprietary standards and technologies, and internationalization. In actuality, these are ideals that remain largely unachieved by most modern hypermedia systems.

In terms of application functionality, it is difficult if not impossible to specify an all-encompassing set of features that sets hypermedia apart from more conventional applications. Typical features of hypermedia applications are hyperlinks, graphical user interfaces (GUIs), integration with back-end databases and systems, dynamically generated pages, and frequently changing content. Many features of hypermedia are now incorporated into a diversity of applications including databases, spreadsheets, and word processors. However, hypermedia applications are recognizably different from conventional applications because they have much richer user interfaces and more complex and flexible navigation mechanisms. To best explain these aspects, a number of screenshots of hypermedia applications are presented in the following pages.

Figure 4 depicts the start-up screen for an interactive television application developed for the UK National

Figure 4. Interactive television application of UK NHS

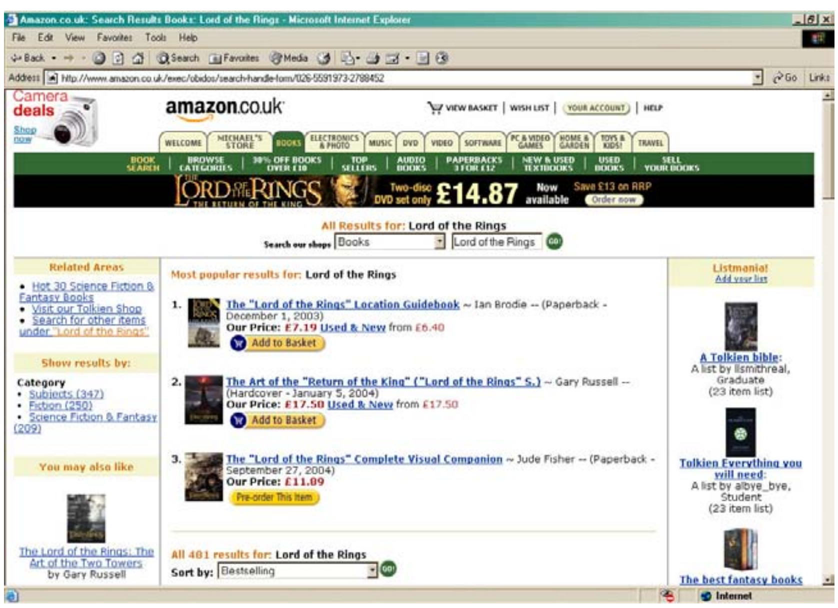


Health Service (NHS). The media types used are text and photographs supplemented by video on demand, and the application is driven by a back-end database with extensive information. Interactive television applications such as this might loosely be considered hypermedia because they include the basic features: support for self-directed navigation and browsing or searching, modular information units, a visual interface, and the use of multiple media. Previous generations of TV-based information services, such as teletext, lacked these essential features and therefore could not be regarded as hypermedia.

However, one would normally expect a hypermedia system to have a more media-rich interface than the UK NHS application. To illustrate this point, Figure 5 shows a screen from a Web-based system widely admired as an example of good design: that of Amazon UK. The variety of navigation mechanisms (e.g., high-level menus, multiple in-line hotspots), highly graphical nature of the interface, and media richness are immediately striking features, as can likewise be remarked of the Web site of Raidio Teilifís Éireann, Ireland's national broadcaster (Figure 6). Both these examples would certainly be regarded as hypermedia applications, even by strict definitions. Media-rich Web sites such as these typically use back-end databases or content-management tools to dynamically generate pages. This is in marked contrast to conventional GUI database information systems where the user interface normally consists of hard-coded, fixed-position elements, content is generally plain-text fields, and navigation mechanisms are basic. Such systems do not qualify as hypermedia, and they still would not if merely ported to the Web without the addition of essential enhancements such as hyperlinks between records and support for nontextual data.

Another common type of hypermedia applications, which preceded the take-off of multimedia desktop computing and the Web in the mid-1990s, is online help systems and electronic documentation. Notably, Microsoft Windows help files bear the file extension CHM, an acronym for compiled HTML. Looking at the example in Figure 7, standard hypermedia features are again obvious: support for purposeful navigation (through the contents or by searching the index) or browsing, cross-referenced nodes of information (visible in the right panel), and support for multiple media (text, graphics, links to video, etc.). Yet another application of hypermedia is electronic encyclopedias. Figure 8 shows a screenshot of one such example: Microsoft Encarta. As with printed encyclopedias, articles contain cross-references to other articles and there is an index of contents. However, media types

Figure 5. Web site of Amazon UK



are richer, including not just text, graphics, and photographs, but also audiovisual data.

Web-Based Systems

In recent years, there has been a flurry of interest in the design of Web-based systems, much of it based upon the premise that by definition they are fundamentally different from so-called traditional or conventional systems. The debate is clouded by confusion over the meaning of the phrase Web-based system, variants of which include Web-based application, Web application, Web-like application, WebApps, Webware, Web-based information system, Web information system, Web-enabled information system, Internet-based information system, and Web site (Holck, 2003).

Starting with the most familiar of these, Web sites date from the early days of the Web and historically denoted static sets of pages, so-called brochureware, whose purpose was to establish a Web presence for external marketing and corporate branding purposes. This notion of a Web site as a unidirectional information-publishing medium is quite different from a Web-based information system, which one would normally expect to be integrated with back-end transaction-processing databases and whose function is to support organisational work. However, many informational Web sites that initially started as brochureware now feature back-end databases, dynami-

Figure 6. Web site of Raidio Teilifís Éireann

Figure 7. Online help for a Microsoft Windows application

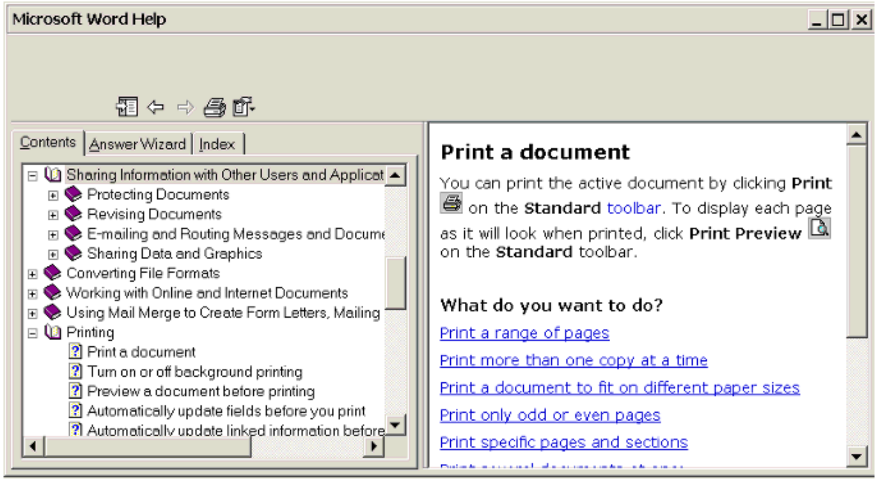
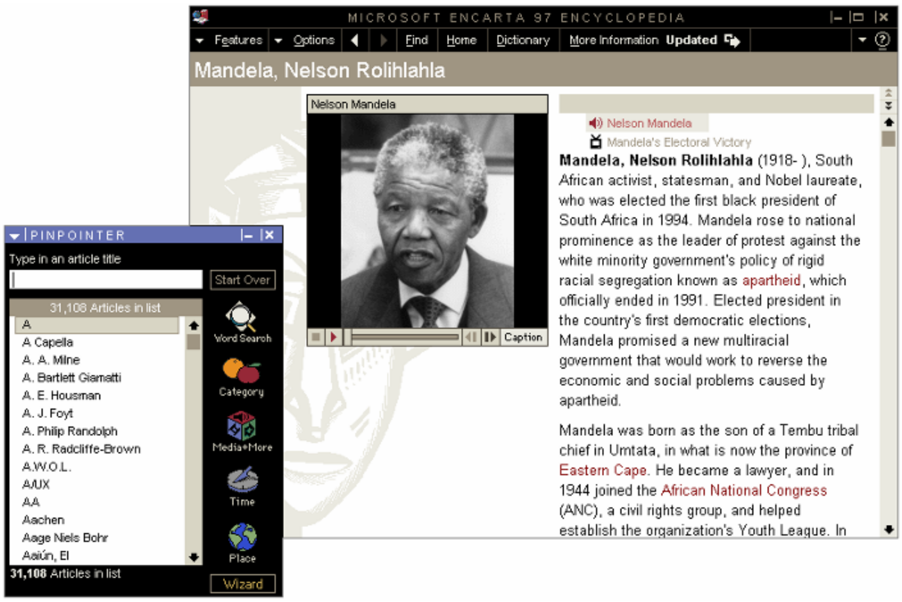


Figure 8. Microsoft Encarta encyclopedia



cally generated pages, and support for real-time transactions, and as such have become fully fledged software applications. Thus, there is no longer a clear distinction between the terms Web site and Web-based application or Web-based system.

Web-based system is a very loose term that in its broadest sense could be construed to embrace all applications that somehow rely upon the World Wide Web as a platform for execution. That could include not just interactive Web sites, but also Web crawlers, agents, middleware, daemons, and systems software. In a narrow sense, Web-based system is generally taken to mean information systems for which human-computer interaction is mediated through a Web-browser interface. Clearly, this is not a de facto fundamental difference. Indeed, Lockwood and Constantine (1999, p. 78) make the point that "current development tools make it easy to 'browserize' almost anything," so little if any redesign may be required to effect the basic migration of a system to the Web. For example, some intranet projects have been as straightforward as Web-enabling existing back-end applications such as Lotus Notes databases. This migration can be as simple as moving a set of files to a Web server. It is therefore obvious that although a system may be said to be Web-based, this does not necessarily imply it is any different from a non-Web-based system as regards software design considerations. Indeed, it may be argued that Web-based is just an adjective that does not fundamentally alter the meaning of the term information system when prefixed to it (Barry & Brown, 2003). The opinion of this author is that it is only when Web-based systems take on additional hypermedia functionality (such as enhanced navigation and multimedia content) that they present design challenges substantively different from those encountered in the design of conventional systems such as enterprise databases, interorganisational systems, or distributed client-server networks (Lang, 2005).

FUTURE TRENDS

Current implementations of hypermedia still have some way to go to reach the ideal functionality of a true hypermedia system, and perhaps most current hypermedia systems should properly be regarded as graphical hypertext systems. Many of the futuristic ideas speculatively set forth by Bush (1945) have been somehow implemented, but others remain as yet aspirational. Much research is ongoing into advanced multimedia features such as digital taste (e.g., electronic tongues), digital touch (e.g., haptic devices), digital smell (e.g., olfactory delivery devices, electronic noses), digital speech (e.g., voice recognition, text to speech), digital audio (e.g., spatial sound), virtual reality, wearable computers, and cybernetics, and it will be interesting to see how these features become integrated into future hypermedia systems (Güven & Feiner, 2003; Roberts, 2004; W3C, 2003; Washburn & Jones, 2004).

CONCLUSION

This article set forth definitions of interactive digital multimedia, hypertext, hypermedia, and Web-based systems, and explored the relationships between these and other associated concepts. It is argued that the term Web-based system of itself is not very meaningful from a software designer's point of view because merely by stating that a system is Web-based does not necessarily imply that radically different design methods or approaches are required above and beyond those that would be engaged for a comparable non-Web-based system. Indeed, Web-based system may soon become a redundant anachronism. It is likely that over time most systems will be ported to the Web and that Web-based interfaces will become the norm. If most systems were to become Web based and most information devices (mobile phones, PDAs [personal digital assistants], televisions, etc.) were to become Web enabled, it is likely that Web-based systems would simply be called systems! A recent example of such a change in computing language is multimedia PC (personal computer), a popular term from the early 1990s that is now defunct because multimedia functionality has become a standard feature of modern PCs.

Murugesan, Deshpande, Hansen, and Ginige (1999, p. 1) speak of "a pressing need for disciplined approaches and new methods and tools" taking into account "the unique features of the new medium" that is the Web. However, misguided assumptions of newness have been common throughout the history of software design. Rather than unnecessarily reinventing design methods and approaches for interactive Web-based systems, it may be beneficial to draw upon the legacy of design experiences from earlier generations of hypermedia and interactive digital multimedia systems. Researchers should aspire to produce timeless contributions, and accordingly, it is preferable to consider interactive Web-site design within the broader banner of hypermedia design, not just because hypermedia system is a less ambiguous term than Web-based system, but moreover because hypermedia is a more enduring concept and embraces technologies that predate the Web (e.g., online help, encyclopedia CD-ROMs [compact disc read-only memory]) as well as those that follow the Web (e.g., WAP [wireless application protocol] and interactive TV applications). Web design should therefore be properly thought of as situated along an evolutionary timeline reaching back to CD-ROM authoring, and extending in the future to new generations of interactive digital multimedia.

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KEY TERMS

Hypermedia: Often taken as synonymous with hypertext, but some authors use the term hypermedia to refer to hypertext systems that contain not just text data, but also graphics, animation, video, audio, and other media.

Hypertext: An approach to information management in which data is stored as a network of interrelated nodes that may be purposefully navigated or casually browsed in a nonlinear sequence by means of various user-selected paths.

Interactive Digital Multimedia: Interactive digital multimedia systems enable end users to customize and select the information they see and receive by actively engaging with the system (e.g., tourism kiosk, interactive television), as opposed to passive multimedia where the end user has no control over the timing, sequence, or content (e.g., videotape, linear presentation).

Multimedia: Broadly defined, multimedia is the blending of sound, music, images, and other media into a synchronized whole. A more precise term is digital multimedia, meaning the computer-controlled integration of text, graphics, still and moving images, animation, sounds, and any other medium where every type of information can be represented, stored, transmitted, and processed digitally.

Web-Based Systems: A loose term that in its broadest sense embraces all software systems that somehow rely upon the World Wide Web as a platform for execution. In a narrow sense, it is generally taken to mean systems for which human-computer interaction is mediated through a Web-browser interface.

XML (Extensible Markup Language): A mechanism for encoding data into computer-understandable forms, useful for applications such as business-to-business electronic document interchange via the World Wide Web.

ICT Applications in Aviation

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INTRODUCTION

Globalization of the social economy will further increase during the 21st century. The mission of international air transportation will become more important, and all airports around the world will have a significant role to play. Furthermore, it is predicted that air transportation demand in the world will double over the next 15 years.

In the meantime, since the September 11, 2001 terrorist attacks on the United States, the environment surrounding the aviation industry has become very severe and has caused adverse impact to the entire aviation industry. Security at airports has been reinforced in all aspects, significantly deteriorated on-time performance, caused mass congestion at the airport, and caused a drastic increase in aviation management and operational costs.

Owing to these issues, the aviation industry in recent years has seen a need to improve both convenience to passengers and security measures, and at the same time improve on-time performance in the most economical manner.

In connection with this trend, the International Air Transport Association (IATA) has been promoting the Simplifying Passenger Travel project to facilitate the process of international travel for next-generation air transportation. Information and communication technologies (ICTs) have an especially significant role to play here, for it is only with the strategic, widespread, intensive, and innovative use of ICT in future airport development polices and programs that the ambitious agenda of passenger convenience and airport security becomes much more possible to achieve. But this involves the need not only to unleash the potential of ICT per se, but also the need to ensure that an enabling environment and capacities that can facilitate its aviation applications are in place.

BACKGROUND

To find out how ICT applications can facilitate air passenger convenience and aviation security, one can evaluate the extent to which the needs of air passengers and the airport authority are met.

Air Passenger Needs

Travel Planning

Through any 3G mobile phone, one can use the in-built videoconferencing facility with his business partners or friends to discuss a travel plan. Once an itinerary has been agreed, one can access the Web site of travel agents and ask for quotes from different airlines regarding routes and accommodation types.

Through e-mail and/or short message service (SMS) messages from the travel agent, the traveler can use his PC, mobile phone, or personal digital assistant (PDA) to find out a plan most suitable to him.

One can then purchase electronic air and rail tickets through the Internet banking service (using his e-certificate). In cities like Hong Kong, mobile e-certificates are issued to individuals to authenticate the online identity of subscribers, and to provide a secure and trusted environment for the conduct of online transactions, such as secure e-mail services, online government services, online entertainment services, online stock trading, and online banking services.

Nowadays in places like Japan, one can also send electronic passport information to an Authorized Agent for the purpose of getting an entry visa for the destination countries. Having matched the data provided by the air traveler to other systems such as law enforcement and intelligence databases, the authorized agent would issue an electronic visa to the traveler in a short time. Also, the traveler can have the choice of traveling hands-free. This means that one can arrange with the concerned airline before travel so that a delivery company would pick up the traveler's baggage at an agreed time before departure.

Commencement of Traveling

Before Departure

On the day before departure, the traveler may need to buy some gifts, and he can access one of the virtual shops at the airport and pick it up on the day of departure.

Assume that a traveler wants to travel hands-free, a delivery company would be asked by the airline to contact him for the purpose of picking up his baggage for delivery to the airport. In order to check the airline and flight number from the e-ticket, the driver could check the traveler's mobile phone by means of his portable identity (ID) terminal. When the driver does this, the ID terminal automatically sends the baggage information to the airline's computer system. Upon arrival at the airport, the baggage will then be transferred to the baggage handling system for security inspection and subsequently delivered to the aircraft.

Departing for Airport and E-Check In

On the day of departure, when the traveler arrives at the rail station, he can pass through the rail ticket gates simply by holding his mobile phone in contact with the designated scanner so that the built-in IC chips could be scanned.

On moving into the passenger terminal, while the traveler is waiting for his friends at an Internet cafe, he may use his PDA or 3G mobile phone to watch a movie. When it is time for boarding, the group would expect to check in quickly through the automatic check-in kiosks, which are installed with one of the International Civil Aviation Organization (ICAO)-endorsed biometrics for passenger identification and passport control.

Arrival at the Destination Airport

When the destination airport is installed with an advance passenger information (API) system, the API data (collected from a passenger's machine-readable e-passport) will be sent by the airline to destination airport, enabling the customs/immigration officials at the airport to organize their clearance process in advance of the arrival of the flight. One instance is the eAPIS Online Transmission System, developed by the United States Customs & Border Protection for commercial operators to submit Advance Passenger Information System (APIS) data and Master Crew Lists (MCLs). With this system, the customs/immigration officials at the destination airport are able to focus on previously selected passengers, significantly reducing the wait time for the majority of passengers and enhancing the quality of the clearance process regarding the inspection of suspected aliens or illegal immigrants.

Upon arrival at the destination airport, one may want to learn about the tourist promotion programs; this can be obtained via the electronic translation facility provided at the airport. By means of his PDA, the passenger can download useful tourist information for getting around in the destination.

Aviation Security Needs

Identity Verification

In air travel there is an increasing need for accurate and efficient verification of passenger identity. Technologies which allow for stronger access control and strengthened document integrity will be welcome by most airports. In May 2003, the use of contactless technology was endorsed as the next generation of data storage for passports by the Air Transport Committee of the ICAO Council (ICAO, 2003a).

In recent years, there has been a steady increase in the testing and piloting of biometrics. Biometrics are unique, measurable characteristics or traits of a human being for automatically recognizing or verifying identity (OECD, 2004). The primary purpose of biometrics is to allow for identity verification (also called authentication) or "confirming identity" (ICAO, 2003b), where a one-to-one match is intended to establish the validity of a claimed identity by comparing a verification template to an enrolment template.

In the context of international travel, facial recognition, fingerprint, and iris scan appear to be the three primary candidates (Mariano, 2001; Fonseca, 2002; *Aviation Daily,* 2002; Krempl & Smith, 2002; Pietrucha, 2002; Basu, 2002; Cooley, 2003; Fisher, 2003; Mainichi Shimbun, 2003; Swissinfo, 2003).

The stability and uniqueness of the fingerprint are well established. The largest application of fingerprint technology is in automated fingerprint identification systems (AFISs) used by police forces in over 30 countries. Iris identification technology involves the acquisition, analysis, and comparison of the unique details contained in the intricate patterns of the furrows and ridges of the iris. This non-intrusive technology offers a high reliability rate for one-to-one verification. Facial recognition technology utilizes distinctive features of the human face in order to perform a biometrics match. Even though two individuals may look alike, the unique physiological patterns of their facial features will be different. A comparison of these three ICAO-endorsed biometrics is shown in Table 1.

Better Resource Utilization

Some countries start implementing trusted passenger programs to expedite the security screening of passengers who participate in such programs, thereby allowing security screening personnel to focus on those passengers who should be subject to more extensive screening (U.S. Congress, 2001).

Table 1. A comparison of ICAO-preferred biometrics

	Facial Recognition	Fingerprint	Iris Scan
Pros	Public acceptability; Ease of use; Useful for watch list	Mature technology; High accuracy; Stable over time; Large database	High accuracy; Stable over time
Cons	Accuracy; Controversial; Questions as to effects of aging over time	Low public acceptability	Very new technology; Not yet user friendly

Determining Suspected Identity

A one-to-many match is intended to check the biometric characteristics of a person against an existing enrollee dataset (e.g., check against a watch list, prevention of multiple enrollments). This security need could be achieved through a combination of biometrics and wireless surveillance technologies.

Real-Time Baggage Tracking

In response to the need for increasing levels of aviation security coupled with higher customer satisfaction levels, international airports are expected to provide real-time baggage tracking capability.

As shown, it can be seen that most passenger and aviation security needs can be achieved through the application of contactless smart card technology, 3G mobile, radio frequency identification (RFID), and wireless surveillance technologies.

ICT SYSTEMS IN AVIATION

A brief description of the features of the key ICT systems applicable in aviation is given below.

Contactless Smart Card Technology (CSCT)

A contactless smart card includes an embedded smart card secure microcontroller or equivalent intelligence, internal memory, and a small antenna; it communicates with a reader through a contactless radio frequency (RF) interface. Contactless smart card technology is used in applications that need to protect personal information and/or deliver fast, secure transactions, such as transit fare payment cards, government and corporate identification cards, documents such as electronic passports and visas, and financial payment cards. Contactless smart cards have the ability to securely manage, store, and provide access to data on the card, perform on-card functions (e.g., encryption), and interact intelligently with a contactless smart card reader. To facilitate airport security screening, electronic passports are expected to be issued by governments in the near future.

Radio Frequency Identification (RFID) Technology

RFID uses an integrated microchip and antenna that reads information. The combination of the chip and antenna is called an RFID transponder, tag, or inlet. When the RFID transponder is placed in the field of an RFID reader, information is transmitted to the reader and processed by a computer. Unlike bar code data storage, line-of-sight communication is not necessary.

Attached to physical objects, including baggage, air cargo, cartons, pallets, and containers, the RFID tags uniquely identify objects. Readers receive data from the RFID tags via radio frequency waves once the tags are within reading range. It is anticipated that by means of RFID tags, air travelers will be allowed to make advance arrangements to have their luggage picked up at home, so they can check in at the departure airport and board their flights unencumbered, and claim their bags at the destination airport.

Third-Generation (3G) Mobile Technology

3G brings together two powerful forces: wideband radio communications and Internet protocol-based services. Together, these lay the groundwork for advanced mobile Internet services, including personalized portals, "infotainment," mobile commerce, and unified messaging, encompassing high-speed data, superior quality voice and video, and location-based services.

Making 3G a reality depends on technology developments in different areas. These include amendments to the radio interface to support wideband communications and in the core network. For instance, General Packet

Radio Service (GPRS) is an enhancement to existing Global System for Mobile Communications (GSM) and Time Division Multiple Access (TDMA) networks that introduce packet data transmission, enabling "always on" mobility. This means that users can choose to be permanently logged on to e-mail, Internet access, and other services, but do not have to pay for these services unless sending or receiving information. Supporting technologies, such as Wireless Application Protocol and Bluetooth, also have an important role to play.

Wireless Surveillance Technology

There are several serious problems with using traditional coaxial or even high-tech fiber-optic cables to transmit video images from the surveillance cameras to the stations at which the images are monitored and/or recorded. Cables are easily damaged or severed by accidents or saboteurs, and thus require nearly constant monitoring, maintenance, and repair. Furthermore, cables cannot be strung over long distances without sacrificing image quality or having to build expensive booster stations along the way. The use of cable thus necessitates the close physical proximity of the monitoring stations to the areas under video surveillance. But proximity might be undesirable if the surveillance is intended to be covert or impossible if the subjects of surveillance (e.g., criminals or suspected terrorists) are constantly on the move.

To search for suspected persons against a watch list, wireless video surveillance can be used in airports. There are several means by which live video images can be transmitted without the use of cables or wires: lasers, radar signals, and radio (all of which are "microwaves," differing only in frequency on the spectrum). The most commonly used microwave is radio-frequency. In America, many law enforcement agencies use radio signals to transmit, relay, and receive live video images. Their use of wireless cameras can either be covert or overt. In covert operations ("stake-outs"), the cameras are usually small devices that beam their signals over short distances (usually to an unmarked van or car parked nearby) from hidden, semi-permanent locations on or near the suspects. In overt operations ("routine patrols"), the cameras are usually large devices that beam their signals over relatively long distances.

IMPACT OF ICT IN AVIATION

More Onsite Tests

More onsite tests in respect of the new ICT systems will cause considerable air passenger and cargo delays. For instance, the Transportation Security Administration (TSA) in the United States is conducting tests on a variety of advanced technologies, including state-of-the-art video surveillance, RFID cards, iris scan readers, and hand geometry readers, to protect against unwanted guests attempting to enter restricted areas of the airport.

Similarly, for a baggage-handling system using RFID, onsite testing must be carried out carefully if multiple sources of electromagnetic interference (EMI) are to be identified, such as other readers, other tags, wireless LANs, and data transmission systems.

Future Technological Research

Technological research of a more or less exotic nature will continue, but technological issues will not be the main ones. In fact, a large proportion of the technologies that will supply the markets of tomorrow already exist. Instead, efforts shall focus primarily on consolidating existing technologies, and on addressing issues outlined here.

ICT Product Development

This includes:

- reinforcing RFID scanners to support non-routine operating environments (primarily temperature, lighting, and humidity);
- developing non-participatory scanning techniques (surveillance by remote identification);
- improving techniques for detecting biometric artifacts (false fingers, false iris, life-size facial photographs);
- three-dimensional face imaging and development of tools for using existing photo archives; and
- performance improvements, and in particular a considerable reduction in "Failure to Enrol" and "False Rejection Rate"—this is essential for the airport security control.

Merger of Technologies

The current telecommunications scenario is, in fact, characterized by a global system fast converging towards the idea of virtual home/office environment, this trend being also fuelled by the evolution that the future wireless/mobile applications are experiencing. The user, while moving, feels the exigency of being continuously and efficiently connected to multimedia information systems and databases scattered across a fixed interconnected backbone (mainly characterized by ICT).

Two aspects highlighted by Honkasalo, Pehkonen, Niemi, and Leino (2002) are worth noting. First, the typical demand for information that users want to access is characterized by heavy data files and applications, calling for fast transmission capability. Second, airports are typical hot spots in which the widely cited exigency of high bandwidth data traffic access is strongly felt, while the overall radio coverage furnished by the mobile access systems to the fixed backbone could be insufficient (Saltkintzis, Fors, & Pazhyannu, 2002). This is mainly due to the fact that the standardization efforts relevant to the third generation of mobile systems focused on the development of a system supporting a wide-area wireless coverage and a high degree of user mobility, but with a maximum target capacity of 2 Mbit/s only.

A further interesting networking configuration that will surely play an important role in the next-generation communications environment is represented by WLAN islands roaming across 3G cellular networks, such as in the case of WLANs deployed either in airplanes or ships.

Therefore, the overall envisaged architecture of the next generation will be likely characterized by the presence of wired and wireless access technologies, such as Ethernet (802.3) for wired access, Wi-Fi (802.11) for wireless LAN access, and wideband code-division multiple access (W-CDMA) for cellular access. In such a scenario, the customer will get guaranteed quality-of-service levels on an end-to-end basis, while he/she is freely and transparently roaming from segment to segment.

Behavioral Issues

The implementation of information systems is affected by the way people perceive these systems and how people behave. ICT systems are no exception. Resistance to change is another important issue. It is a major behavioral factor that can have a significant impact on the implementation of proposed ICT systems.

Over the last few years, ICT has gained tremendous publicity. The general level of expectations regarding the system held both by top management and users may now be too high. Over-expectations may hinder the successful implementation of an ICT system.

Cultural Issues

People may not have confidence in a new ICT system because it is relatively new to them. It may take them a long time to understand and trust the technology.

Business Process Issues

As is the case with most breakthrough technologies in aviation, implementing new ICT products or systems can require the fundamental redesigning of business processes if optimal benefits from using such products or systems are to be obtained.

Data Management Issues

ICT systems such as RFID capture and deal with enormous volumes of data. We need to filter out the useless data, identify what needs to be stored, and consider how and where to store data.

Security Issues

An ICT system such as RFID could make possible an omnipresent state of surveillance. The security and integrity of information and the privacy of cargo customers are always primary issues surrounding the adoption of RFID.

Legal Issues

The traditional doctrines of privacy protection agencies, such as those relating to proportionality, purpose, and traces, will be challenged by the spreading use of biometrics and the many new ICT products used by the police. Resolving these issues will require responsible communication and education on the part of all players: privacy protection agencies, governments, citizens, and the industry. Solutions will be based on careful choices of legal and technical approaches.

FUTURE TRENDS

Despite the promise associated with ICT, as shown above there are still many formidable obstacles to its adoption. In particular, technological, financial, and cultural issues must be addressed before the benefits can be realized in aviation.

For instance, in the case of RFID, technological issues relating to laws of physics must be managed. Although radio waves can pass through most articles, metal and liquids are problematic. In addition, there are multiple sources of potential background interference, as RFID tags and readers attempt their two-way communication. For communication to take place, hardware must be tuned to specific radio wave frequencies, but frequency availability is not consistent worldwide. Accuracy and encryption are other technological challenges facing RFID today.

Although RFID is already used in many applications today, its current costs preclude widespread adoption on low margin items. To some extent, cost is a technological problem, but even if hardware issues are resolved on a unit basis, there will still be substantial costs associated with retooling baggage handling systems, air cargo terminals, warehouses, and trucks with RFID equipment. In addition, the full benefit of RFID will be realized only when personnel can be redirected from the menial work of scanning, searching, and verifying a product, to the more complex work of anticipating problems and collaborating on solutions. This will require substantial retraining. In the short run, start-up costs will receive the most attention, but in the long run, there will be substantial costs involved in maintaining and upgrading software, hardware, and data needs.

Similarly, wireless video technology is a risky business for two reasons: (1) though such transmissions are often "modulated" or otherwise encrypted, they are nevertheless sent on "open," non-secured frequencies, and so can be intercepted and, given time, decoded; and (2) airport staff routinely stationed near the transmitters can suffer serious health problems if over-exposed to microwave radiation.

On the other hand, it is clear that contactless smart card technologies have a bright future ahead of them in the world's regulatory scene. As the need for increased security and privacy becomes apparent to policymakers and citizens, the possible uses and actual implementation of smart cards will radically grow. The potential areas of application are almost limitless.

CONCLUSION

Through the application of proposed ICT in the aviation industry, one would anticipate the following passenger convenience and aviation security enhancements:

- **Comprehensive Airport Information via Mobile Devices:** Airport facility guides, flight information, and user location information via Global Positioning System functions, and tourist information in other languages.
- **Facilitated Airport Procedures:** E-ticket services using mobile phones with IC chips, automated departure procedures, and biometric technology will allow passengers to complete their procedures smoothly and safely.
- **Airport Internet Access:** With the installation of wireless LAN facilities and Internet cafes, airport users will have easy access to broadband Internet services.
- **Real-Time Baggage Handling System:** The use of RFID tags will reduce the incidence of lost baggage and allow passengers to travel from their home to their destination without being burdened by luggage.
- **Better Aviation Security:** In conjunction with ICAO-endorsed biometrics, CSCT is an excellent privacy-enabling solution for applications that need to protect personal information and ensure that communication with the contactless device is secure. The on-chip intelligence uniquely enables systems that use CSCT to comply with mandatory privacy and security guidelines, as well as deliver the speed and convenience of contactless communication. Also, through wireless surveillance technology, less airport crimes would occur.

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KEY TERMS

3G: Abbreviation for "third-generation" mobile telephone technology. The services associated with 3G provide the ability to transfer both voice data (a telephone call) and non-voice data (such as downloading information, exchanging e-mail, and instant messaging).

Asynchronous Transfer Mode (ATM): A network technology based on transferring data in cells or packets of a fixed size. The small, constant cell size allows ATM equipment to transmit video, audio, and computer data over the same network, and assure that no single type of data hogs the line.

Biometrics: Usually refers to technologies for measuring and analyzing human physiological characteristics such as fingerprints, eye retinas and irises, voice patterns, facial patterns, and hand measurements, especially for authentication purposes. In a typical IT biometric system, a person registers with the system when one or more of his physiological characteristics are obtained, processed by a numerical algorithm, and entered into a database. Ideally, when he logs in, all of his features match 100%; then when someone else tries to log in, she does not fully match, so the system will not allow her to log in.

General Packet Radio Service (GPRS): A packet-linked technology that enables high-speed wireless Internet and other data communications. GPRS provides more than four times greater speed than conventional GSM systems. Using a packet data service, subscribers are always connected and always online so services will be easy and quick to access.

Quality of Service (QoS): A networking term that specifies a guaranteed throughput level. One of the biggest advantages of ATM over competing technologies such as Frame Relay and Fast Ethernet is that it supports QoS levels. This allows ATM providers to guarantee to their customers that end-to-end latency will not exceed a specified level.

W-CDMA: A wideband spread-spectrum 3G mobile telecommunication air interface that utilizes code division multiple access (or CDMA, the general multiplexing scheme).

Wi-Fi: Abbreviation for "Wireless Fidelity"; a set of product compatibility standards for WLAN based on the IEEE 802.11 specifications. Wi-Fi was intended to be used for mobile devices and LANs, but is now often used for Internet access. It enables a person with a wireless-enabled computer or PDA to connect to the Internet when in proximity of an access point.

Category: Concepts, Trends, and Challenges

Identifying E-Business Options

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INTRODUCTION

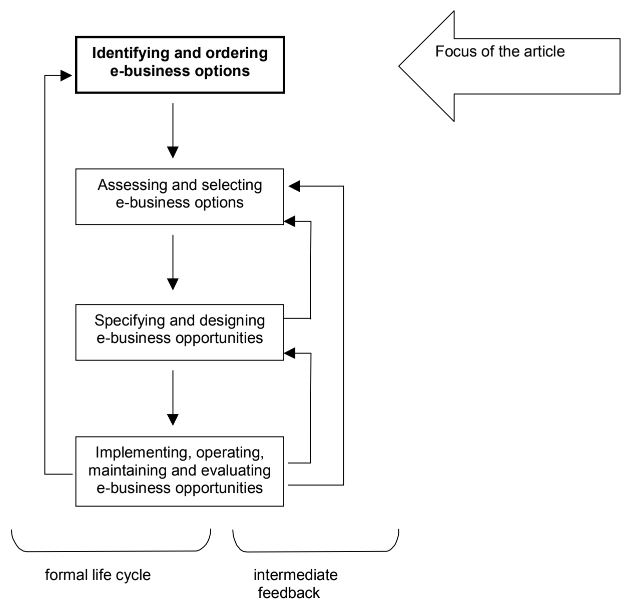
The past few years, many organizations have been using the Internet in quite arbitrary and experimental ways. This phase, which can be considered as a period of learning and experimentation, has created a need for a more systematic approach to the identification, the ordering and the assessment of e-business options. It is the objective of this paper to address this need by presenting a methodology that aims at supporting management in using alternative e-business applications in the first stage of the decision-making process.

Figure 1 shows how a systematic decision-making process can be organized by using e-business options. The steps are based on Simon's intelligence, design, and choice trichotomy (Simon, 1960). First, alternative e-business options have to be identified and ordered. Then the possible options have to be assessed and selected. After this stage the selected opportunities have to be specified and designed. Next, implementation, operation, maintenance, and evaluation may follow. In Figure 1 this is called the "formal life cycle". We will apply the word "e-business option" referring to the possibility to use an electronic network for a business purpose. An e-business opportunity is defined here as an assessed and selected e-business option.

In practice, different intermediate feedback activities, interrupts, delays and adjustments are often necessary to reconsider earlier steps (Mintzberg, Raisinghani, & Théorêt, 1976). This is—among other reasons—because decision-making processes of this kind take place in dynamic environments and decisions are made in political contexts (Pettigrew, 2002). Moreover, participants in decision-making processes are often lacking the necessary information to make well-considered decisions right from the start (Miller, Hickson, & Wilson, 1996). In Figure 1 these activities are called "intermediate feedback".

The methodology presented in this article focuses mainly on the first stage of the decision-making process: the identification of e-business options and the ordering of these options. Further, the focus is only on e-business options in the context of an organization and its current or new external stakeholders.

Figure 1. Focus of the article in the light of the desicion-making context



The methodology helps identify e-business options, describe them in a global way by specifying each option in six dimensions, and order them according to organization- dependent priorities. Only after management has assessed and selected an option can this option be specified more precisely in order to design an application (see also Figure 1).

This methodology aims at contributing to practice as well as to theory. Practitioners, such as (e-business) managers and (e-business) consultants, can use the methodology to identify and order e-business options in a systematic rather than an intuitive, imitating or precedent-based way. This methodology can also be used to challenge certain e-business strategies or to consider unconventional alternatives.

The contribution to theory is based on the fact that many existing e-business frameworks are directed at the assessment of certain e-business alternatives, but that general approaches addressing the identification of e-business options from scratch, are still scarce. This argument will be explained in the next section.

BACKGROUND

Although Chung-Shing Lee's contribution (2001) of providing a framework to evaluate e-commerce business models is useful, evaluation can only take place after the identification of options, which is the focus of this article.

Barua, Konana, Whinston, and Yin, (2001) introduce an e-business value model that supports management in determining where to deploy organizational resources by highlighting specific areas of opportunity. Barua et al. also emphasize that organizations should not merely concentrate on the existing products or services. They suggest that the Internet may open up opportunities to reach new customers and to introduce new products or services.

The ideas of Barua are in line with those of Ansoff (1965), who identifies product market areas to be focused on by organizations. Ansoff suggests that two important strategic questions of organizations are: (1) whether they should focus only on their existing markets and customers or also on new markets and customers, and (2) whether they should merely focus on existing products and services or also on the development of new ones. With respect to e-business these two fundamental questions are highly relevant, since the Internet makes many organizations rethink their product-market combinations fundamentally. Therefore, these two questions are addressed in the approach as described in this article.

Straub and Klein (2001) build on these ideas by stating that e-commerce can produce three categories of effects: first-order, second-order, and third-order effects. First-order effects involve reducing costs and increasing productivity. Second-order effects concern the pursuit of new markets and improving services, and third order effects lead to far-reaching transformations affecting goods and services, ways of targeting as well as distribution (Andal, Cartwright, & Yip, 2003). These issues are also addressed in the methodology as described in this article; they will be identified explicitly.

We can conclude that there are already a considerable number of models that can be used to assess and evaluate current e-business applications and measure their readiness for the future. However, there seems to be a lack of approaches that can help analysts generate options and future directions regarding utilizing the Internet. The approach as described in this article aims at making suggestions with respect to how such a methodology could take form.

METHODOLOGY

Dimensions and Elements

Organizations can use the Internet as a means of communication with the outside world in different ways. These different ways can be analyzed by distinguishing among the following dimensions: stakeholders groups, stakeholders' statuses, channel strategies, communication modes, product/service groups and product/service statuses.

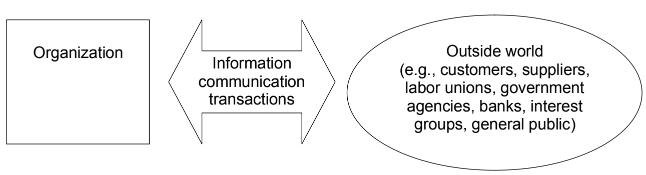
These dimensions are derived from the elementary notion that organizations can be perceived as open systems. In order to survive, good relations have to be established with parties in the outside world. For that reason, organizations exchange information to relevant parties in that outside world. These communications may lead to transactions. See Figure 2.

In order to generate potential e-business options, it has to be identified with which parties in the outside world the organization intends to exchange information. These can be current or new parties, since electronic networks can also be used to extend the reach of organizations. When this outside world has been identified, the way of using electronic networks has to be considered. Here we can identify communication modes, channel strategies and (current or new) products and services. These dimensions are further explained in the next paragraph.

Dimension #1: (External) Stakeholders Groups

Organizations exchange information and communicate with all external stakeholders, who can be divided in *business partners* and *other stakeholders*. It is relevant

Figure 2. Organization as an open system



to distinguish between business partners and other external stakeholders because the communication mode between the organization and these two kinds of stakeholders groups is different (see also the paragraph on communication modes). With business partners, an organization has both a transactional (including monetary) exchange relation and an informational and communicational relation. Business partners include customers, suppliers, banks, insurance companies, shareholders, and governments (e.g., concerning taxes, licenses, and regulations).

With other external stakeholders, organizations only have an informational or communicational relation. Examples are the press, special interest groups, (e.g., environmental groups), and the general public. The number of external stakeholders groups is organization-dependent: the user of our methodology has to map out and group all external stakeholders who may be relevant to the analysis.

Some relevant questions with respect to stakeholders are:

- What are the current groups of business partners?
- What are the current groups of other stakeholders?

Dimension #2: Stakeholder Statuses

We distinguish between two statuses, namely *current* and *new*. By using the Internet, an organization can transform or extend its business with respect to new stakeholders. New stakeholders can be new customers, new suppliers, new banks, or even new governments. New customers can be reached by entering new markets (market extension) or by disintermediating current intermediaries and, in this way, targeting final consumers. The same applies to suppliers. By using electronic marketplaces, organizations can broaden their suppliers' base or disintermediate backward to replace suppliers by the initial producers of the supplies.

Some relevant questions with respect to stakeholder statuses are:

- Could the organization reach new business partners by using the Internet?
- Could the organization reach new other stakeholders by using the Internet?

Dimension #3: Channel Strategies

In this article we distinguish between Internet channels and non-Internet channels (although our methodology also allows further refinements). Organizations can choose to use the Internet as an exclusive medium for communication exchange purposes with one or more (groups of) stakeholders. This is called a single-channel Internet strategy. The alternative is to combine the Internet with non-Internet channels. This is called a multi-channel strategy.

Some relevant questions with respect to channel strategies are:

- Can the organization use the Internet as a single-channel strategy to reach a current group of business partners?
- Can the organization use the Internet as an additional-channel strategy to reach a new group of business partners?
- Can the organization use the Internet as a single-channel strategy to reach a current group of current other stakeholders?

Dimension #4: Communication Modes

We distinguish among *informational*, *interactional,* and *transactional* communication modes. Informational means a one-sided provision of information, (e.g., by putting a product catalogue on the Internet). Interactional means a two-sided information exchange, (e.g., by enabling customers to ask questions). Transactional means the exchange of products or services or the agreement about such an exchange, (e.g., to order a product and to pay over the Internet). Interactional mode includes informational mode; transactional mode includes interactional and, hence also informational mode (Grover & Ramanlal, 2004).

A relevant question with respect to communication modes is:

- Could the organization use the Internet to provide information, to exchange information or to engage in transactions?

Dimension #5: Product (and Service) Groups

Organizations can use the Internet to buy or to market their products and/or services. The number of product/service groups is organization-dependent: the user of our methodology has to map out and to group all current products and services that may be relevant to the analysis.

Some relevant questions with respect to product/service groups are:

- What are the current or new final products and services and could the Internet be used to facilitate the buying or selling process?
- What are the current or new inputs and could the Internet be used to facilitate the buying process?

Dimension #6: Product (and Service) Statuses

We distinguish between two statuses, namely *current* and *new*. Organizations can use the Internet to buy or sell their current products and services, but they can also transform or extend business by buying or marketing new products or new services on the Internet. Many products can be extended or transformed by using the Internet.

A relevant question with respect to product statuses is:

- What are possible new final products/services and inputs?
- Could the Internet be used to facilitate the buying or selling process of new products or services?

Examples of a Newspaper Publisher

A publisher of a regional newspaper has many options with regard to using the Internet. We will use the different dimensions of our methodology to describe four of these options. These options are also shown in Table 2.

- **Example 1:** The publisher may choose to put the contents of (a part of) the newspaper on the Internet as an additional service for his current subscribers (extension of current product to current customers, multi-channel).
- **Example 2:** The publisher may choose to put the contents of (a part of) the newspaper on the Internet as a service extension to his current products for current subscribers as well as new clients.
- **Example 3:** The publisher may choose to develop a new single-channel Internet newspaper, using special Internet features (e.g., interactivity, news on demand) to reach new customers (new product, new customers, single-channel Internet).
- **Example 4:** The publisher may choose to develop an Internet newspaper, based on a current newspaper, using special Internet features as a free new service for current subscribers and a chargeable service for new Internet customers (the English newspaper *The Economist* makes use of this option).

To illustrate the different dimensions of an e-business option, the e-business options in this example are generated in an arbitrary way. Many other options are also possible. In the next sections we will show how options can be generated and ordered in a systematic manner.

Generating Potential Options

In order to systematically generate potential e-business options once the (company-dependent) elements of all dimensions are determined, a closer look is required at the structure of the description of the potential options. In our view, the following general format can be used to describe all potential options:

<communication mode> ***options concerning*** <product status> <product group> ***with*** <stakeholder status> <stakeholders group> ***using a*** <channel strategy>

All possible combinations of values applied to the six variables in the general format then make up the complete set of potential options. If p is the number of product/service groups and s is the number of stakeholders groups that are distinguished by the organization concerned, this will lead to 2 * 2 * 2 * 3 * p * s (i.e., 24 * p * s) potential options. So it is obvious that these potential options can be generated in a systematic manner, namely by straight-

Table 1. Examples of some e-business options of a newspaper publisher

Example nr	**Stakeholders Groups and statuses** *Dimension # 1, # 2*	**Channel strategies** *Dimension #3*	**Communication modes** *Dimension #4*	**Product and service groups** *Dimension #5*	**Product and service statuses** *Dimension #6*
1	Current subscribers	Internet *and* traditional newspaper = multichannel	Information	Content of current newspaper	Current
2	Current subscribers and New clients	Internet *and* traditional newspaper = multichannel	Information	Content of current newspaper	Current
3	New customers	Internet single-channel	Transaction	Newspaper	New
4	Current subscribers and New customers	Internet and traditional newspaper = Multichannel	Interaction for current subscribers, transaction for Internet/only customers	Current newspaper, adapted	New

Table 2. Dimensions of e-business options

Dimension	Dimension order
Stakeholders groups	6
Product groups	5
Channel strategies	1
Communication modes	4
Stakeholder statuses	2
Product statuses	3

Table 3. Elements of e-business options

Element	Dimension	Elements order
Customers	Stakeholders groups	1
Suppliers	Stakeholders groups	2
Shareholders	Stakeholders groups	3
Banks	Stakeholders groups	4
Governments	Stakeholders groups	5
Physical goods	Product groups	3
Digital products	Product groups	1
Services	Product groups	2
Single-channel Internet strategy	Channel strategies	1
Multi-channel strategy	Channel strategies	2
Informational	Communication modes	1
Interactional	Communication modes	2
Transactional	Communication modes	3
Current	Stakeholder statuses	1
New	Stakeholder statuses	2
Current	Product statuses	1
New	Product statuses	2

forwardly combining each possible element with each of the six dimensions. Each combination results in a potential option.

Rather than writing out these 24 * p * s potential options by hand, they can also be generated by means of a tool. The tool can consist of a database with a *Dimensions* table containing the six dimensions and an *Elements* table containing all (2 + 2 + 2 + 3 + p + s) elements per dimension. A sample content of such a database will be shown in the next section. Furthermore, the database has to have a reporting facility which, based on the joining of these two tables, can generate the 24 * p * s descriptions of the potential options in our general format.

Ordering Potential Options

The potential options can be ordered by adding the ordered dimensions to the ordered elements within each dimension. The ordering of the dimensions and their elements implicitly implies an ordering of the generated options. The next example should make this clear.

Example

Suppose that the publisher distinguishes three general product groups (Physical goods, Digital products, and Services) as well as five stakeholders groups (Customers, Suppliers, Shareholders, Banks, and Governments). After choosing one particular way of ordering the dimensions and the elements within each dimension, the contents of our two database tables could be as shown in Tables 2 and 3.

This means that in this example we will first consider:

- *Informational options concerning current digital products for current customers using a single-channel Internet strategy*
- Then, similar options for the other stakeholders groups (4 groups in this case),
- then, similar options for the other product groups (2 groups in this case),
- then, similar options for the other communication modes (2 modes in this case),
- then, similar options for the *new* products,
- then, similar options for the *new* stakeholders, and,
- finally, similar options for the other channel strategy.
- We will obtain the descriptions of potential options by simply placing the respective elements into the general format that we introduced earlier.
- In our example, this generates 360 potential options (namely, 5 * 3 * 3 * 2 * 2 * 2).

Different criteria can be used for ordering the different elements. One criterion may be to prioritize from current to new. This means that potential options, including current stakeholders, current products, and multi-channel strategies, appear at a higher place on the list than potential options including new stakeholders, new products and single-channel strategies. This is in accordance with Straub et al. (2001) who state that Internet applications tend to move from first-order to second-order and then to third-order effects (see the background section). If a company chooses to follow this pattern, the list will first suggest the less risky options.

Another approach may be to look for a strategic fit. If a company intends to reach new groups of customers, it is reasonable to give new stakeholders groups a higher ranking. The same applies when an organization intends to use the Internet to launch new (Internet-based) products or services. In that case, these new products and services should get a higher priority. If the company-dependent elements are identified in the right way, the list will, in any case, provide all potential options.

Once the list of potential options has been generated and ordered, a list of valid options has to be composed.

The difference between a potential and a valid option is determined by whether a potential option is possible. This means that impossibilities have to be eliminated from the list. To give an example: it is impossible to deliver a bottle of orange juice over the Internet. So delivering orange juice over the Internet is a potential option, but not a valid one. Ordering orange juice over the Internet is a potential option as well as a valid one, since it is actually possible.

However, not all (valid) options will make sense from a business perspective. This means that options have to be assessed, often by using a range of criteria. So once the list of valid options has been acquired, the next stage of assessment can begin (see Figure 2).

Tool Support

The approach as described in this article will be supported by a tool that enables one to easily:

- Record the product/service groups and the stakeholders groups (organization-dependent);
- Generate the potential e-business options; and
- Order the e-business options.

The tool will consist of a database, which contains the proper:

- Data structures (tables) already containing all organization-independent data;
- Forms to enter and update the organization-dependent data (i.e., the product/service groups and the stakeholders groups); and
- Reporting facility to generate and order the potential e-business options.

E-business consultants, managers, and business analysts can use this tool to support the process of business improvement of organizations. The methodology suggests conventional as well as highly unconventional approaches to the use of the Internet and helps people specify certain directions of e-business-related change.

This approach, including this tool, can be used in interviews and workshops to generate and discuss directions of change that may improve final decision-making.

FUTURE WORK

When the options are identified and ordered, they have to be assessed on the basis of one or more criteria (see Figure 1). These criteria are organization-dependent. Many organizations use multi-criteria methods (Grimbergen et al., 2001; Parker, Benson, & Trainor, 1988) to assess IT investment alternatives, including e-business options. We intend to extend the methodology as described in this article by incorporating this next step. To support this next step, a tool will be developed. This tool should, among other things, enable an organization to record the results of the assessment and selection process. So, our methodology will then aim at covering and supporting the first two stages of the e-business decision-making process as depicted in Figure 1.

A prototype of the methodology as described in this article has been applied in two organizations. We intend to describe these cases and extend this case base with the objective to refine and improve our methodology.

CONCLUSION

It can be concluded that there is already a considerable number of models for assessing current e-business applications and for measuring the readiness of e-business for the future. However, there is a lack of approaches that can help consultants, managers and academics to generate new options and new directions regarding utilizing the Internet and other new (electronic) communication channels. In this article, such an approach has been offered, including a tool that supports this goal. The approach contributes to a more creative and systematic way of decision-making with respect to e-business. It describes the more trivial as well as the highly unconventional e-business options in a global but complete and systematic way. These descriptions lead to an extensive list of potential options. This list can serve as the basis for further systematic decision-making and may stimulate people to make conscious and well-considered e-business decisions. Further, the approach could be extended so that the assessment and selection processes are incorporated as well. Finally, these processes could also be supported by a tool.

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KEY TERMS

E-Business Opportunity: An assessed and selected e-business option.

E-Business Option: A possibility to use an electronic network for a business purpose.

E-Business Value Model: A model which conveys to management where to focus organizational resources by highlighting specific areas of opportunity.

External Stakeholders: Organizations exchange information and communicate with all external stakeholders, who can be divided in *business partners* and *other stakeholders*.

Internet Option: A possibility to use the Internet for a business purpose.

Implementing CRM Systems in Online Enterprises

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INTRODUCTION

Companies are increasingly embracing customer relationship management (*CRM*) as a major element of corporate strategy, for two important reasons: new technologies now enable companies to target chosen market segments, microsegments, or individual customers more precisely; and new marketing thinking has recognised the limitations of traditional marketing and the potential of more customer-focused, process-oriented perspectives (Payne, 2002; Ragins, & Greco, 2003).

The first *CRM* procedures were implemented to provide more efficient customer transactions. The gradual shift from transaction to interaction, as a long-term process, required the implementation of analytical marketing procedures, based on databases and data processing technology. Brobst and Rareyk (2004) outlined the evolution of analytical *CRM*, identifying five distinct stages (see Table 1). The interactive marketing stage is possible only using the *Internet* as a *CRM* strategic channel—which allows real-time, continuous collection, analysis, and use of data to adapt the company's offer and communication to the individual profile and behaviour of the customer. The introduction and use of *CRM* in the online environment requires a complex process of planning, analysis, strategy design and implementation. This article presents a model for the implementation of a customer-centric strategy in online businesses, discussing the advantages and the challenges of this new system.

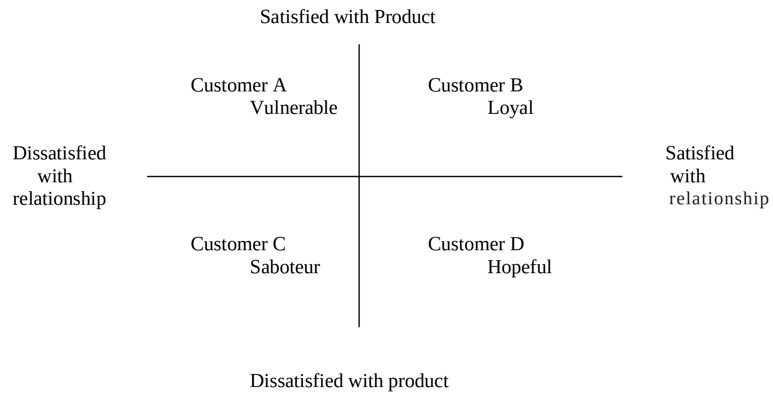
BACKGROUND

The *Internet* user has the opportunity to switch the suppliers with several mouse clicks, to compare price and products on a worldwide basis, and to select without external pressure the best available offer. The winning combination of low price/high quality product does not work properly on the *Internet* because the same offer may be available at hundreds of other online retailers

Table 1. The five stages of analytical CRM (From Brobst & Rareyk, 2004)

Stage of analytical CRM	**Main Strategic Orientation**	**Challenges**
Mass marketing	Create a database of customers improving the effectiveness of mass marketing operations and reducing the costs of blanket marketing campaigns	Data and database quality—reliability and elimination of double entries
Segment marketing	Deliver product offers differentiated by customer segment. Use ad hoc analysis to develop an understanding of customer segments and design product offerings appropriate to each segment	The capacity to dynamically segment the market based of various criteria applied to the customer database. Performance management and proactive capacity planning for the database is a prerequisite to success
Target marketing	Treat each customer as an individual. Every customer and prospect is scored based on their propensity to buy and targeted accordingly	The introduction of data-mining technology combined with the calculation of customer lifetime value
Event-based marketing	Focuses on enabling personalised marketing communication driven by individual behaviour patterns.	The implementation of "software event detectives," to identify events relevant for customer relationship and then initiate personalised communications in response to such events. Events detection implies more frequent data acquisition and updating
Interactive marketing	Real-time interaction with customers, adapted to their profile, behaviour, and reactions	Integration of analytical and operational CRM—databases connected with customer management applications

Figure 1. The eLoyalty Matrix (Adapted from Conway & Fitzpatrick, 1999)



(Wundermann, 2001). The only possibility to increase the competitive advantage of online retailing is to create not only product-related satisfaction but also customer-firm relationship satisfaction (Bradshaw & Brash, 2001).

The eLoyalty Matrix (see Figure 1), an economic model developed at eLoyalty (Conway & Fitzpatrick, 1999), considers the situation of a company-customer long-term relationship, in which, to a given moment, various types of customers experience a variation in the level of satisfaction determined by relationship and/or product strategies.

Customer A is satisfied with the product purchased, but dissatisfied with his or her relationship with the company. This customer type is vulnerable to switching. The customer/company relationship profoundly affects how a product or company is viewed and affects customer behaviour. Properly managed and serviced, this category of customer can become a significant source of future transactions and move into the loyalty quadrant.

Customer B is very satisfied with the product and the relationship with the company. The company can count on his or her repeat purchase and will most likely benefit from referral business via positive word of mouth.

Customer C is a saboteur to the organisation. Because of a negative experience, these customers will never buy from the company again, and they can also discourage other potential customers from ever interacting with the company.

Customer D was not satisfied with the product but is hopeful that the next purchase will be satisfactory. A good relationship creates a reservoir of goodwill upon which the customer is willing to give the company another chance. However, the good relationship cannot represent an absolute deterrent of customer defection, and the company needs to take urgent measures to adapt its product offer to the customer's needs before it is too late.

As the eLoyalty Matrix indicates, *CRM* implementation represents the key to increasing customer loyalty in the digital environment (Lindström & Andersen, 2000; Reichheld & Schefter, 2000). Despite a rising consciousness about the importance of loyalty marketing, 70% of online retailers lack operational strategies for cultivating their all-important customer relationships (FollowUp.Net, 1999).

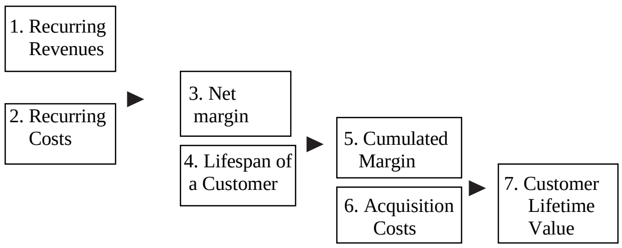
The implementation of an efficient customer relationship management strategy requires the introduction of a customer-focused organisational culture (Rheault & Sheridan, 2002). The key operations for building an effective *CRM* strategy include the following (Conway & Fitzpatrick, 1999):

- identifying the characteristics of the main customer segments;
- modelling the current and the potential value of each customer;
- creating proactive strategies and operational plans, or business rules, which will support the desired experience for the customer, starting with the highest value customers; and
- redesigning the organisation, processes, technology, and reward system to implement the relationship strategies.

The strategic planning process of an e-business organisation needs to be adjusted to the needs of a *customer-centric culture*. This adjustment has two major stages:

1. Implementing the tools of the *CRM* system within the operational structure of the firm
2. Introducing customer-centric values, objectives and procedures in the organisational culture

Figure 2. Seven-step process to measure customer lifetime value (Adapted from Bacuvier, 2001).



IMPLEMENTING THE CRM SYSTEM

Before the strategic planning process can be applied to customer centric procedures, the firm needs to put in place the tools and procedures to collect relevant information about its customers, to process efficiently this information, and to segment the market. The implementation of customer-centric systems comprises a number of essential stages.

Collecting Customer Information

As the *CRM* system is based on a customer's profile and transaction history, the company needs to collect information about its customers. The implementation of *CRM* procedures requires the existence of historical data that are used to identify the main market segments and create an accurate customer profile. These data are available either though online automated systems that register the history of customer-firm interaction (historical data) and/or buying the necessary data from a third party (usually a specialised market research agency). The collected data is stored in databases and is then accessed for processing.

Calculating the Customer Lifetime Value (CLV)

The *CLV* consists in taking into account the total financial contribution (i.e., revenues minus costs) of a customer over his or her entire life of a business relationship with the company. Despite its simplicity, the measurement of *CLV* requires great care. All cash flows involved in the process have to be identified and measured on a detailed level and allocated precisely to each customer or type of customer. The diagram in Figure 2 represents a concise seven-step approach to measure *CLV* (Bacuvier, 2001).

The calculation of the customer lifetime value is not problem free. However, most of these problems can be successfully solved, taking into consideration two main issues:

- The company applying this method has to clearly define from the beginning the purpose of using customer lifetime value analysis and the expected benefits.
- The problems raised by the customer lifetime value analysis are often industry and company specific, and as a result the company has to select the most appropriate way to apply this concept in its particular situation.

Despite its utility, it should be kept in mind that the calculation and application of *CLV* has all the limitations of a method that uses old or present data to predict future consumer behaviour. Its use is based on the existence of consumption tendencies that, although evolve in time, have a certain stability on short to medium term.

Value Segmentation

Segmentation is the key to understand the lifetime value of a specific customer, and to apply the most appropriate customer management strategy (Gurău, 2003). As a result of the customer lifetime value calculation, the company's clients can be segmented in terms of profitability, using dimensions that are discriminating either on the revenue side (e.g., usage intensity and behaviour) or on the cost side (e.g., products purchased, channel used, intensity of customer care usage and service levels). Using this analysis, the company can have a complete mapping of the "wells" of value creation and "pits" of value destruction of the business and an understanding of why they are such.

To be effective, customer behaviour profiling needs to be connected with customer *segmentation* on different value categories, using *CLV* (Ness, Schroeck, Letendre, & Wilmar, 2001). The connection between customer value and customer behaviour can be highlighted creating a relationship equity matrix (Conway & Fitzpatrick, 1999).

Table 2. Differentiated combinations of strategic approach for various customer segments

Value/Loyalty	**High Value**	**Low Value**
Loyal	Retain	Conquer Increase revenues Reduce recurring costs Reduce acquisition costs
Disloyal	Retain Reduce acquisition costs	Increase revenues Reduce recurring costs

Analysing the matrix, the strategic priority of each segment is easily identifiable.

Customer E, high-value but disloyal, represents a group that deserves the greatest amount of attention. The company is at risk of losing profitable, influential customers.

Customer F is what makes the company successful at present. Companies must pay great attention to this group as a way of expressing appreciation for their ongoing business and recognising their importance.

Customer G, low value and disloyal, does not represent a group with long-term potential. If he or she chose to switch suppliers, the economic loss will be minimal for the company. This customer is usually opportunistic and price oriented.

Customer H, low value but loyal, can be over-serviced, and therefore unprofitable for the company in the long term.

The analysis and the definition of each customer segment in terms of profitability will depend on each firm's profile and strategic objectives. The *customer life cycle* also needs to be taken into consideration. Sometimes, the low value/loyal customers can evolve into highly profitable customers, either through increased purchase or through positive referrals.

Strategies for Profit Maximisation

Considering the procedure of *CLV* calculation, in any business there are essentially five levers of customer value creation (Bacuvier, 2001):

1. **Conquer:** Acquire new customers with positive customer values or who contribute to spread the fixed costs over a wider basis.
2. **Increase Revenues:** Generate more revenues from existing customers at each transaction.
3. **Retain:** Increase the loyalty of customers in order to extend their individual lifetime with the company.
4. **Reduce Recurring Costs:** Improve the efficiency of operations in order to reduce the cost of serving each customer.
5. **Reduce Acquisition Costs:** Improve the process of attracting new customers.

These five strategies should be used differently for each customer segment, in order to optimise the potential of value creation. Table 2 proposes differentiated combinations of strategic approach for the four customer segments defined in the relationship equity matrix.

Figure 3. The relationship equity matrix (adapted from Conway & Fitzpatrick, 1999)

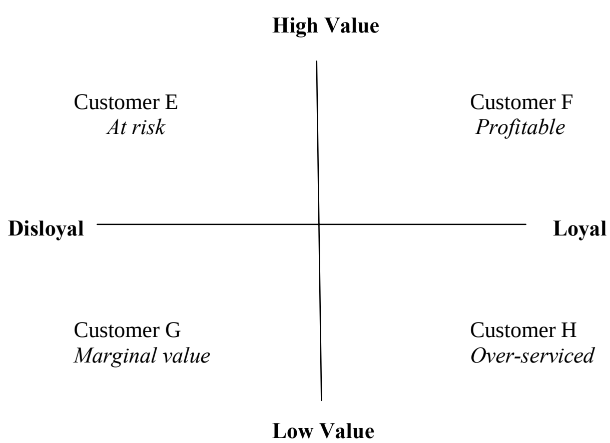
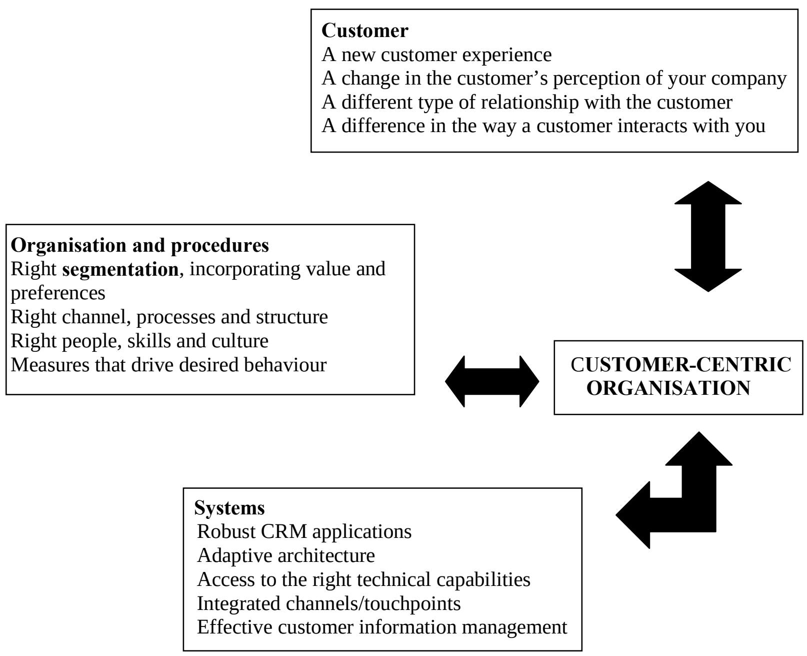


Table 3. The key changes triggered by CRM implementation (Adapted from Forsyth, 1999)

Organisational	Managing Change	Sales and Marketing	Technical
Incorporating "customer" into the business planning cycle	Changing the boundaries of marketing, sales, and communication channels	Incorporating "customer" into marketing decisions and sales operations	Providing an evolving, user-friendly CRM system
Setting customer-related objectives	Changing the customer culture to be customer oriented rather than product focused	Centralising control of the sales and marketing process	Building the CRM database from the operational or "legacy" systems
Multifunction teams required to implement customer relationship programs	Implementing a process of "continuous change"	Learning the new skills of CRM-based marketing	Providing a cost-effective environment with good performance

Figure 4. The CRM journey—Realizing full value (Adapted from Forsyth, 1999)



The main goal of this stage in the strategic planning process is to understand the characteristics of customer segments and to identify the correct mix of operational activities, capable to optimise the value of each customer segment.

Implementing a Customer-Centric Corporate Culture

Once the customers segments have been identified and prioritised in terms of profitability, it is possible to redesign the corporate culture of the business organisation around a customer-centric approach.

The redesign of the corporate culture as customer-centric (see Table 3) needs to simultaneously transform and adjust (a) the technological systems and procedures used to deal with customers (information collection systems, customer databases, customer segmentation, customer relationship strategies and their implementation); (b) the internal operations and processes within the organisation (hierarchical structure, links and collaboration between different organisational departments, structure of managerial functions and responsibilities); and (c) the values and the objectives of the organisation (application of the customer lifetime value concept, mass customisation, pursuing an increase of customer satisfaction in order to retain and increase the return value of each client, differentiation through consistent customer service). In customer-centric online organisations, the integration of analytical and operational *CRM* tools offers the possibility to identify, assess and define precisely the main customer segments in terms of profitability, and to build predictive customer profiles. The planning process should incorporate both strategic and operational perspectives, creating continuity and consistency among various organisational levels. The implementation process becomes more flexible, offering the possibility of a quick adjustment at the level of individual customer campaign.

The integration of customers' databases with data mining tools and customer management applications permits the effective management of customer interaction at individual level. Intelligent software agents can be used, for example, to identify particular events relevant for customer relationship, and then activate customer management software that automatically sends an e-mail message to the targeted client. By integrating intelligent agents and e-*CRM* technology, customer communication can be fully or partially automated using a single knowledge base via a variety of independent electronic channels such as online chat, e-mail or SMS messaging.

FUTURE TRENDS

This article attempted to present, analyse and assess the advantages and the challenges of *CRM* system implementation, and to propose a model to redesign the organisational structure in this context. This model can provide beneficial information both for academics and practitioners:

1. On the basis of this theoretical framework, future research projects can be initiated to analyse the specific procedure of introducing a *customer-centric culture* in various *CRM*-based online organisations.
2. The model can be used by managers and business practitioners to reflect on the advantages/problems of implementing a *CRM* system in their organisation and to identify the main aspects regarding the adaptation of the business process to the new organisational structure.

CONCLUSION

The flexible and interactive nature of the Internet offers the possibility to collect a vast amount of data about online customers and their interaction with the company. Processing this data provides a good basis to segment the market precisely, to predict the behaviour of customers, and to implement one-to-one marketing campaigns.

On the other hand, the volatility of online markets requires an increased focus on customer relationship and customer loyalty. Research shows that a 5% increase in customer retention can increase the company profits with 20% to 100% (Reichheld, Markey, & Hopton, 2000). In this situation, *CRM* processes become a major element of corporate strategy for digital organisations.

The applicability of the traditional approach to marketing in the online business environment has been increasingly questioned and criticised in recent years. This approach emphasised the management of key marketing mix elements such as product, price, promotion, and place within the functional context of the marketing department in order to create a winning offer. The new *CRM* approach, whilst recognising the importance of the marketing mix, reflects the need to create an integrated cross-functional focus on customer-firm interaction (Winer, 2001).

The implementation of the *CRM* model will restructure the whole enterprise, creating new procedures for market research, strategic planning, operational implementation, and managerial control. Considering the magnitude of change, an organisation needs to assess its core business and consider the form of CRM that is more appropriate for its structure and market. Then, having identified the present and the future focus of CRM, the organisation has to access and implement the appropriate information architecture to enable their *CRM* strategy (see Figure 4).

Ultimately, the organisation's success in *CRM* will involve creating an appropriate strategic vision of the future, making the appropriate choice of applications, creatively using appropriate analytical techniques to exploit the data, and, finally, incorporating the customer-centric procedures into a flexible organisational process at the corporate level (Payne, 2001).

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KEY TERMS

Customer-Centric Approach: Organisational strategy that aims to explore and understand customers' needs and motivations and to restructure all organisational processes to provide superior value to consumers.

Customer Lifetime Value: The total net income a company can expect from a customer during the entire period of customer-company interaction.

Customer Management Software: Software application that allows the company to interact with multiple customer segments and to send them personalised offers.

Customer Relationship Management: An organisational strategy that starts, maintains, and optimizes relationships to increase the loyalty of customers.

Data Mining Tools: Software applications that extract predictive information from large databases, which can then be analyzed to enhance corporate data resources and generate predictions regarding business trends and customer behaviour.

Online Customer Relationship Management: The methodologies, software, and Internet capabilities that help a company manage customer relationships in an efficient and organised manner.

Relationship Equity Matrix: Analytical model developed by Conway and Fitzpatrick (1999) that allows a representation of various consumer categories and of the associated CRM operations performed by the company.

Category: Concepts, Trends, and Challenges

Indexing Mobile Objects

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INTRODUCTION

The past few years have shown a significant increase in the volume and diversity of data stored in database management systems. Among these are spatiotemporal data, one of the faster developing categories of data. This phenomenon can be attributed to the flurry of application development concerning continuously evolving spatial objects in several areas: mobile communication systems, military equipment in battlefields, air traffic, truck fleets, and others.

In standard database applications, data remain unchanged unless an update is explicitly stated. Applying this mode of operation to constantly moving objects would require frequent updates to be performed; otherwise, the database would be inaccurate and unreliable. In order to capture continuous movement and to avoid unnecessary updates, object positions are stored as time-dependent functions, requiring updates only when a function parameter changes. The moving objects are considered responsible for updating the database about alterations in their movement. In the following article is a short review on basic indexing schemes for accommodating moving objects in database systems so that complex queries about their location in the past, present, and future can be served.

BACKGROUND

The indexes developed for moving objects can be classified according to criteria such as the kind of supported queries, the type of the accommodated objects, and their applicability to various-use cases. This article focuses on the last criterion. Thus, an index is characterized as *practical* when it has been implemented and experimentally investigated. Otherwise, it is *theoretical*, and its main utility is indicating inherent complexities. The following addresses practical indexes.

Database Representation

Most applications usually assume objects of fixed shape and volume and are interested only in their location as a geometric point at various instances in time. The optimal way to register such spatiotemporal information depends on its intended use, which is either the postprocessing of the recorded data, or the exploration of current and future locations.

In the first case, object trajectories must be indexed. The trajectories are usually calculated by the linear interpolation of sampled locations, both to accommodate storage limitations but also—more important—because of the very nature of the data generators (e.g., GPS equipment generates discrete location data). As a result, each trajectory consists of a sequence of connected line segments in the three-dimensional space, for which semantically related line segments must be indexed. This indexing operation requires cautious extensions to spatial indexes (Gaede & Günther, 1998).

In the second case, the object position is considered as a time function x(t). Usually x(t) is modeled as a linear *parametric* function of time:

$$x(t) = x(t_{ref}) + v(t-t_{ref}),$$

specified by two parameters: the *reference position* x(t_{ref}) at a specific time t_{ref}, and the *velocity vector* **v**, which defines a space *dual* to the *time-location* space.

Query Types

Location-Based Queries

Location-based queries are further categorized into *range* and *nearest-neighbor (NN)* or *proximity* queries. A range query is characterized as (i) *time-slice* or *snapshot* when, given a hyper-rectangle *r* located at time *t*, it asks for all moving objects contained in *r* at that time; (ii) *window* when it requests reporting all objects crossing a hyper-rectangle *r* during a time interval $\mathbf{t}=[t_s,t_e]$; and (iii) *moving* when it specifies a trapezoid τ by connecting a hyper-rectangle r_1 at time t_s and a hyper-rectangle r_2 at time t_e and inquires all objects crossing τ.

On the other hand, nearest-neighbor queries request the nearest moving object to a given location at time *t* or during a time interval $\mathbf{t} = [t_s,t_e]$. The generalization this type of queries demands the *k nearest-neighbors* (kNN). Sometimes, *reversed nearest neighbor* (RNN) searching is required for reporting all objects having a given object as their nearest neighbor.

Trajectory-Based Queries

Trajectory-based queries concern (i) information about the semantics of the movement (e.g., objects entering, leaving, crossing, and bypassing a region during a given time instance or interval). For example, "*find all mobile phones entering a particular cell between 2 p.m. and 5 p.m. today*"; and (ii) Derived or navigational information, such as travelled distance, velocity, and so forth; for example, "*report all objects whose travelled distance between 2 p.m. and 5 p.m. 3 days ago was smaller than 40 mph.*"

Continuous Queries

Continuous queries considers that the range or point query is also moving: "*find all my nearest restaurants as I drive towards the current direction for the next 5 minutes*." Despite its conceptual simplicity, these queries are inherently complex, because they are equivalent to constantly posing location-based queries.

Soundness-Enriched Queries

Soundness-enriched queries demands answers enriched with validity (temporal or spatial) information; namely, the future time t at which the result expires, and the change that will occur at time t. For instance when one asks "*report the pharmacy nearest to my position as I am now moving,*" the database will return the nearest pharmacy ID i, the future time t that i ceases to be the closest pharmacy and a new pharmacy $i2$ that would be the next nearest one at time t. Alternatively, the database returns a validity region r around the query position, within which the answer remains valid. Returning to the example, i will be accompanied by the region for which it is the nearest.

This class aims at reducing the number of generated queries: Because the query and the server responses are delivered via a wireless network, the extra information could spare network bandwidth, because the user will release new inquiries only when it is absolutely necessary.

MOBILE OBJECT INDEXING

Practical indexes can be classified into two subcategories according to the time dimension: The structures capable of answering queries about the present and the future belong to the first group, and the second one comprises indexes serving inquires about the past. The presentation of the indexes will focus on (i) the type of the queries they support; and (ii) the main performance and implementation characteristics they exhibit. Table 1 summarizes the presentation.

Querying About the Present and Future

The members of this grouping are further classified based on three types of supporting inquiries:

Structures Supporting Range Queries

Kollios, Gunopoulos and Tsotras (1999b) suggested solutions for one- and two-dimensional range querying that

Table 1. Categorization of presented indexes

Querying about the Present and Future	
Query	**Index**
Range	Kollios et al. (1999b)
	Šaltenis et al. (2000)
	Benetis et al. (2002)
	Tao et al. (2003)
Simple Proximity	Kollios et al. (1999a)
	Aggarwal and Agrawal (2003)
Continuous Proximity	Song and Roussopoulos (2001)
	Tao et al. (2002)
	Iwerks et al. (2003)
Time-Parameterized	Tao and Papadias (2002)
Validity	Zheng and Lee (2001)
	Zhang et al. (2003)
Querying the Past	
Query	**Index**
Reporting	Pfoser et al. (2000)
	Pfoser and Jensen (2001)
	Porkaew et al. (2001)
	Hadjieleftheriou et al. (2002)
	Lazaridis et al. (2002)
Aggregating	Papadias et al. (2002)
	Tao et al. (2004)
	Sun et al. (2004)

employ mathematical transformation and use either off-the-shelf spatial indexes (e.g., the R-tree; Gaede & Günther, 1998), or simplex range searching in the two-dimensional dual space.

In Šaltenis, Jensen, Leutenegger, and Lopez (2000), the TPR-tree—a time-parameterized version of the R*-tree (Gaede & Günther, 1998) for objects moving with constant velocities in one-, two- and three-dimensional space—was introduced, which became the de facto spatial index for time-slice, window, and moving queries. The TPR-tree is a practical and well-tested solution that avoids the dual space technique and the reduction to higher dimensional spaces. TPR-tree algorithms were extended in Benetis, Jensen, Karciauskas, and Šaltenis (2002) so that two-dimensional NN and RNN queries for a query point q during a time interval $\mathbf{t}$ can be served.

Further improvements where introduced as the TPR*-tree (Tao, Papadias, & Sun, 2003), which exhibits new insertion and deletion algorithms based on a novel cost model. Extensive experimentation proved the superiority of the TPR*-tree: The average query cost is almost five times less, and the average update cost is nearly constant. Thus, the TPR*-tree can be characterized as the state-of-the-art index for serving range queries. However, this fact does not invalidate the practicality of the TPR-tree, especially when one accepts to trade the administration cost for index maintenance for the ability to answer two-dimensional NN and RNN queries.

Structures Supporting Nearest Neighbor Queries

The members of this subcategory are distinguished as follows:

- **Simple Proximity Indexes:** Kollios, Gunopoulos, and Tsotras (1999a) suggested preliminary practical solutions for dealing with the simple problem of locating the nearest moving neighbor of a static query in the plane. The generality of the approach also permits locating nearest-neighbors within a specified time interval and for restricted data movement in fixed routes.

  On the other hand, Aggarwal and Agrawal (2003) introduced methods for indexing moving objects with nonlinear trajectories in arbitrary dimensions, such as d-dimensional parabolic trajectories, that satisfy the convex hull property. The convex hull property relates the locality in parametric space to the locality in the positions of objects, and, thus, suggests the employment of standard indexes (e.g., the R*-tree).
- **Continuous Proximity Indexes:** Song and Roussopoulos (2001) studied the kNN problem for a moving query point and static data points and introduced algorithms that extend static kNN queries, capitalizing on the fact that, when the query point moves to a new position, some part of the previous answer also belongs to the new one. The proposed algorithms can be implemented easily, a fact that one should consider when using off-the-shelf R-trees.

  Continuous kNN search in a static data set organized as an R-tree T has been studied by Tao, Papadias, and Shen (2002). The authors observed that when the query point is moving on a line segment, it is sufficient to use a bound-and-bound traversal of T that employs heuristic node pruning rules. The extensive experimental evaluation of this method confirms its usefulness.

  Finally, Iwerks, Samet, and Smith (2003) presented algorithms for answering continuous kNN queries on a constantly moving point set, whose members can change either location or velocity. In general, their approach is quite interesting and extends naturally the repertoire of mobile NN-queries but, as the authors noticed, further research is needed for fine tuning.

Structures Supporting Soundness-Enriched Inquires

This class of indexes returns either temporal or spatial validity information which specifies the conditions under which the answer remains effective, in addition to the answer itself. The solutions devised so far are relatively simple, but also quite promising for further development and research:

- **Time-Parameterized Queries:** Tao and Papadias (2002) introduced the time-parameterized (TP) queries that return, along with the answer set, its expiration time and the event that invalidates it. The authors also demonstrate how TP queries can be used to answer continuous *spatiotemporal* and *earliest event* queries: The first type refers to the case when one should provide results for a given time span, as they are generated. The second type asks for the evaluation of the earliest time in the future a specified event could take place; for example, in the scene of moving point objects and query point q, find the first time q catches a point.
- **Validity Queries:** Zheng and Lee (2001) considered the problem of enabling mobile clients to

determine the validity of query results according to their current location. Thus, the number of client queries—and therefore the network traffic—is reduced: The server returns the answer along with a validity region *r* within which there is no alteration of the answer, allowing clients to issue subsequent queries only when they leave *r*. Zhang, Zhu, Papadias, Tao, and Lee (2003) dealt with validity NN, kNN and window queries. For the first two cases, they suggested algorithms that implicitly calculate the validity region. The third case—window queries—is reduced to determining the maximal rectangle around the center of the window inside which the result remains unchanged and then appropriately refining it.

Querying the Past

Historical databases on moving objects accommodate spatiotemporal information, which can be processed to either *report* or *enumerate* all objects satisfying certain spatial and temporal conditions. In the first case, the corresponding indexes are characterized as *reporting* and in the second, as *aggregating* or *enumerating*.

Reporting Indexes

In Pfoser, Jensen, and Theodoridis (2000) the STR-tree and the TB-tree are proposed. Both treat spatiotemporal queries on mobile object trajectories without future prediction. The first index constitutes an extension of the R-tree; lines belonging to the same trajectory are kept closely together and time is the main dimension. In contrast, the TB-tree serves spatiotemporal queries by properly cutting every trajectory into pieces which it stores cautiously. Experimental evaluation of the index proved its efficiency, with further tuning of its performance achieved in Pfoser and Jensen (2001): In the presence of constraints by the infrastructure environment (such as roads, lakes, etc.), one can employ a proper segmentation of the original query range in a set of subranges and eliminate dead space.

The case of indexing moving objects whose extent may change was treated in (Hadjieleftheriou, Kollios, Tsotras, & Gunopoulos, 2002). The authors approximated the object movement with a minimum bounding rectangle (MBR). In addition, in order to eliminate empty space and overlap they artificially split every trajectory in pieces and insert those into a partially persistent R-tree. Porkaew, Lazaridis, and Mehrotta (2001) also approximated trajectories by MBRs stored in an R-tree and proposed algorithms for combinations of spatial and temporal range, NN, and kNN queries.

Lazaridis, Porkaew, and Mehrotra (2002) also approximated trajectories by MBRs stored in an R-tree and suggested algorithms for moving window queries with known (*predictive*) and unknown (*nonpredictive*) moving patterns. In short, they use a priority queue along with specific intersection conditions which guide and prune the search of the R-tree.

Aggregating or Enumerating Indexes

Papadias, Tao, Kalnis, and Zhang (2002) introduced three indexes for answering aggregate queries in spatiotemporal databases, the aRB-tree, the aHRB-tree and the a3DRB-tree. The first (aggregate RB-tree) refers to the case of fixed spatial dimensions whereby one needs to maintain historical summary data. For dynamic regions the authors propose the latter two indexes: aggregate historical RB-tree (aHRB-tree), which uses a node copying technique, and aggregate 3DRB-tree (a3DRB-tree), which is applicable when all region changes are known in advance.

The aforementioned indexes have a “defect”: If an object remains in the query region for several time stamps during the query interval, then it will also participate in the answer several times. Because the “distinct counting” property is very crucial in many decision-making queries—such as traffic analysis and mobile-phone-users’ statistics—Tao, Kollios, Considine, Li, and Papadias (2004) suggested algorithms that replace the direct counting of the objects by FM sketches. In this way, the resultant structure becomes *approximate* and of bounded probability failure, but it can also be properly extended to support distinct sum queries and spatiotemporal association rules extraction.

Finally, the first approach to support approximate queries about the past, present, and future was recently reported in Sun, Papadias, Tao, and Liu (2004), which introduced (i) the adaptive multidimensional grid-based histogram (AMH) for answering present time queries, and (ii) the application of the exponential smoothing—a time-series forecasting method—for serving queries about the future based on recent historical data.

FUTURE TRENDS

As can be seen in previous short review of contemporary solutions in this area of research, some very interesting topics arise that require further consideration. One area deserving attention is that of designing indexes capable of capturing the uncertainty of a moving object’s location. This uncertainty arises due to the combination of network delays and continuity of motion. Preliminary work by Trajcevski, Wolson, Zhang, and Chamberlain (2002) partially addresses modelling and querying in this domain. In addition, it would be very interesting to efficiently manipulate nonlinear trajectories since the scope of indexable moving objects would be significantly extended.

Another appealing subject, especially for extending mobile application capabilities, is the design of indexing structures capable of serving "mixed" queries concerning the past and future of movement; the approach in Sun et al. (2004) can be considered as a first attempt towards this direction. Along this same line of research, the incremental valuation of validity queries is also very intriguing.

Finally, it would be very helpful from an engineering perspective (i) to test and evaluate indexes with real datasets—until now, every experimental investigation is conducted with "semireal" data whose movement component is generated; and (ii) to design efficient updating algorithms for the indexes, which deviate from the usual 'deletion and reinsertion' practice, introducing perhaps a trade-off between either the query time or the accuracy of the result and the update time.

CONCLUSION

A broad category of applications, emerging from the technological advances that occurred in the last years in telecommunications and hardware, constitute the framework known as "mobile computing." A key issue in such a framework is the fast and timely access to a constantly changing data set. This fact indicates the crucial role of indexing moving objects. Provided in this study is a review of some contemporary solutions for this area of research from the application perspective and presented some very interesting topics for further consideration.

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KEY TERMS

Database Management Systems: Software systems for organizing the information in a database in a way that permits data input, verification, storage, retrieval, and combination.

Indexing: To create an external memory data structure in order to speed up search and retrieval of information.

Mobile Computing: The infrastructure, both networking and software applications, that permits networked devices to be moved freely within the broadcast coverage area, contacting others, and conducting computations.

Moving Object: Any object (e.g., automobile, vessel, pedestrian) equipped with a location-detection device.

Query: A request to retrieve data from a database.

Spatiotemporal Data: Multidimensional data with spatial (two- or three-dimensional) and time dimensions.

Trajectory: A set of multidimensional points which define the route of a moving object during a time interval.

Category: Concepts, Trends, and Challenges

Information Assurance in E-Healthcare

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INTRODUCTION

There is growing concern that the healthcare industry has not adopted IT systems as widely and effectively as other industries. Healthcare technological advances generally emerge from the clinical and medical areas rather than clerical and administrative. The healthcare industry is perceived to be 10 to 15 years behind other industries in its use of information technology (Raghupathi & Tan, 1997). Incorporating new technology into the healthcare organization's processes is risky because of the potential for patient information being disclosed. The purpose of this study is to investigate the information assurance factors involved with security regulations and electronic medical record initiatives—a first necessary step in making the healthcare industry more efficient. Noncompliance of a healthcare organization's employees with security and privacy policies (i.e., information assurance) can result in legal and financial difficulties, as well as irreparable damage to an organization's reputation. To implement electronic medical initiatives, it is vital that an organization has compliance with security and privacy policies.

E-health technology is a relatively current phenomenon. There are two types of distance-related healthcare that are technology driven. Telehealth is known for involving telemedicine—medicine practiced over a distance, with the impetus of control being in the physician's hands (Maheu, 2000). E-health involves the patient or physician actively searching for information or a service, usually via the Internet (Maheu). Electronic medical records fall into the e-health category because the physician, healthcare partners, and patient would be able to access the information through an Internet connection.

Security and information assurance are critical factors in implementing e-health technologies. There is a lack of a well-developed theoretical framework in which to understand information assurance factors in e-healthcare. The theory of reasoned action (TRA) and technology acceptance model (TAM) enable a conceptual model of information assurance and compliance to be formed in the context of healthcare security and privacy policy. The relationship between behavior and intentions, attitudes, beliefs, and external factors has been supported in previous research and will provide a framework for ensuring compliance to security and privacy policies in healthcare organizations so that HIPAA (Health Insurance Portability and Accountability Act) regulations are enforced and electronic medical records (EMRs) can be securely implemented.

Traditionally, records in the healthcare industry have been paper based, enabling strict accessibility to records. This allowed for confidentiality of information to be practically ensured. The uniqueness of healthcare records and the sensitive information they contain is specific to the industry. Over the many years that medical records have been kept, those involved in the field have undertaken a self-imposed rule of stringently protecting the patient information while providing quality care.

The patient's expectation for confidentiality of personally identifiable medical records is also critical. According to Rindfleisch (1997, pp. 95-96), in his study of healthcare IT privacy, the threats to patient information confidentiality are inside the patient-care institution; from within secondary user settings which may exploit data; or from outsider intrusion into medical information. Rindfleisch (1997) examined specific disclosures which could release sensitive information such as emotional problems, fertility and abortions, sexually transmitted diseases, substance abuse, genetic predispositions to disease—all of which could cause embarrassment and could affect insurability, child custody cases, and employment.

The process of healthcare treatment includes not only the patient and physician but also nurses, office staff who send out bills and insurance claims, the insurance company, billing clearinghouses, pharmacies, and any other companies to which these processes can be outsourced. There is an estimate that states as many as 400 people may have access to your personal medical information throughout the typical care process (Mercuri, 2004). The government is also a partner in national health concerns, and also maintains databases containing information on contagious diseases, cancer registries, organ donations, and other healthcare information of national interest. (See http://www.fedstats.gov/programs/health.html for a listing of the databases.)

With the advent of government mandates such as EMRs and HIPAA regulations, the increased accessibility of sensitive records requires intense effort to create policies that limit access for those who are authorized. Although there is an area of information economics which views information as an asset that can be numerically valued for its benefit, the same perspective has not been adopted in healthcare. Especially in the United States, clinical information and patient care are considered proprietary (Hagland, 2004). There is no specific associated cost with one's medical information—what damage is done when one's medical information has been utilized improperly? Even though damages are ill-defined, there are regulations and standards for emerging technology in healthcare. The two most current important security and privacy issues involve HIPAA regulation and the government mandate for EMRs.

BACKGROUND

The HIPAA Regulation . . .

HIPAA was enacted in 1996 and covers insurance reform for ensuring preexisting coverage when changing jobs as well as the standardization of electronic transmissions. It consists of two components, the Security Rule and the Privacy Rule. If the rules are not enacted, there are severe financial penalties enforced by the government (Mercuri, 2004). Also, an organization risks having internal employees disclose information that would be of a confidential nature to patients, which could result in legal consequences.

The Privacy Rule (Markus, 2004) focuses on the use and disclosure of medical information, specifically that which is personally identifiable, also known as protected health information (PHI) in the industry. The goal of the Privacy Rule is to ensure protection of PHI across transmissions to health partners (insurance companies, billing clearinghouses, etc.). This requires the patient to fill out the Notice of Privacy Practices Patient Acknowledgment form, which suggests that the patient has read the HIPAA privacy information and allows the patient to determine the people to which one's PHI can be disclosed.

The Security Rule requires that PHI be protected specifically in electronic storage and transmissions. Implications for HIPAA compliance have been intense. Developing standards and security encryptions for existing software, as well as ensuring that third-party partners are compliant, has been time-consuming and costly. However, Privacy and Security Rule compliance will be critical for successful implementation of electronic medical record infrastructure.

Electronic Medical Records

An electronic medical record (EMR) contains a patient's medical history with a physician. The capture of one's medical information can be made available to authorized users such as other physicians, pharmacists, insurance companies, and the government. Due to the inherent virtualization of the record, the physician's office or hospital will not have physical control as they have in the past. Therefore, security measures, mainly technical components, are critical to EMR implementation. EMR records will also fall under the HIPAA Privacy and Security Rules. Since the healthcare industry has been reluctant to implement EMR plans for cost, security, or other reasons, the government has taken an active role to encourage development of EMRs through financial incentives. Healthcare and IT organizations are also collaborating to develop standards (Mercuri, 2004).

Measures Needed for Better Management

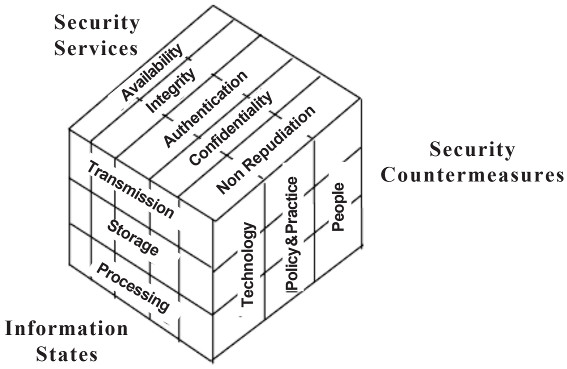
Handling of sensitive information will be vital to understanding the compliance for HIPAA regulation, as well as for the implementation of EMRs. With information now being stored and transmitted electronically, a new paradigm exists for power over the information. How organizations measure the success of HIPAA compliance will reflect on how sensitive information is handled. However, it is uncertain how the healthcare industry monitors this. The old adage of "what is not measured is not managed" comes to mind and one wonders if compliance will be monitored after training is administered and policies are implemented. The purpose of this study is to develop a preliminary framework of issues that determine compliance to information assurance and security policies.

Information Assurance

Figure 1 (from Maconachy, Schou, Ragsdale, & Welch, 2001) in which the aspects of information assurance are depicted. They discuss information assurance as an expansion of the "coverage, responsibilities, and accountability of security professionals" which includes "proactive offensive activities" (p. 307).

Aspects of security services, information, and security countermeasures fall under the information assurance (IA) umbrella. The focus of IA is integrating the relationships between these, since a weakness in one would result in a weakness in the entire system. The information can be either currently in storage, in processing, or in transmission mode. The Security Services are carried not only by technological details such as availability of the system,

Figure 1. Information assurance model (From Maconachy, Schou, Ragsdale, & Welch, 2001)



integrity of the data, authentication of users, and confidentiality, but by operations and procedures, and, most importantly, people. People "are the heart and soul of secure systems ... and require awareness, literacy, training, and education in sound security practices for the system to be secured" (Maconachy et al., p. 308). Whether or not a person follows a policy and uses the IA technology will determine how secure the system ultimately will be.

In terms of healthcare, information assurance provides a well-developed model in which to integrate the technological and behavioral issues in e-Healthcare security and privacy context. E-healthcare will be successful only if information assurance is carefully planned and monitored for compliance. In the premise offered for this research, information assurance is inherent in security and privacy policy compliance, and provides the structure for integrating the variety of research areas involved. Therefore, a theoretically-sound framework for incorporating TRA and TAM in the context of healthcare information assurance is proposed to bridge the gap between policy creation and policy compliance. This area has not been researched previously and will provide an important contribution to e-healthcare implementation in the industry, especially in bridging the gap between the technical and behavioral aspects of e-healthcare information assurance.

Government resources from Health and Human Services and associated National Institute for Standards and Technology (NIST) are helpful in framing the variables into a model for information assurance and compliance. The Department of Health and Human Services developed *Delivering Consumer-Centric and Info-Rich Healthcare: Framework for Strategic Action* (Thompson & Brailer, 2004), which discusses the readiness for change in healthcare, as well as a framework for action and leadership. NIST offers policy and security frameworks as well as healthcare tools and other assistance for both the clinical and administrative aspects (see http://www.nist.gov/public_affairs/healthcare.htm).

Healthcare Culture, Security, Compliance, and Information Assurance

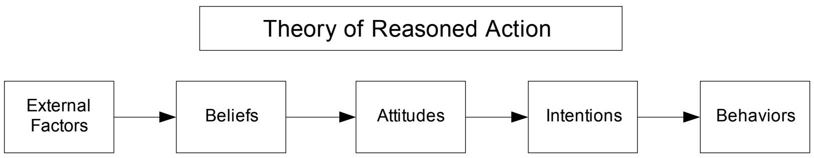
It is often stated that an organization is only as strong as the weakest link. "When you start bringing in the users, your system is going to be as trustworthy as the least trustworthy person who touches it" (Baldwin, 2000). The opportunity with HIPAA and EMRs is to realize that privacy and security of PHI must be managed in a technologically driven environment. This supports our premise that, although technological tools can aid in monitoring security and privacy compliance, they cannot provide the comprehensive measure—comprehensive adoption includes people issues. Trish Markus (2004) questioned the establishment of a "culture of compliance," which advocates the management involvement and commitment through communication and training procedures. Mercuri (2004) quoted a chief information officer as stating that HIPAA "compliance is not sold in a bottle," therefore, "providing employees with policies and procedures for their job classification and requiring them to read and sign off on them" is not adequate (p. 27). Culture includes a shared vision and a positive link to company strategy. Indeed, organizational culture can determine if compliant attitudes, intentions, and behaviors will become second nature (Gue, 2002).

Theory-Based Research

Academic research in the healthcare area has been specific, usually technology-related versus theory building and testing. TRA and TAM are utilized for the purpose of this research because the factors including a person's attitudes, beliefs, and intention to adopt a technology such as EMRs and to examine one's intentions to comply with information assurance policy associated with those EMRs. Hu, Chau, and Tulu et al. (1999, 2002, 2003) researched TAM in the context of healthcare technology adoption, with mixed results. In their 1999 telemedicine study Hu et al. found that TAM is adequate, with exception to TAM's explanation of attitude and intention. Perceived usefulness was significant on intention to use telemedicine. For the physician to perceive telemedicine as being useful, Hu et al. (1999) suggested that proper user training is essential. Attitude also significantly influenced physician behavioral intention.

In similar studies, TRA was utilized and was extended in information technology usage. Amoako-Gyampah and

Figure 2. Diagram of the theory of reasoned action



Salam (2004) measured constructs for ERP (enterprise resource planning) project communication, training, belief in the project benefits, attitude towards ERP system, perceived usefulness, ease of use, and behavioral intention to predict usage of ERP systems. TAM was extended to external variables of project communication, beliefs in ERP system benefits, and training. Findings were significant for project communication and training affect on beliefs in the system benefits. Also, shared beliefs strongly affected both PU (perceived usefulness) and PEU (perceived ease of use) in the ERP setting.

An example of TRA utilization in another study by Salam, Iyer, Palvia, and Singh (2005) examined associations between the formation of trust, technology usage, and development of a relationship with a vendor website. It suggests that managers develop factors that affect the trustworthiness of their companies. This correlates to managing the factors that affect compliance with security and privacy policies.

Capturing Information Assurance Issues in Healthcare IT Policy Implementation

The widely accepted theory of TRA has been utilized often to support the causal relationships between external factors, beliefs, attitudes, intentions, and behavior. TAM is a TRA spin-off and has supported the intention to use, perceived usefulness, and behavior when adopting new technology. This same theoretical basis can be used to examine the acceptance and compliance behavior of users who are to adopt new organizational policy. In the context of information assurance, the TRA model will capture the compliance of healthcare security and privacy policies (see Figure 2).

Our premise is that through one's external factors, beliefs, attitudes, and intentions, one will decide to either comply or not comply with security and privacy policies. We will examine the context of compliance with security and privacy policies within the TRA, because the user of the policy will, in essence, determine the success of such policies and compliance with HIPAA. The user can be defined as the physician, clerical staff member, IT staff, administrative staff, nursing staff, and so forth.

COMPONENTS OF THE FRAMEWORK

Organizational Culture

The main components of organizational culture which relate to information assurance compliance are management commitment and its enforcement of IA Policies. The extent to which management seems committed and is willing to enforce IA policies will affect how strongly one believes in management commitment and its enforcement of those policies.

Figure 3. Diagram of the technology acceptance model

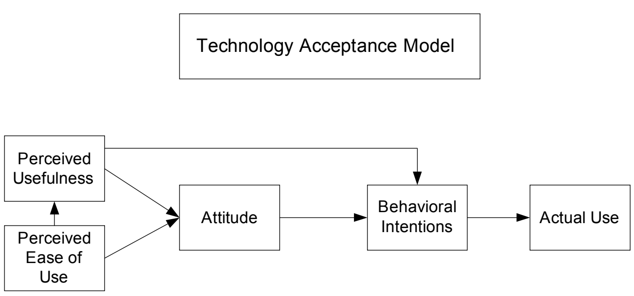
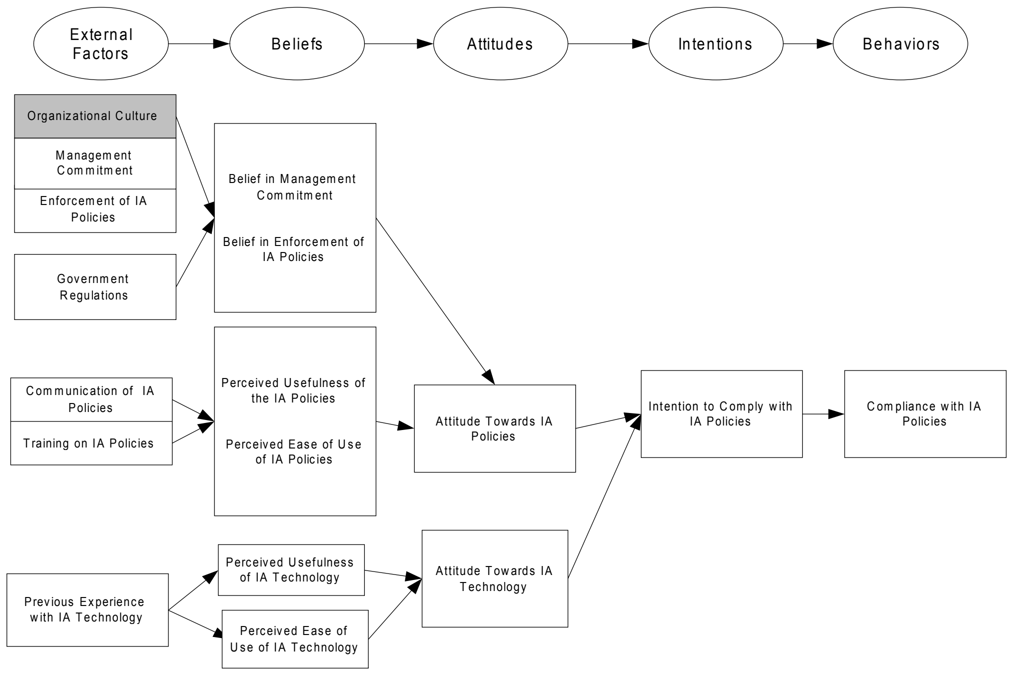


Figure 4. A conceptual framework for applying the theory of reasoned action and the technology acceptance model in e-healthcare information assurance



Government Regulations

Government regulations such as HIPAA and mandates such as EMRs will affect how strongly the management of healthcare organizations is committed to communicating and enforcing information assurance policies.

Training and Communication

Amoako-Gyampah and Salam (2004) found in their research on ERP implementation that Training and Communication influence the beliefs on attitude and its mediation effects on the intention to use an ERP system. Accordingly, training on IA Policies and the communication of those policies should also have an influence on the perceived ease of use and perceived usefulness of such policies. If employees feel that training is helpful in information assurance and compliance, employers may be urged to offer further training, even in the maintenance phase, so that information assurance can be increased as much as possible. If the policies are communicated often, and in various ways, especially in how they are important and relate ensuring security and privacy of patient information, employees should be more apt to find it beneficial to use and comply with the policies.

Previous Experience with IA Technology

The TAM model is appropriate and supported in demonstrating the influence between a person's prior experience with a technology and how useful and easy that technology will be to use. Much of the research has shown that this perception of usefulness and ease of use enables one to develop attitudes towards that technology in order to determine whether they will use the technology (Davis, 1989; Venkatesh & Davis, 2000). In this case, the attitude towards technology will affect one's behavior and choice to comply with the policies. If the implementation of information assurance and security policies involves technological barriers that decrease functionality of the technology or are too difficult to manage, the user is less likely to use the technology, therefore, less likely to comply with the policy.

This framework captures how factors such as organizational culture, government regulations, training, policy, and previous experience lead to belief, attitude, and intention formation regarding IA policy compliance behavior. Belief systems such as management commitment, enforcement of policy, the ease of use and perceived usefulness of IA policy and technology, shape one's attitude towards IA technology and policy. This attitude development then affects one's intention to comply with IA policies and, therefore, actual compliance behavior.

FUTURE TRENDS IN E-HEALTHCARE

The environment for healthcare is changing rapidly, and the processes involved will transform how patient care is conducted. Along with the implementation of EMRs, the ultimate goal is the EHR (electronic health record), which will include the consolidation of a patient's lifetime health records from each healthcare provider. This EHR is a virtual roadmap that guides the physician in the journey to medical decision-making. Having this information at hand, even available via handheld devices, makes critical information available to physicians to share data while geographically dispersed. This is the dawn of telemedicine, which is already gaining popularity in New Zealand and Australia. Smart card technology is emerging as a new technology which can be applied to enable patients to carry their own virtual medical charts in their pockets (Raghupathi & Tan, 2002).

There are additional legal and financial issues to be handled in the future. The legal aspects of implementing telemedicine and EMRs need clarification. Who owns the EMR? Who will be responsible for attempts at unauthorized access? Will the patient be allowed to view and edit their EMRs—for example, add their living will or organ donor preferences (Pyper, Amery, Watson, Thomas, & Crook, 2001)? If a vendor is utilized to store healthcare data for an organization, what happens to the data if the company goes out of business (Songini & Dash, 2000)? Will insurance companies consider telemedicine consults for payment?

These legal, financial, and technical issues will need to be resolved so that the transformation of healthcare processes are successful and patient care is administered in the most appropriate manner possible, regardless of how, where, and what information is utilized to make the most informed medical decisions.

CONCLUSION

The contribution of this research is to propose a theoretically sound framework in which behavior and technology are analyzed in compliance and information assurance in e-healthcare. This will enable future research in moving the field forward in healthcare information assurance research and practice. The next step in this research is to examine how healthcare organizations can measure the success of security and privacy policy compliance to achieve an information assurance threshold. The importance of understanding compliance within this context will be critical to determining the success of security and privacy policies.

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KEY TERMS

Confidentiality: Not releasing or disclosing information to unauthorized individuals, entities, or processes (Fariborz, Navathe, Sharp, & Enslow, 2003).

EMR: electronic medical record; also known as EHR (electronic health record), CMR (computerized medical record) or CPR (computer-based patient record). There are subtle differences between these; for example, EHR is often used specifically for ambulatory care records (Marietti, 1998).

HIPAA: Health Insurance Portability and Accountability Act (1996) requires the secretary of health and human services to publicize standards for the electronic exchange, privacy, and security of health information.

- **Privacy Rule:** addresses the need for healthcare organizations to allow patients to choose how their information is disclosed
- **Security Rule:** addresses the security of electronic transmission of medical information

Information Assurance: Information operations that protect and defend information and systems by ensuring their availability, integrity, authentication, confidentiality, and nonrepudiation (Maconachy, Schou, Ragsdale, & Welch, 2001).

NIST: National Institute of Standards and Technology

- NIST was founded in 1901 and is a non-regulatory federal agency within the U.S. Commerce Department's Technology Administration. NIST's mission is to develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life. (see www.nist.gov)

Privacy: The rights of individuals regarding collection, storage, processing and use in decision making about personal information about themselves (Turn, 1999).

Security: A collection of policies, procedures, and safeguards that help maintain integrity and availability of information systems and control access to their contents (Rindfleisch, 1997).

Telemedicine: "When physicians use electronic communication and information technologies to provide or support clinical care from a distance" (Patel & Rushefshy, 2002, p. 328).

Category: Concepts, Trends, and Challenges

Information Integration for Relationship Management

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INTRODUCTION

In the past 20 years, an explosion in the ability of firms to acquire and integrate vast amounts of electronic customer information has occurred. For example, in the early 1990s, Lotus Development Corporation introduced, then withdrew a software product called *MarketPlace: Households* from the market after widespread public concern. The $695 product had a searchable database of 120 million Americans, containing their names, addresses, estimated incomes, consumer preferences, and other personal details. Fast forward to 2005, and companies like ChoicePoint Inc. hold personal information on virtually every single American and sell it over the Internet. Though the ability to technologically acquire and manage information has been possible since the mid 1960s, it was not until the 1990s that the Internet allowed even the smallest of firms to collect, purchase, and integrate information about potential customers. This "interactive information integration" capability is a process of consolidating and managing customer information from all available sources. The recent proliferation of affordable client devices such as desktop computing combined with advances in telecommunication (broadband, mobile devices, etc.) in the early part of the 21st century has enabled this trend to continue and grow.

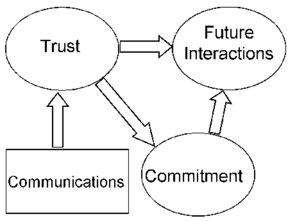
Optimally, marketplace information is used to develop need-based offerings generated from specific individual-level data. These customized solutions can lead to long-term profitable relationships for both customers and firms. However, the level of acceptance of the collection and use of personal information varies among consumers, and the human and technological ability of firms to properly secure information is not perfect. Miscues, such as ChoicePoint's report that personal data for more than 140,000 people had been stolen and Time Warner's report that data tapes containing information on more than 600,000 past and present employees was lost (Perez & Brooks 2005), affect attitudes toward the collection and use of personal information, particularly in marketing communications.

BACKGROUND

Within the span of only a few years, marketers have witnessed an explosion in the number of available electronic communication vehicles. These new media channels include the firm's Web site, directed online advertisements placed on Web pages, commercially oriented e-mails, text messaging, and direct communication to mobile devices (e.g., smart phones and PDAs). In each of these communication media, the collection and use of personal information can influence the development of relationships between firms and individual consumers. Firms differentiating themselves by better targeting their messages must collect and use personal information.

However, the willingness to provide information is not the same for all consumers (Berendt, Günther, & Spiekermann, 2005) and perceptions of appropriate use of information falls along an *intrusion continuum* (Petty, 2003), with some individuals advocating a right to privacy and strongly opposed to any information collection processes, while others appreciate that personal information use is a prerequisite for improved service and value. Firms consider consumer information as a resource to be used internally and shared with strategic partners (third parties). Internal use allows integration of seemingly disparate customer information into meaningful user profiles, which are used to develop highly personalized communications. Information from consumers comes knowingly (i.e., through filling out online forms) or unknowingly (i.e.,

Figure 1. Marketing communication's role in building relationships



online behavior tracking). Yet, individuals are often unaware of the information's accuracy, how the information is used, or who has access to it.

We present an interdisciplinary synthesis of recent research concerning information integration use in relationship marketing in the emerging electronic marketing communications arena. We present our perspective of how different levels of information acquisition and integration used in electronic marketing communications impact consumer perceptions and relationship building, couched with a discussion of recent legal and policy issues related to online privacy. We conclude with a discussion of future trends and implications of electronic marketing communications, coupled with privacy concerns on perceptions and subsequent customer relationships.

RELATIONSHIP MARKETING

Researchers in the field of marketing have adopted a relationship-based philosophy toward marketplace interactions. Firms have moved from generic mass marketing communications toward highly individualized targeted communications. Figure 1 provides a general illustration of marketing communications' effect in the relationship marketing process. The purpose of targeted communications is the formation of relationship commitment from customers. As committed customers, they are more likely to stay with the firm, speak positively about the firm, and disclose information to the firm, leading to even more targeted communications.

With electronic communications overall, developing trust is seen as an important step in the relationship building process (Lee & Turban, 2001). Trust is accepted to be essential in the development of successful relationships (Morgan & Hunt, 1994; Garbarino & Johnson, 1999). Trust leads an individual to believe that the company will "…perform actions that will result in positive outcomes … as well as not take unexpected actions that result in negative outcomes" (Anderson & Narus, 1990, p. 45).

In marketplace interactions, trust is necessary before one is willing to share personal information. However, for the Internet, because it is a relatively new means for engaging in commercial and communication activity, uncertainty and risk are often noted as reasons for an individual's reluctance to provide information, and trust is essential (Suh & Han, 2003).

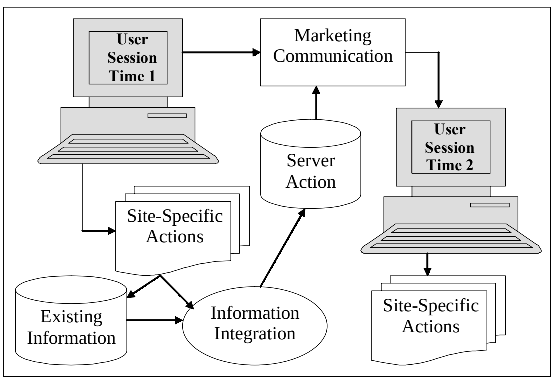
Role of Communication in Relationship Marketing

Communication, or information exchange, is an important antecedent of trust in relationship marketing (Morgan & Hunt, 1994). Marketing communications in the electronic environment are any actions that result in electronically based information being shared between an individual and a firm. Therefore, electronic communication is more than just firm-created communications and encompasses individual actions such as visiting a firm's Web site, sending e-mail, receiving newsletters, filling out forms, engaging in text messaging with service personnel, tracking a package, or responding to an offer sent via short messaging service (SMS) or mobile text messaging. Such a broad definition allows that any electronically enabled interaction between the firm and an individual is viewed as a communication act.

INFORMATION INTEGRATION AND MARKETING COMMUNICATIONS

The integration of information is a powerful tool for developing personalized marketing communications (Peltier, Schibrowsky, Schultz, & Davis, 2002). Information integration, as illustrated in Figure 2, is a technology-

Figure 2. Information use to create personalized marketing communications



based approach that assimilates relevant data from internal and external sources to develop an offering from the firm (Jhingran, Mattos, & Pirahesh, 2002).

As an Internet user begins his or her session, information is collected based on current actions and previously stored information. This information is then integrated to offer a marketing communication to the user. The user's response is collected to be used to calibrate and modify future communications (Gatarski, 2002; Sherman & Deighton, 2001).

Existing Information

This encompasses any information that has been collected previously about or from a particular user. An individual firm may have access to data about a user's purchasing history, demographics, or financial status, but also data regarding previous usage patterns on the Internet (Bhat, Bevans, & Sengupta, 2002), as well as communications that the user may have had with the company through telephone conversations, e-mails, chat room comments, responses to previous communication, or from contracted secondary sources (Romano, Donovan, Chen, & Nunamaker, 2003).

Site-Specific Information

Beyond collection of information related to a specific purchase (e.g., name and items purchased), we refer to technological tools to obtain real-time information about a user. The use of client- and server-side technologies allows the specific actions in a current Internet session to be tracked and recorded.

Cookies are the most prevalent client-side technology. Cookies are small text files which are capable of tracking and recording information such as the specific visited Web page URLs and information provided to such Web sites. Alternatively, server-side technologies are managed at the company's servers. Log files keep track of items such as which Web pages are called and how long a page is kept open. Web bugs combine the capabilities of server log files and cookies by tracking users across participating Web sites. Web bugs not only track behavior on a single Web site, but can also be used to track behavior across Web sites over time.

Information Integration

This is the ability to efficiently and systematically combine information from many sources. With the large amount of information that is available, the ability of firms to integrate and extract situation-specific data and apply them in a targeted communication is a valuable asset which can provide the firm with a strategic competitive advantage (Roth, Wolfson, Kleewein, & Nelin, 2002).

Server Actions

In terms of Internet marketing communications, the information integration process utilizes information resources to have the server react differently for each customer or a customer group. The precision to which the server reacts is driven by the amount of information integration used to form a profile (Wiedmann, Buxel, & Walsh, 2002). A profile may include not just demographic data, but also psychographic information (Peltier et al., 2002). Peltier et al. (2002) further provide that marketing communications can be developed to match the purchasing needs of that segment of each profiled segment.

Marketing Communications

Since the early 1990s (Blattberg & Deighton, 1991), firms have used technology and proprietary customer data as the basis for developing new product sales forecasts. Today, most electronic marketing communication efforts of firms are matched with some aspect of the individual (Raghu, Kannan, Rao, & Whinston, 2001). These efforts include both asynchronous and synchronous communication formats. Asynchronous formats are exemplified by brand-building Web sites in which the visitor interacts with the brand itself, online advertisements which are ads placed on content sites (Zhou & Bao, 2002), and opt-in commercially oriented e-mails (Krishnamurthy, 2001a) or unsolicited e-mails (a.k.a., "spam"). Telecommunication advances have also led to the emergence of synchronous formats of communication, such as wireless communication technologies which include instant messaging (IM) also known as text messaging, and communication to mobile devices, such as smart phones and PDAs, particularly in Asia (Fowler, 2005). Information integration is essential for these mobile communication strategies to be successful. The communications represent building blocks in the relationship. However, the degree to which these communications are accepted by users and contribute to a relationship depends on whether the individual has given the marketer permission to use that information (Godin, 1999; Krishnamurthy, 2001b).

Permission marketing suggests consumers will be more accepting of a message if they agreed to receive it (Godin, 1999). Krishnamurthy (2001b) extended this concept with *permission intensity*—a combination of a user's willingness to receive a message and the leeway they allow the marketer to use personal information.

A real issue with using technology to create personalized communications is that individuals may not know their personal information collected or how it is used. Consider the following events:

- **May 2000:** FTC recommends that Congress take action to create legislation for all commercially oriented Web sites to comply with "the fair information practice principles—consisting of notice, choice, access and security" on the collection and usage of personal information (FTC, 2000).
- **January 2002:** Eli Lily and Company settles with the FTC after an e-mail containing the e-mail addresses of all 669 subscribers to its Prozac medication reminder service was sent to the entire list inadvertently in the "To:" field (FTC, 2002).
- **August 2002:** DoubleClick Inc., the nation's leading Internet advertising service, settles with 10 states for $450,000 over their privacy practices of tracking online behavior through cookies and Web bugs (Culberg & Reilly, 2002).
- **February 2003:** The largest fine ever assessed by the FTC was on Mrs. Fields Cookies and Hershey Foods Corporation ($185,000) for collecting personal information from children without parental consent in violation of COPPA (FTC, 2003).
- **April 2005:** New York Attorney General Eliot Spitzer files suit against Intermix Media for downloading spyware and adware to users' PCs without warning or with misleading disclaimers (Richmond, 2005).

As the above stories verify, the clash between personal information and business use of technology is ongoing. Technological improvements have made it much easier and cheaper for virtually any firm to obtain personal information (Rust, Kannan, & Peng, 2002). There is a constant tradeoff between a communication's value and personal privacy (Foxman & Kilcoyne, 1993).

A key influencer of why an individual is willing to give information is the reputation of the firm (Andrade, Kalcheva, & Weitz, 2002). The more reputable a firm is perceived to be, the less concern an individual has over the collection of personal information. Additionally, the more complete and comprehensive a firm's privacy policy, the less concern an individual has over information collection and use (Culnan, 2000; Milne & Culnan, 2002). Unfortunately, the content of privacy policies of even the most popular Web sites is difficult to comprehend, which affects the policy's usefulness (Milne & Culnan, 2002).

FUTURE TRENDS

Information integration trends fall along two streams—advances in technology and behavioral issues relating to privacy concerns. A potential means of increasing consumer trust in a firm's privacy standards is through the use of seals of approval. Seals of approval from trusted third parties may lead to increased trust in an Internet firm's operation, as suggested by Miyazaki and Krishnamurthy (2002). However, Internet-based seals of approval are not well known by users, and one study found that even if they are aware of the seal's legitimacy, less than half reported that the seal affects their purchasing decisions (Head & Hassanein, 2002). Therefore, there appears to be a limited role in using third-party seals to allay an individual's privacy concerns. An alternative to third-party seals of approval may be effective co-branding through the use of affiliate programs. A reputable, trusted firm that offers affiliate programs needs to be careful in too freely allowing affiliates which may not adhere to the same level of customer orientation in their quest for increased sales.

In terms of public policy, a specific mechanism that potentially could improve user trust is the widespread adoption of the World Wide Web consortium's Platform for Privacy Preferences (P3P). P3P allows a user's stated privacy preferences to be compared with a Web site's information collection practices. When the firm wants more information than the individual has stated as preferences, the user would be notified (Powell, 2002).

Technologically, the 21st century is likely to witness new and unforeseen convergences of electronic devices. For example, the physical locations of technology to track and record information is moving away from the firm and toward the individual, as illustrated by U.S. approval in October 2004 of an implantable chip that could contain an individual's medical history. The use of radio frequency identification (RFID) chips to track the movement of individual products is yet another example of this shift. So-called "location-aware" applications may provide marketers with the ability to directly target users (via communication to their mobile devices) who are at specific locations, such as outside a specific shop or at a specific mall. Convergences and applications such as these may require individuals, businesses, and governments to take proactive positions on acceptable circumstances for personal information use and perhaps even on the question of who owns personal information.

CONCLUSION

The preceding sections have synthesized recent literature concerning the integration of electronic communications in the development of customer-firm relationships. We have discussed the importance of marketing communications for firms as they attempt to build trust and acquire long-term (repeat) customers. Firms want positive relationships with customers since these customers are likely to speak positively about the firm, purchase again from the firm, and trust the firm enough to share valuable personal information.

At the individual level, research indicates that individuals' level of concern for privacy is likely to influence acceptance of marketing communications. Additionally, the threshold of privacy intrusion perception may rise with the increased sharing of traditionally sensitive personal information such as medical or financial information than with less sensitive data such as purchasing patterns or electronic behavior. However, with the availability of seamless, real-time information integration, many individuals may not know how, who, or when their personal information is being shared between parties or is being used to create marketing communications, and privacy concerns may not surface. As consumers learn that their personal information is being collected without their knowledge and is being used in the development of electronic communications, especially when the communication uses personal information and is intrusive, there is potential for a backlash against the message sponsor and even against the technology itself. This may lead to grassroots efforts to change public policy, as more consumer interest groups push for legislative action at all levels of government.

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KEY TERMS

Client Side: Activities that occur on the user's computer, which may interact with the server. (Note that "clients" may now include mobile devices, such as smart phones and PDAs.)

Customer Relationship Management (CRM): Methods and technology-based capabilities that help an enterprise proactively manage customer relationships to deliver value to customers. CRM typically involves tracking individual customer behavior over time (in a database) so that the resulting knowledge (typically mined from clickstream data, purchase histories, etc.) can be used to configure solutions tailored to each individual customer's preferences, needs, and desires. This process of personalizing each customer's experience is often termed "mass customization."

Information Integration: The process of consolidating and managing customer information from all available sources. Also called customer data integration.

Permission Intensity: Composed of two elements, the amount of information an individual provides an organization and the permission to use the information to develop personalized communications.

Permission Marketing: The act of requesting customer approval before sending a marketing communication.

Relationship Commitment: The degree to which either party of a commercial relationship (firm or customer) is likely to remain in the relationship.

Relationship Marketing: The process of creating a long-term beneficial commercial relationship between a firm and a customer through the use of individualized interactive communications and offerings.

Server Side: Activities that occur on an organization's Web server, which may interact with multiple clients.

Information Privacy and E-Technologies

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INTRODUCTION

The use of various e-technologies for e-commerce, e-government, and mobile commerce is characterized by the collection of personal information—both routinely as well as surreptitiously—and the possibility of misuse of that information. Various uses of e-technologies that collect or disseminate personal information include corporate and government databases, e-mail, and wireless communications. (For a discussion of clickstream tracking and spyware, hardware and software watermarks, and biometric devices, see Szewczak, 2005) The main challenge to personal information privacy is the surreptitious monitoring of user behavior without the user's consent and the possible misuse of the collected information resulting in financial and personal harm to the user. In light of this reality, people limit their use of e-technologies, even to the point of limiting the success of e-commerce (Szewczak, 2004). Our focus is primarily on e-technology use in the United States of America, though clearly e-technology is global in nature and poses challenges and issues for societies around the world. Also, in light of the 9/11 terrorist attacks on the World Trade Center and the Pentagon and the U.S. government's response to them, the issue of information privacy takes on a new urgency (for more information, see www.privacyinternational.org).

THE IMPORTANCE OF INFORMATION PRIVACY

The results of a 1998 survey conducted by Louis Harris & Associates, Inc., revealed that worries about protecting personal information ranked as the top reason why people are generally avoiding the Web (Hammonds, 1998). A survey by NFO Interactive (for more information, see www.nfoi.com) found that the safekeeping of online consumer personal information was the main reason people chose not to shop online.

Furthermore, TNS and TRUSTe's quarterly study of consumer attitudes and behaviors on privacy topics found that many Web users are skeptical of the necessity of giving their personal information to online businesses and do not like registering at Web sites they visit. Forty-three percent of those surveyed stated they did not trust companies to not share personal information (e.g., see www.TRUSTe.org/articles/quarterly_index1.php). The misuse of credit card data for activities such as identity theft is a major concern (Westin, 2003). Identity theft involves the surreptitious assumption of a person's identity to secure bank loans, credit cards, and mortgages in that person's name. Victims usually do not have to pay for credit card purchases made in their name, although they may be liable in thefts involving other types of loans. It can take months and years for innocent victims to restore their damaged credit histories. Some identity thieves assume the identities of whole companies, using an employer identification number to secure commercial loans, corporate leases, or expensive office products. The Federal Bureau of Investigation claims that many identity thefts originate in Russia, Romania, and West Africa (O'Brien, 2004b).

Failed Internet companies such as Boo.com, Toysmart.com, and CraftShop.com have either sold or have tried to sell customer data that may include phone numbers, credit card numbers, home address and statistics on shopping habits, even though they had previously met Internet privacy monitor Truste's criteria for safeguarding customer information privacy. The rationale for the selling was to appease creditors (Sandoval, 2000). Selling customer data is in direct opposition to the top Internet privacy issue as identified by Dhillon and Moores (2001).

In his excellent study on privacy in the information age, Cate (1997) adopted the definition of privacy as "the claim of individuals, groups, or institutions to determine for themselves when, how, and to what extent information about them is communicated to others" Westin (1967, p. 7). Westin's and Cate's definition is interesting, because it allows for flexibility in discussing privacy within the context of e-technologies. Whereas many people worry about divulging personal information electronically, other people seem more than willing to give it away, trading their personal information for personal benefits such as free shipping and coupons (Kuchinskas, 2000). Personalized service is the main benefit. A Web site can save a shopper time and money by storing and recalling a user's tastes and buying habits (Baig, Stepanek, & Gross, 1999). Microsoft's Passport is designed to allow a user to visit many Web sites without reentering personal information at each site (Clark, 2001). Internet service providers are willing to allow Web users cheaper access to the Internet, provided the users are amenable to having their online behavior tracked for marketing purposes by specialized software (Angwin, 2000). SBC Communications has told its customers that it will take away discounts for its popular offerings like high-speed Internet access if they choose not to have their personal information shared among the company's subsidiaries (Lazarus, 2004).

E-TECHNOLOGY CHALLENGES TO INFORMATION PRIVACY

Corporate and Government Databases

The practice of gathering personal information about customers and citizens by corporations and governments is well established. Software is available that is dedicated to analyzing data collected by company Web sites, direct-mail operations, customer service, retail stores, and field sales. Web analysis and marketing software enable Web companies to take data about customers stored in large databases and offer these customers merchandise based on past buying behavior, either actual or inferred. It also enables targeted marketing to individuals using e-mail. Governments routinely collect personal information from official records of births, deaths, marriages, divorces, property sales, business licenses, legal proceedings, and driving records. Many of the databases containing this information are going online (Bott, 2000; Cropper, 2005). Personal information that were once stored in filing cabinets in attorneys' offices, hospitals and financial institutions can now be accessed with a click of a mouse (I. Armstrong, 2002).

Public records, however relevant for ensuring fairness in government action, may be accessed online to acquire personal information about a wide variety of topics including a person's lifestyle or sexual history which may be included in court documents (e.g., divorce decrees). The same is true for private medical records if an insurance holder sues over payment claims. The problem is compounded by the fact that counties have sold information in bulk to commercial companies that repackage it or resell it to other companies or to individuals (Leach, 2004). Although most states require information like Social Security numbers be concealed before documents are made available online, it is impractical and sometimes impossible to catch every instance (Ogles, 2004).

Internet service providers maintain archives of Internet message boards. Even users who adopt pseudonyms to protect their identities when expressing opinions may be identified through logs of Internet access, length of time online, time of day the Web was surfed, and credit card numbers used to shop (Bedell, 2001).

The deregulation of the financial services industry provided by the Gramm-Leach-Bliley Act (GLB) has made it possible for banks, insurance companies, and investment companies to begin working together to offer various financial products to consumers. Personal financial information that was kept separate before deregulation can now be aggregated. In fact the ability to mine customer data is one of the driving forces behind the creation of large financial conglomerates. Services can be offered to customers based on their information profiles. Large credit bureaus such as Equifax and Trans Union have traditionally been a source of information about a person's credit worthiness. Their databases contain information such as a person's age, address, and occupation. Credit bureaus sell personal information to retailers and other businesses (Westin, 2000a).

Like personal financial information, medical information is for most people a very private matter. Despite this fact, there is a wealth of personal medical data in government and institutional databases. As *Consumer Reports* (Westin, 2000b, p. 23) noted:

The federal government maintains electronic files of hundreds of millions of Medicare claims. And every state aggregates medical data on its inhabitants, including registries of births, deaths, immunizations, and communicable diseases. But most states go much further. Thirty-seven mandate collection of electronic records of every hospital discharge. Thirty-nine maintain registries of every newly diagnosed case of cancer. Most of these databases are available to any member of the public who asks for them and can operate the database software required to read and manipulate them.

Much of personal health information available to the public is volunteered by individuals responding to 800 numbers, coupon offers, rebate offers, and Web-site registration. Much of the information is included in commercial databases like Behavior-Bank sponsored by Experian, one of the world's largest direct-mail database companies. This information is sold to clients interested in categories of health problems, such as bladder control or high cholesterol. The Medical Information Bureau (MIB) is a database of medical information shared by insurance companies. If a person has a medical condition that an insurance company considers significant, the company will report that information to the MIB, where medical conditions are represented by codes (for more information, see www.privacyrights.org).

E-Mail

E-mail accounts for 70% of all network traffic, yet only 10% of it is protected by security measures. Thus, it is susceptible to tampering and snooping (L. Armstrong, 2000; Weingarten & Weingarten, 2002). In many companies, employee e-mail communications are routinely monitored. Despite the fact that most companies had policies alerting employees that they were subject to monitoring, 25% surveyed had fired employees based on evidence collected during monitoring (Seglin, 2000). Hackers can also be a problem. Programs can be surreptitiously installed that monitor a user's keystrokes. The keystrokes can be sent across the Internet to a computer that logs everything that is typed for later use (Glass, 2000).

Google, Inc., released an e-mail service called Gmail, which searches for certain words in users' incoming messages, then displays text ads related to those words. Not only do users find the targeted ads a nuisance, privacy advocates object to the fact that perhaps thousands of a user's messages may be stored on Google's servers over time, where the user has little control over them. These stored messages may be combined with records of a user's search activity captured using clickstream tracking and spyware to create a detailed portrait of a user (Delaney, 2004; Wildstrom, 2004).

Another threat to information privacy related to e-mail is phishing. Phishing uses e-mail messages to entice unsuspecting consumers to Web sites that resemble the home pages of trusted banks and credit card issuers. Web site visitors are then induced to reveal passwords and bank account, Social Security, and credit card numbers (O'Brien, 2004a). Phishers profit by acquiring personal financial information and working with international crime syndicates to fence stolen data. They cover their tracks by routing e-mail and Web sites through multiple Internet hosts located throughout the world (Krebs, 2004).

Wireless Communications

Echelon, a monitoring operation run by the U.S. National Security Agency, uses satellite technology to listen in on virtually all international and (to a limited degree) local wireless communications, including phone calls, faxes, e-mail, and all radio signals. Echelon is designed primarily for nonmilitary targets, including governments, organizations, and businesses around the globe (Port & Resch, 1999). Various consumer services, such as GM's satellite-based Onstar and wireless tollbooth collection systems such as EZ-Pass and FasTrak can monitor and record a traveler's activities (for more information, see www.cdt.org/privacy).

Wireless advertising poses a host of challenges for privacy advocates. Wireless service providers know customers' names, cell phone numbers, home or office addresses, and the location from where a customer is calling as well as the number a customer is calling. Each phone has a unique identifier that can be used to record where in the physical world someone travels while using the cell phone (Petersen, 2000). The Federal Communications Commission requires cell phone service providers to be able to identify the location of a caller who dials 911, the emergency number, using Global Positioning System (GPS) technology or triangulation based on the distance of a cell phone's signal to nearby cellular towers. Because a cell phone service provider can track the location of a 911 call, it can track the location of any other call as well (for more information, see www.privacyrights.org).

Five major U.S. wireless carriers have proposed the development of a 411 directory of wireless mobile phone numbers to satisfy the needs of small businesses that use wireless phones as their primary mode of communication with their customers. A national survey conducted by TNS showed that 53% of mobile phone users are against the establishment of such a 411 directory. 56% of respondents would opt-out of publishing their numbers (www.TRUSTe.org/About/Press_Release/12-07-04.php).

Radio frequency identification (RFID) devices transmit identification numbers on request from a compatible reader using radio frequencies. RFID devices are tiny and easily concealable in consumer items such as clothing, cosmetics and tires (www.Junkbusters.com/rfid.html). They are becoming an indispensable technology in supply-chain management. For example, Wal-Mart has adopted an electronic product code to track pallets and cases coming through its dock doors (see www.Walmartstores.com). Ultra high frequency RFID tags provide faster data-transfer speeds and longer read ranges. Some RFID readers can read data transmitted by many different RFID tags, enabling retailers to compile a more complete profile of shoppers than is possible by scanning bar codes of products a consumer purchases. Some technology experts predict that a network of millions of RFID receivers will be placed strategically in airports, seaports, highways, distribution centers, warehouses, retail stores, and homes to collect, process and evaluate consumers' behavior. It could be used by governments to monitor the activities of its citizens (see Electronic Privacy Information Center, 2005).

FUTURE TRENDS

How the information privacy issue is ultimately resolved will be decided by the values inherent in a society. Because privacy issues have been addressed in court and precedents established in state and common law, it seems likely that the information privacy issue will be resolved in the world's legislatures and resulting laws enforced in the courts (Lessig, 1999). At the federal government level, the U.S. has seen the passage of the Health Insurance Portability and Accountability Act that prohibits unauthorized disclosures of personal medical information, punishable by a fine up to $250,000 and 10 years in jail (Lueck, 2003). The GLB requires that a financial institution give its customers a privacy policy (for an interesting recent study of Internet privacy policies of the 50 largest U.S. companies, see Plesak, 2005), the right to opt-out of the sale of personal data to third parties, and safeguards to prevent fraudulent access to financial information (see Privacy Rights Clearinghouse, 2004).

CONCLUSION

Various uses of e-technology that collect or disseminate personal information include corporate and government databases, e-mail, and wireless communications. The challenges to information privacy posed by the various forms of e-technology are not the result of the technology itself, rather it is the uses of the technology that pose the threat to the integrity of information privacy. In particular, the surreptitious monitoring of user behavior without the user's consent and the possible misuse of the collected information pose the biggest threats. Unless information privacy is adequately safeguarded, both individuals and businesses will experience unwanted consequences.

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KEY TERMS

Biometrics: The use of technological devices to identify people through scans of their faces, hands, fingers, eyes, or voice.

Clickstream Tracking: The use of software to monitor when people use the Internet and what sites they visit.

Global Positioning System: Satellite technology that locates people and objects on earth with high accuracy.

Hardware and Software Watermarks: Unique identifiers (e.g., a serial number) embedded in computer equipment and programs.

Identity Theft: The stealing and use of a person's identity through the acquisition of personal information without that person's knowledge or permission.

Personal Information: Information about, or peculiar to, a certain person or individual.

Phishing: Using e-mail to entice unsuspecting consumers to Web sites resembling those of trusted banks and credit card issuers with a view toward collecting personal information.

Privacy: The claim of individuals, groups, or institutions to determine for themselves when, how, and to what extent information about them is communicated to others (Westin, 1967).

Radio Frequency Identification: Devices that transmit identification numbers on request from a compatible reader using radio frequencies.

Spyware: Software that installs itself on computers when programs are downloaded and that tracks each user click, usually without the user's knowledge or permission.

Category: Concepts, Trends, and Challenges

Information Security for Legal Safety

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INTRODUCTION

The growing use of information technology in sensitive daily transactions highlights the significance of information security to protect information assets. Vulnerabilities associated with public and private transactions pose challenges that government, private organizations, and individuals are compelled to respond to by adopting appropriate protection measures. Information security responds to the need of transacting parties for confidentiality, integrity, and availability of resources (Pfleeger, 2000). Information security is required in transactions carried out among, businesses, public administrations, and citizens. An organizational response to information security threats includes setting up and implementing appropriate policy frameworks that are typically endorsed by agreement. Beyond organizational objectives lies an emerging legal framework instigated by the role of information security as a means to safeguard information assets that are socially significant. Organizations are often required to implement information security measures mandated by industry regulations or legislation, such as in electronic banking transactions. The scope of these legal and regulatory requirements is to mitigate potential risk that entails liabilities for shareholders, employees, customers, trading partners, or other third parties involved in a transaction. Information security and its subsequent regulation are equally important for public services. In e-government services made available to citizens and businesses, information security ensures e-government transactions. The remainder of this article presents an overview of the prevailing legal and policy issues that are currently associated with information security.

BACKGROUND

Electronic transactions typically require a high level of assurance with respect to the content and management of the transaction, the authentication of the trade partners, threats against enterprise resources, and so forth. The following presents a brief and non-exhaustive overview of the regulatory background on information security. If not properly treated, security risks may nurture liability risks for the parties who fail to adopt security countermeasures. Liability in this regard might emanate from general legal requirements or as it has become increasingly apparent from specific legislation that addresses specific security matters. The evidential value of electronic documents, for example, can be challenged as long as the contents of the transaction and the conditions under which it was carried out cannot be ascertained (Mitrakas, 1997). Information security can also function as negative proof of actions that are under investigation in a digital forensics process.

The *U.S. National Information Systems Security Glossary* defines information security as "the protection of information systems against unauthorized access to or modification of information, whether in storage, in processing, or in transit, and against the denial of service to authorized users or the provision of service to unauthorized users, including those measures necessary to detect, document, and counter such threats" (1992, p. 38). Information security threats can be distinguished in categories such as the following:

- **Natural threats**, which are described by terms such as *acts of God*, sometimes described as *force majeure*; for example, unforeseen events such as a flood or an earthquake.
- **Accidental threats** caused by the actors involved, such as, for example, missing out in a plan or a procedure.
- **Intentional threats** by actors directly or indirectly involved, such as, for example the deletion of data with the intent to transfer funds without authorization.

Although threats might carry liability or criminal consequences to the implicated parties, the basis for information security in law is the legal duty of care that transacting parties must show in their daily or business dealings (Lindup & Lindup, 2003). The duty of care is yet more significant in situations where a party acts under a certain capacity or in a trade. There are situations, however, whereby the law mandates certain information security measures in order to protect against information threats, such as, for example, in the case of processing personal data. In such cases, there is a set of duties of the implicated personal data controller to implement security safeguards on personal data stored or processed (Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of personal data and on the free movement of such data, p. 31).

Information security objectives must be associated with the acts at hand and strive to detect the implementation of the following principles with the evidence in hand:

- Confidentiality ensuring that information is accessible only to those authorized to have access, according to the International Standards Organization (ISO). Confidentiality is typically ensured through encryption.
- Integrity is the condition that exists when data are unchanged from their sources and have not been modified, altered, or destroyed at any operation according to an expectation of data quality.
- Availability of data is the degree to which a system is operable and in a committable state at the start of an assignment.
- Accountability of parties involved for acts performed being held to account, scrutinised, and required to give an account. Especially in white collar crime, accountability is often associated with governance.

Whereas the aforementioned principles might only be fully observed within highly organized environments that operate on the basis of audited security policies and practices (e.g., in white-collar crime investigated in a corporation) in other less organized environments odd data has to be put in context through social methods and mundane practices to pinpoint actions in the crime under investigation. To determine information security measures, it is typically required that a risk assessment is carried out by measuring two quantities of risk the magnitude of the potential loss, and the probability that the loss will occur. Prior to a risk assessment, it is advisable to carry out a vulnerability assessment by identifying and quantifying vulnerabilities in a system that seeks network and information security measures (Dunn & Wigert, 2004).

Information security is an enabler to ascertain basic rights, such as the right to confidentiality, personal data protection, trade secrets, and so forth. In information society, information security is gradually becoming a significant factor upon which basic rights depend in order to be exercised by all members of the society. Information security as such is not a right in itself; there is no such thing as a right to information security. This article argues that although information security is an instrument to exercise and enjoy other basic rights and freedoms, it should be encouraged and afforded protection in a meaningful way (Dworkin, 1977). Within the European Union, internal market rules that sometimes depend on information-society services rely on information security in order to take meaningful effect. Conditions regarding the encouragement and exercising of information security include, for example, exceptions with regard to crime investigation through digital forensics, lawful interception, and so forth. A balance, however, must be sought to ensure that legitimate users are granted sufficient access to information security resources and that they are not unnecessarily constrained in the choice of information security resources that evolved over time. The commercial use of public networks has resulted in a surge of regulation concerning an array of issues, among which information security plays a lynchpin role (Rathmell & Valeri, 2002). It is important to stress that information security regulation is twofold in the following situations:

- Addressing risks associated with an attacker carrying out an illegal act, such as hacking or spreading viruses.
- Setting out the requirements for the party that is attacked to take out appropriate measures mitigating risks or face the consequences.

LEGAL CONSIDERATIONS

Information security has emerged as a legal requirement in order to ensure, for example, the legitimate use of computer resources; protection against cyber-crime, and compliance in critical areas such as electronic signatures, personal data protection, and so forth. At an international level, the legal framework of information security includes the UNCITRAL Model Law on Electronic Signatures (United Nations, 2001), which recommends that countries adopt laws allowing the enforceability of electronic signatures, subject to a risk assessment with regard to reliability and trustworthiness. Similarly, the OECD Information Security Guidelines (2002) aim at creating a culture of security by effectively managing risk (Ward, 2003). When carrying out risk assessments, it is necessary to consider legal risks in the audit processes.

Information security is necessary to control risk in transactions. An information security approach and information security rules allow for the assessment of threats and mitigation of risk. Whereas a threat is the possibility of hindering the operation of an information system, risk is the probability that a threat might materialize. The principles of proportionality and reasonableness have been enshrined in the EU Directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data. Privacy protection requires the setup of discreet environments to process personal data in a way that leaking such data to another environment can never go undetected. An example includes the use of social security numbers; for example, as a business identifier or as reliable input in building identification profiles that are merged into comprehensive databases. The duty to maintain the confidentiality of data that is stored within or exchanged between information systems is another necessary condition that concerns service providers and users of data alike because failure to protect implies liability consequences for the implicated parties.

Regarding data protection, Directive 2002/58/EC of the European Parliament and Council, concerning the processing of personal data and the protection of privacy in the telecommunications sector, has introduced new rules for an array of issues associated with information security in electronic communications. Although the scope of the Directive is to warrant an equivalent level of protection of fundamental rights and freedoms to ensure the free movement of such data, equipment, and services across the European Union, the protection of the legitimate interests of subscribers is equally observed. The directive prohibits wiretapping and eavesdropping without the prior consent of the users concerned, with the exception of legally authorized interceptions.

Another pertinent issue for privacy is related with the use of cookies that can reveal user behavior; Directive 2002/58/EC stipulates that member states must ensure that the use of electronic communications networks to store information or to gain access to information stored in the terminal equipment of a subscriber or user, is only allowed on condition that the subscriber or user concerned is provided with clear and comprehensive information and is offered the right to refuse such processing by the data controller. The ability to treat cookies remotely implies that, if cookies are used as tracking devices, the end user must have exclusive control over them.

Cybercrime law protects certain rights and assets such as privacy by making interception and unauthorized access illegal. To investigate cybercrime and crimes carried out with the help or by information technology, law enforcement agencies seek access to content of communications, data in transit, stored data, and authentication data. In terms of legislation, the efforts of the Council of Europe and the Organisation for Economic Cooperation and Development (OECD) can be highlighted. The Convention on Cybercrime of the Council of Europe stipulates in Article 15 that investigative powers and procedures are subject to conditions and safeguards provided for under its domestic law in a way that provides for adequate protection of human rights and liberties (Council of Europe, 2001). The protection afforded to citizens must be commensurate with the procedure or power concerned. This convention is currently nonbinding, pending ratification by national parliaments; however, it makes significant steps towards defining crimes related to computer systems.

The *OECD Cybersecurity Guidelines* stipulate that security should be implemented in a manner consistent with the values recognized by democratic societies including the freedom to exchange thoughts and ideas, the free flow of information, the confidentiality of information and communication, the appropriate protection of personal information, openness and transparency.

Some countries, however, have already initiated data retention schemes that might be further extended, in spite of concerns regarding their success. The issue of data retention requires addressing security threats such as spam because, for the time being, it is not necessarily clear whether service providers have to retain all data or selected portions of them. In the latter option, privacy considerations have to be addressed along with a duty to implement spam filters at the service-provider level.

INFORMATION SECURITY THROUGH SELF-REGULATION

In addition to the legal framework, information security is addressed through voluntary frameworks imposed by trade partners. Voluntary frameworks include policies and agreements that aim at setting out the conditions for information security safeguards within an organisation, or in transaction frameworks. A security policy lays down the rules for network information access, determines the process to enforce policies and lays out the architecture of the security environment of an organisation. At a bilateral level, the parties use service level agreements to specify the quality service they seek from their provider and ensure availability rates for their applications. Quite often, however, parties might set up security frameworks, which are activated by means of subscriber agreements that are executed individually. In this case, the service can be a generic one that does not necessarily allow for a high degree of customization (Kiefer, Wu, Wilson, & Sabett, 2004).

Additional measures such as internal policy drafting and mapping, audit, and control of enforcement are also essential to support a security framework (Caelli, Longley, & Shain, 1991; Clarke, 2004). An approach to information security includes

- Detecting and recognizing of a threat and the risks it poses through an appropriate threat analysis, a vulnerability analysis, and risk assessment;
- A strategy on a security plan and subsequent implementation; and
- An audit of the implemented security plan.

Information security can be assured through security policies that are drafted on the basis of international standards (ISO, 2000). Regardless of the form that information takes, or means by which it is shared or stored, it should always be appropriately protected. The International Standards Organisation (ISO) standard known as ISO 17799 provides recommendations and guidance for information security management. This standard provides a shared basis to develop organizational security standards and effective security management practice. Beyond businesses and financial institutions, the ISO 17799 has also been recognized as appropriate for use in government environments (Deprest & Robben, 2003).

A security policy identifies the rules and procedures that parties accessing computer resources must adhere to in order to ensure the confidentiality, integrity, and availability of data and resources as well as accountability, if required. Furthermore, a security policy formalizes an organization's security posture, describes and assigns functions and responsibilities, and identifies the incident response procedures. Voluntary security frameworks are binding to the extent that this is the intent of the parties involved. Breach of warranty in a publicized or otherwise security policy is a breach of an obligation that is likely to result into the party involved paying damages. From a legal viewpoint a security policy supports the following requirements:

- Communicates security information in binding manner by ensuring management involvement;
- Makes enforcement of a security framework possible;
- Identifies the areas of responsibility for users, administrators, and management by means of which the consequences of noncompliance are determined and is enacted by senior management; and
- Meets the requirement to protect certain rights (e.g., privacy) while contributing to enterprise productivity goals.

The components of a security policy are adapted to the type and corporate goal of an organization. Typical elements of a security policy include the following:

- **Security Definition:** A security policy includes a well-defined security vision for the organization. The security vision should convey to the readers the intent of the policy in ensuring the confidentiality, integrity, and availability of data and resources through the use of effective and established security processes and procedures. The security policy definition addresses why the security policy is implemented and what it entails in terms of the mission and the business goals of the organization.
- **Enforcement:** A security policy identifies how a security policy is enforced and how a breach is managed. This requirement is necessary in order to ensure that incidents are handled in an appropriate manner while the security policy remains binding across the organization.
- **User Access to Computer Resources:** A security policy regards the roles and responsibilities of users accessing resources on the organization's network. This section ties organizational procedures to individual roles and aims at controlling the acts or omissions of the human factor in secure processes. Additionally, some organizations may require that other organizations meet the terms and conditions identified in the organization's security policy before granting access.

It is necessary to ensure that security policies are consistent with other applicable policies within the organisation concerned. Additional requirements of the security policy framework involve the definition of the conditions to deliver services in areas of particular interest, such as electronic signatures and data protection, for example ETSI (2001) and IETF (2003). Standards in this area provide guidance and set the framework in order to deliver services, control and rely upon electronic signatures (Mitrakas, 2005). European Union regulatory initiatives highlighted the significant effort is beginning to take shape in the European Union with regard to information security. The European Network Information Security Agency (ENISA) aims at providing support to member states, the E.U. Commission, and stakeholders with regard to information security management and policy. The Network Information Security Standardisation (NIS) Steering Group aims at liaising with the industry and ENISA in order to provide an appropriate forum for standardisation in the European Union (ETSI, 2003).

FUTURE TRENDS

Beyond legislation, the evolution of case law is expected to enhance and determine the admissibility and evidential value of data that are protected, according to specific information security policies, in those application areas in which they emerge as a requirement. Remarkably, to date there has been little done to address in a uniform manner the requirements pertaining to the legal value of information security policies. Additional requirements might seek to cover the mapping and methods on the reconciliation of information security policy frameworks in overlapping transactions especially in the field of outsourcing services. An additional area of future attention could address information security policy frameworks as they relate to applications. As present day requirements for transparency within organizations instigated by the requirements for greater corporate accountability are likely to be further raised, it is expected that online applications will increasingly become more demanding in explaining to the end user what they do and actually warranting the performance and trustworthiness of a system or service (Mitrakas, 2005). To date, general conditions and service agreements cover part of this requirement; however, a comprehensive description of the technical features and functionality of the application in a way that allows the end user to gain some insight, while protecting the vital security interests of the service provider, is needed. Tailoring information security policies further to meet the needs of particular groups of organizations is an additional expectation.

Additional requirements of a framework for information security require the definition of the conditions to deliver services in applications. Standards in this area provide guidance and set the framework in order to deliver services and control and rely upon electronic signatures (Mitrakas, 2005). In emerging technologies, and applications the definition of security threats must addresses the requirements on organizational responsibility and transparency. Additionally, self-imposed frameworks, through agreement or best practices, must also be put in place in an effort to provide guidance to trade parties and confidence to citizens. Cybercrime prevention can further extend to awareness programs as well as the development of industry specific threat and risk assessment methodologies in order to deal with current information security risks emanating from malicious attacks as well as terrorism. Additional attention can be dedicated to areas that affect large populations, such as, for example, e-government, where public interest is high.

CONCLUSION

Information security has emerged as a way to ensure the integrity, confidentiality, and availability of certain assets that are necessary to carry out transactions in an information society. Information security is a necessary instrument to allow members of the society to exercise and enjoy basic rights. Political and legal initiatives, aimed at encouraging and protecting in a meaningful way the evolution of security to protect those rights. Cross-border cooperation becomes essential to ensure the applicability and robustness of measures adopted and practices employed. An essential requirement for business level applications is to gain a common understanding of the legal implications of security in electronic communications and transactions especially with regard to threats and vulnerabilities that are successfully exploited to the detriment of a trade party that might carry liability or bear penal consequences.

Further efforts are necessary to clarify the boundaries of the legal framework application with regard to information security. Especially in new or emerging technologies and applications, further definition of security threats is needed that addresses the requirements of organizational responsibility and transparency. Additionally, self-imposed frameworks, through agreement or best practices, must also be put in place in an effort to provide guidance to trade parties and confidence to citizens. Penal law aspects can further extend to awareness programs and the development of industry-specific threat and risk assessment methodologies in order to deal with current information security risks emanating from malicious attacks and terrorism. Special emphasis can be dedicated to areas that affect large populations, such as e-government.

Harmonizing the requirements for cross-border cooperation can be facilitated by initiatives aiming at effective mutual assistance arrangements. There is an urgent need to ease the reporting and investigation of suspicious incidents and to provide information to help investigations without facing legal sanctions or complex processes. Information security is necessary as an instrument that puts into practice legal requirements; there is, however, a way to go before it can be fully leveraged in legal processes.

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KEY TERMS

Accountability: Accountability of parties means holding to account, scrutinising, and being required to give an account; especially in white-collar crime, accountability is often associated with governance.

Availability: Availability of data is the degree to which a system is operable and in a committable state at the start of an assignment.

Confidentiality: Confidentiality ensures that information is accessible only to those authorized to have access and it is typically ensured through encryption.

Information Security: Information security is the protection of information systems against unauthorized access to or modification of information, whether in storage, processing or transit, and against the denial of service to authorized users or the provision of service to unauthorized users, including those measures necessary to detect, document, and counter such threats.

Integrity: Integrity is the condition that exists when data is unchanged from its source and has not been modified, altered, or destroyed at any operation according to an expectation of data quality.

Risk Assessment: Risk assessment is determined by measuring two quantities of risk, the magnitude of the potential loss, and the probability that the loss will occur.

Security Policy: Security policy is a document that lays out the rules for network information access, determines the process to enforce policies and lays out the architecture of the security environment of an organisation.

Vulnerability Assessment: Vulnerability assessment is the identification and quantification of vulnerabilities in a system that seeks network and information security measures.

NOTE

This article expresses the author's personal views.

Inherent E-Commerce Barriers for SMEs

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INTRODUCTION

Electronic commerce (e-commerce) is the fastest growing industry the world over and it impacts business, international trade, and national economies. The number of nations who are offering e-commerce solutions is increasing every year. Despite the downturn in the Internet economy represented by the crash of many "dot-com" companies, several forecasts continue to predict huge potential in global e-commerce over the next several years (Deschoolmeester & Van, 2000). For example, global business-to-business (B2B) commerce over the Internet is expected to reach between U.S. $2 trillion to about U.S. $10 trillion by 2004 (http://www.emarketer.com/ereports/ecommerce_b2b/welcome.html). Large businesses have found e-commerce a tool for exponential economic growth but small businesses are still far from the e-commerce revolution because of inherent problems in generally acquiring the basic e-commerce infrastructure and expertise. Governments of many nations are providing support and incentives for small and medium enterprises (SMEs) to use e-commerce platforms to expand globally to sell their products or trade online with other businesses, but the e-adoption campaign for SMEs to invest in online services has not been encouraging (A Study Report on Thailand, 2001; Sharma & Wickramasinghe, 2004; Sharma, Wickramasinghe, & Gupta, 2004). E-commerce certainly has been streamlining supply-chain activities, speeding inventory turnover, and reducing cycle times, yet SMEs don't appear to be in the forefront of the e-commerce movement. SMEs have modernized and automated the way they do business and have been exploiting Internet technology to expand their reach and communication with their partners, suppliers, and customers, however, their use of such ICT tools is limited to mostly administrative matters (Beal, 2000; Ihlström & Nilsson, 2000). Many of the medium scale enterprises are using the Internet and ICT only for office automation such as word-processing, spreadsheets, accounting, and payroll (Poon & Swatman, 1997). SMEs in Asia have yet to take the actual plunge into e-commerce, are still skeptical of the e-commerce hype, and are reluctant to embrace much of the required technology (Haynes, Becherer, & Helms, 1998; Mehrtens, Cragg, & Mills, 2001). E-commerce is still relatively a new playing field for SMEs (Chau & Turner, 2002; Sugasawa & Liyanage, 1999).

BACKGROUND

There are few studies conducted for examining e-commerce adoption by SMEs in Asia. (APEC, 1999; Beal, 2000; Sharma & Wickramasinghe, 2004). Hasio presents a qualitative study of the barriers faced by SMEs to introduce B2B e-commerce in Singapore. The investigation employs an interpretative approach that draws on the theory of "technological frames". The results of Hasio's study highlights four key factors that explain the adoption difficulties: lack of familiarity (with technology), risk aversion, lack of trust, and incongruent cultural practice. Similar to Hasio, Dhawan, and associates (Dhawan et al., 2000) examining the problems associated with building B2B e-marketplaces for SMEs. Both these studies were more focused on EDI aspects and B2B commerce rather than business-to-customers (B2C). However, all these studies conducted on this subject enhanced our understanding of the adoption difficulties involved in e-commerce.

As e-commerce is becoming the way to trade, it is the large corporations that are exploiting their finances and technical expertise to jump into this electronic abyss whereas, SMEs are finding too many obstacles to participate in e-commerce (Ihlström & Nilsson, 2000; Tan & Ouyand, 2003; Walczuch, Van, & Lundgren, 2000). Following a review of the current literature, this article describes the key factors that are hindering SMEs' participation in e-commerce and the obstacles to SMEs for e-adoption. Although this study is limited to Asia, many of the findings do contribute significantly to the factors hindering all SMEs' e-adoption efforts.

OBSTACLES OR BARRIERS TO THE ADOPTION OF E-COMMERCE

Asian governments are actively encouraging the diffusion of e-commerce in SMEs as a way to improve their competitiveness and access to new markets. Many initiatives have been taken such as: raising awareness, establishing development centers, creating business access points, and providing education and training programs. Despite all these, they continue to encounter numerous obstacles to adoption of e-commerce (APEC, 1999; Sharma, Wickramasinghe, & Gupta, 2004; Sharma & Wickramasinghe, 2004; Thong, 2001; Thong, Yap, & Raman, 1996).

Lack of Awareness

The primary obstacle to adoption of e-commerce among SMEs is lack of awareness of e-commerce, and the availability and access to telecom infrastructure at a reasonable cost (APEC, 1999). The SMEs are not aware of the current developments or the role they could play in this new marketplace. Personnel involved in SMEs find e-commerce literature too technical and complicated. Unless, the governments or other agencies simplify technical information for them, SMEs can not adopt e-commerce concepts and begin implementation. English as a common language of an e-commerce is a big barrier in many Asian countries since the people involved conduct their business using the local language. The lack of awareness is closely linked to the fact that SMEs in Asia are usually slower in adopting new technologies given the often high investments necessary. Many of the Asian SMEs are also less risk taking and not ready to experiment (Sharma & Wickramasinghe, 2004).

Poor Customers, Suppliers, and Business Partners' Base

Another obstacle experienced by Asian SMEs is the lack of a critical mass among customers, suppliers, and business partners. The lack of a critical mass of these stakeholders is due to either ignorance or fear of a lack of security and privacy when using electronic means. The e-commerce infrastructure is very poor in Asian countries and online shopping is not yet very popular among masses. Due to low use of e-commerce, there are few customers and suppliers using e-commerce and this acts as a discouraging factor for SMEs to join the e-commerce revolution (APEC, 1999). Until sufficient numbers of their main local customers or suppliers participate in online commerce activities, there is little incentive for individual SMEs to become engaged in e-commerce themselves. In Asian countries, SMEs cited several factors contributing to low levels of customer e-commerce use including: language barriers and low levels of English fluency, lack of familiarity with e-commerce technologies, a cultural preference for more traditional trade practices involving face-to-face contact between buyer and seller, and continued preference for the use of cash in transactions (APEC, 1999; A Study Report on Thailand, 2001; Beal, 2000; Turpin, 2000; Sharma et al., 2004; Sharma & Wickramasinghe, 2004).

Trust and Confidence

Lack of trust and confidence in various aspects of the electronic marketplace was identified as another main obstacle to the growth of the e-commerce market in general, and for SME engagement in e-commerce in particular. SMEs fear doing business with international marketplaces, due to cultural backgrounds, and a fear of being deceived, due to lack of knowledge of new technologies. The security issue is perceived as very important across the Asian region, and the majority of SMEs have the fear of electronics. Security may not be a serious problem but due to the low level of technology diffusion and awareness among SMEs, it is still a psychological barrier for SMEs (APEC, 1999; Beal, 2000; Turpin, 2000). Many of these SMEs owners do not have technical backgrounds, and they are not convinced that the technology standards such as encryption etc. exist to protect them. Due to perceived security fears, SMEs are not willing to use electronic payment systems. Credit cards and e-checks are still a distant dream for many of them. Security, legal, and liability issues were often identified as very important concerns of participating SMEs in Asia (APEC, 1999; Sharma et al., 2004; Sharma & Wickramasinghe, 2004).

Lack of Legal and Regulatory Framework

The lack of a comprehensive and acceptable legal and regulatory framework is an issue for Asian SMEs. Many of the Asian countries still do not have laws for electronic contracts, invoices, and other types of documentation in place. Few countries have taken the lead but the majority of others are still in formulating laws. E-commerce demands several legal and liability issues to be addressed before it is widely accepted by SMEs and others in the Asia. Conducting business through electronic networks raises numerous legal questions that include: the legal status and enforceability of electronic contracts; the legal jurisdiction of international e-commerce transactions; intellectual property rights and copyright protection for digital content; the privacy of personal data; and the validity of electronic "evidence" in legal disputes (APEC, 1999). Unless these issues are addressed, Asian SMEs may not choose e-commerce as a medium for their business. Asian SMEs also have concerns about international legal protection such as global patent applicability, global taxation, and consumer protection (APEC, 1999; A Study Report on Thailand, 2001; Beal, 2000; Turpin 2000).

Taxation

Asian SMEs are more concerned about taxation because many of them like to avoid taxes. Also, taxation processes in these countries are not transparent and are often subject to the discretion of evaluators. Malpractice is common practice to avoid taxes and SMEs do not want to adopt other countries tax laws which they anticipate could be more stringent. SMEs also lack the guidance of lawyers since many of then can not afford the high fees. The application of existing taxation on commerce conducted over the Internet requires that tax principles be consistent with the established principles of international taxation, neutral with respect to other forms of commerce, avoid inconsistent national tax jurisdictions and double taxation, and simple to administer and easy to understand (Hall, 1995; Sharma et al., 2004; Sharma & Wickramasinghe, 2004). It is apparent that much needs to be accomplished before these taxation laws can be implemented.

Lack of Knowledge of E-Commerce

Asian SMEs lack extensive knowledge of e-commerce technologies and that itself is one of the big obstacles for their participation and engagement in e-commerce. Due to a lack of knowledge of e-commerce technologies, there is an internal resistance to change, and skepticism of the benefits of e-commerce among SMEs. E-commerce demands fundamental shifts in business strategies, operations, and technologies. Many participating SMEs indicated that they have limited access to information about the business models and technologies that are the basis of e-commerce success. Lack of knowledgeable staff in SMEs is also responsible for non-adoption of e-commerce. An issue often cited by participating Asian SMEs was the general lack of success stories available to demonstrate that e-commerce can be successfully implemented by firms that are similar in some way to their own (APEC, 1999). Many SMEs are not willing to engage in e-commerce because they fear that there will be many who will copy their ideas and approaches overnight if they disclose their implementation of e-commerce (Bennet, Polkinghorne, Pearce, & Hudson, 1999; Chau & Turner, 2001).

Poor Information Infrastructure Access, Quality, and High Costs

Despite the cost reduction of Internet-based technology, implementing e-commerce solutions still represents a considerable and costly challenge for most SMEs in Asia (Chapman, James-Moore, Szczygiel, & Thompson, 2000). Large corporations with more funding, more attainable skills, and with strengths in building solid business strategies, can afford e-commerce deployment. Most SMEs typically with less cash, a shortage of IT expertise, and necessary infrastructure, are not able to afford e-commerce (Hall, 1995). The level of information infrastructure to support e-commerce applications differs greatly among the Asian countries from very poor to moderate. Most of the SMEs have connected to the Internet, but have simply opened a homepage and an e-mail address (APEC, 1999; A Study Report on Thailand, 2001; Beal, 2000; Turpin, 2000). The cost of telecommunication infrastructure for requisite bandwidth is also beyond the reach of many of the SMEs. Most of the Asian countries suffer poor infrastructure of electricity and energy. There are many parts of Asia where getting 4-5 hours electricity in a day itself is an issue, therefore, SMEs can not think of engaging in e-commerce. Additionally, telecommunication access and usage costs are still prohibitively high in most Asian countries, and are seen as a major obstacle among SMEs for e-adoption (APEC, 1999; Sharma et al., 2004; Sharma & Wickramasinghe, 2004).

Weak Payment and Delivery Systems

Although Asia's Internet players are rushing to promote e-commerce as a creative business mode for the new economy, few of them can break through the last-mile barriers to online purchasing. These barriers have been attributed to the lack of a standard credit system and an effective express network, two critical elements for the operation of online shopping and business transaction. Very few SMEs—those that are technology developers themselves—support electronic cash, electronic checks, and micro-payment. The majority of customers and suppliers do not use credit cards for their payments in Asian countries. Therefore, the development of electronic payment systems, including the use of credit cards, is limited. Since a credit card culture is not present in the society, both credit card companies and consumers shy away from using credit cards for transactions. The financial network of banks and other institutions do not have their databases integrated and available online (APEC, 1999; A Study Report on Thailand, 2001; Beal, 2000; Turpin 2000).

Asian countries do not have strong road, rail, and air network to support an e-commerce delivery system. Further, many postal systems are not as efficient as is found in developed countries. Due to the poor quality and limitations of the postal delivery and other distribution channels, the speedy delivery of products and services is not possible. Thus, consumers do not perceive the benefits of e-commerce reducing costs and fast delivery (Sharma et al., 2004; Sharma & Wickramasinghe, 2004).

FUTURE TRENDS

Current trends and developments suggest accelerating change for smaller businesses in the future. New technologies, organizational structures, and a move by entrepreneurs to more knowledge-based service businesses, are likely to increase productivity and profitability. It is important that the SMEs have sufficient ICTs infrastructure and skilled manpower to handle the challenge of competing in knowledge economy. More studies need to be conducted to examine how inherent barriers for SMEs for e-commerce can be removed. Networks, knowledge, and relationships have become crucial assets to business survival in the new economy. Research indicates that network building is a major new source of competitive advantage and an essential regional and indeed global management requirement (Levy & Powell, 2000). Because regional policies encourage inter-firm alliances and the development of regional economic communities, the fostering of a culture of connectivity, networking, learning, and trust between regional small and medium-size tourism enterprises may offer a potential solution for a win-win situation. It is suggested that SMEs would benefit from increased information flow through regional networking and cooperative e-marketing campaigns to enhance market visibility, global positioning, and strategic leverage in the new economy (Ho, 2001).

CONCLUSION

SMEs in Asian countries can become more competitive by promoting the development and use of e-commerce. The governments have to encourage the development of Internet Service Providers (ISPs), liberalization, and regulatory reform to increase competition in the provision of telecommunications services and encourage lower rates and service innovation. Measures should be taken to promote greater awareness of the opportunities and benefits of e-commerce for SMEs, such as training and skills development programs, and the distribution of best practices. The government should enhance the climate for investment to attract and retain venture capital and investment in SMEs with potential for rapid growth (Bode & Burn, 2002). Asian countries should initiate specific measure to build e-commerce capabilities among SMEs through seminars, workshops, training, or other activities that build awareness of e-commerce issues and concerns of SMEs. Continued emphasis by governments of these countries and other multilateral organizations on e-commerce will be important and necessary.

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KEY TERMS

E-Business (Electronic Business): The conduct of business on the Internet. It is a more generic term than e-commerce because it refers to not only buying and selling, but also electronically back end integration with other business processes such as servicing customers and collaborating with business partners.

E-Commerce (Electronic Commerce): Defined as the conduct of buying and selling of products and services by businesses and consumers over the Internet. E simply means anything done electronically, usually via the Internet. E-commerce is the means of selling goods and services on the Internet.

ICTs (Information and Communication Technologies): Includes telecommunication technologies, such as telephony, cable, satellite, and radio, as well as digital technologies, such as computers, information networks, internet, and software.

Knowledge Economy: The knowledge-based economy is all about adding ideas to products and turning new ideas into new products. Relationships with trading partners, customers, and suppliers, distribution networks, intellectual property, patents, image, etc., are all elements of a knowledge economy. These elements represent intellectual capital.

SCM (Supply Chain Management): Defined as process or processes involved for the supply of items and services from vendor through to customer.

SMEs: There is no consensus on the definition of SMEs throughout the Asia-Pacific region due to the differences in the general economic development within each country and their prevailing social conditions. Various indices are used by member economies, among them: number of employees; invested capital; total amount of assets; sales volume; and production capability.

Innovation Translation and E-Commerce in SMEs

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INTRODUCTION

Adoption of a new technology cannot be automatically assumed. The implementation of an e-commerce system in a small to medium enterprise (SME) necessitates change in the way the business operates, and so should be considered as an innovation and studied using innovation theory. In this article we argue that the decision to adopt, or not to adopt a new technology, has more to do with the interactions and associations of both human and nonhuman actors involved in the project than with the characteristics of the technology.

As e-commerce necessarily involves interactions of people and technology, any study of how it is used by SMEs must be considered in a socio-technical context for its true complexity to be revealed (Tatnall & Burgess, 2005). This complexity is due, to a considerable degree, to the interconnected parts played by human actors and by the multitude of nonhuman entities involved: small business managers, sales people, procurement staff, computers, software, Web browsers, Internet service providers, modems and Web portals are only some of the many heterogeneous components of an e-commerce system. In this article we will argue that the complexity of these systems is best seen and understood by taking this heterogeneity into account and finding a way to give due regard to both human and nonhuman aspects. The implementation of an e-commerce system in an SME necessitates change in the way the business operates and we contend that this is best studied in the light of innovation theory. In this article we examine how innovation translation, informed by actor-network theory, can be usefully applied in analysis of the adoption, or nonadoption, of e-commerce. We illustrate this in two Australian case studies.

ACTOR-NETWORK THEORY

One view of the adoption of electronic commerce by an SME suggests that decisions are made primarily based on their perceptions of the characteristics of the technology concerned. Innovation diffusion (Rogers, 1995) uses this approach and a researcher would probably begin by looking for characteristics of the specific e-commerce technology to be adopted, and the advantages and problems associated with its use. We contend that while there may be some validity in such an approach, it is unlikely to provide the complete explanation as it would miss other influences due to interpersonal and interbusiness interactions, and to the background of the people involved. We further suggest that this is particularly the case in SMEs, where the more formal adoption procedures generally used in larger companies often do not apply.

We argue that actor-network theory (ANT) has much to offer in a situation like this. A researcher using an actor-network approach to study innovation would concentrate on issues of network formation, investigating the human and nonhuman actors and the alliances and networks they build up. They would investigate how the strength of these alliances may have enticed the small business to make the adoption or, on the other hand, to have deterred them from doing so (Tatnall, 2002; Tatnall & Gilding 1999). Although some research approaches to technological innovation treat the social and the technical in entirely different ways, actor-network theory proposes instead a socio-technical account in which neither social nor technical positions are privileged.

In our experience it is often the case that when a small business is considering a technological innovation it is interested in *only some aspects* of this innovation and not others (Tatnall 2002; Tatnall & Burgess, 2002). In actor-network terms it needs to *translate* (Callon, 1986) this piece of technology into a form where it can be adopted, which may mean choosing some elements of the technology and leaving out others. What results is that the innovation finally adopted is not the innovation in its original form, but a translation of it into a form that is suitable for use by the recipient small business (Tatnall, 2002).

Unlike the more formal procedures used by larger organisations, in many instances a small business proprietor will adopt e-commerce because a friend is using it, or because they know a competitor is using it, or because a son or daughter learned about it at school (Burgess, 2002; Tatnall, 2002). The nature of each small business, the interbusiness interactions in which they engage, and the backgrounds and interests of particular individuals in each are also likely to have an important affect that would, most likely, have been ignored by the essentialist approach offered by innovation diffusion. Actor-network theory, in examining alliances and networks of human and nonhuman actors, provides a good foundation from which small business adoption and use of e-commerce can be researched. The ANT approach will be further amplified in the case studies that follow, particularly in respect of the identification of actors and networks (Tatnall, 2005).

THE CASE STUDIES

Each of the case studies that follow will include a discussion, under the umbrella of actor-network theory, of the approach taken by each of these SMEs to the adoption, or nonadoption, of e-commerce. In each case, data for the study was obtained through a series of semistructured interviews (2001, 2002) with the proprietors and personnel of the businesses involved. The data was then subjected to an ANT analysis in which actors and networks were identified and interactions were traced. The approach used in ANT to identify and trace networks is to "follow the actors" (Latour, 1996, p. 10) and investigate the leads each new actor suggests. This means that it is primarily the actors themselves, and not the researcher, that determine the direction taken by the investigation.

Adoption of the Bizewest Portal by a Storage and Transport Company

Company Background

In June 2000 the Western Region Economic Development Organisation (WREDO), in Melbourne, Australia, received a government grant for a project to set up a B-B portal (Pliaskin & Tatnall, 2005). This innovative project was to create a horizontal portal, *Bizewest*, which would enable the whole range of small to medium enterprises in Melbourne's west to engage in an increased number of e-commerce transactions with each other. An important aspect of the development was youth involvement, and students from local high schools who were studying information technology related subjects, were to be given the opportunity to consult with SMEs on a one-to-one basis in the development of their Web pages for the portal. Bizewest became operational in June 2001.

The business to be considered here is a medium-sized Melbourne company with about 50 employees that stores frozen food and transports it to supermarkets and other locations around the country. An interview with the general manager, who is also owner of the business, was conducted soon after his company adopted the Bizewest portal. When asked whether the company had already begun to make use of B-B e-commerce, he replied that they "do a little bit of it at the moment," and went on to describe how the company had only recently got all the computers in their office networked, and how this meant that they could now link all their staff to the portal.

Description of E-Commerce in the Company

Clients of the business include both small and large companies from many parts of the world, and it has dealt online with some of the larger ones now for over two years. In one case the firm is directly online with their client's stock so that they can facilitate all their freezing work. The general manager has found, however, that many companies are slow coming online and suggests this is because they are not really sure what systems to use. The general manager has been involved with the local industry group for over 12 years and was no stranger to innovation and change. When approached by WREDO to be involved in the Bizewest project he indicated that he would. When asked if he had any specific expectations for Bizewest, he said that he did not, but that he thought it was "a really good idea." He indicated that he thought it was great for the region in giving local businesses a chance to work with one another. When asked about the benefits he saw in adopting the portal he stated these in terms of time savings and better service.

A major reason that the company adopted the portal was the hope that it would provide a better opportunity to deal with people in the local region. The general manager thinks that it is going to provide many benefits for everybody, not just his company, and this is important to him. He thinks that use of the portal will change his business by enabling it to use people in the local region, and that "working together for the benefit of everybody" will be advantageous for the region. Another factor that prompted the adoption of the portal was being able to involve school students in creating the company's web pages. With a long interest in the community and in education, the general manager saw this as important.

ANT Analysis of the E-Commerce Adoption

It is clear from the study that the transport company has "not really been into computers," and has only recently started coming to grips with this technology. Although the manager had some idea of the benefits to his company of using the portal, he had no clear plan for using it. It was just "a really good idea." The reasons he adopted this innovation thus had little to do with the characteristics of this technology, and much more to do with his involvement with the local business community and because of his belief that the portal had the potential to improve business in the region. As someone with a long-term interest in education, he was persuaded by the use of school students in developing the Web sites: he saw this as a good reason to get involved.

Among the actors contributing to this adoption are: the general manager himself, the local community, the local school students, the western region, WREDO, office staff of the company, the company's larger customers, and the portal. The community and the region, in particular, should also be seen as networks that could be dissected into a large number of individual actors if this was required. As far as the general manager was concerned, the portal was definitely a black box, the contents of which he did not really want to investigate.

Impact of the Portal

The general manager had a wider view of business that just his own, and was especially interested in fostering business in the local community and in the region. He saw the Bizewest portal primarily in terms of a means of achieving greater participation of business in the region and in getting SMEs in the region to work together for their mutual benefit. He certainly wanted to make use of a B-B portal, but his main interest was in one that would get the local business community working together. He was thus most interested in a translation of the portal to become a means of achieving greater business cooperation and community involvement within the western region.

Nonadoption of E-Commerce by a Small Chartered Accountancy Firm

Company Background

The second case is of a small chartered accountancy firm, which is a family business in the western suburbs of Melbourne. Employees of the business are the main accountant, who has a degree in accounting and is a CPA, the main accountant's father—who previously ran the business but, as he is not qualified, is limited these days mainly to supporting the taxation side of the business; another accountant (CPA), and a full-time secretary. The firm offers services that are typical of a small accounting business: advice on basic accountancy and bookkeeping for small businesses; preparation and lodgement of taxation returns; taxation advice; investment and financial planning advice and advice on the use of accounting software. Its clients include both individuals and small businesses.

Description of E-Commerce in the Company

For a while, some members of the business had been debating whether to set up a Web site. The business does have an Internet connection, which they use for basic research and to connect to the Web site of the Australian Society of Certified Practicing Accountants. The employees of the business are happy to interact via electronic mail with customers who wish to do so. All of the employees were comfortable with using computers, Microsoft Office software, accounting software, dedicated financial analysis software and with browsing the Internet.

The decision about whether or not to set up a Web site seemed to come down to two major opposing viewpoints. The first viewpoint, held by the main accountant, was that a Web site was the way of the future and customers would expect it. Some competitors also already had one. The opposite viewpoint, held by the father, was that it is a waste of time and money, that there was nothing you could put on a Web site that customers would want anyway, and "who is going to do it?" Other members of the business seemed quite apathetic about the whole matter. Undeterred, the main accountant investigated the cost of a Web site with a few local ISPs, and found that it was relatively low. He also discovered a few new terms, such as *domain name*, *URL*, *traffic costs*, and so forth, which were a little off-putting. One of the ISPs asked who would be responsible for uploading the Web site content to keep it current, at which point the main accountant "felt a hot flush come over him." He found the terminology to be quite intimidating, even with his computer expertise. In the end, the final decision was to wait and see for another twelve months and then review the decision. In the meantime, the secretary was given the task of following up possible sources of expertise, either consultants or training materials, so that any future investigation may not seem so daunting.

ANT Analysis of the Nonadoption of E-Commerce

The initial conflict of interest between father and son produced a stalemate. The apathy of the other members, if anything, supported the argument of the father: "they don't care, so why bother?" The ISPs did not help themselves by failing to recognise that they had a potential customer who they turned away with technical jargon. It seems that in this instance, the Web site was never given a chance to effectively negotiate its own position. It had to rely on human actors within the business who were not quite sure of its capabilities, and actors in the ISP who did not understand the needs of the main accountant. Another outcome of the negotiations was that the overall question: Would the Web site result in extra profits for the business? was never actually asked. Although the decision has been postponed for the short term, have the accountants really helped any future negotiations by selecting the secretary to investigate further sources of information? The main accountant believes that the secretary is "very self-sufficient" and will "probably do it better than any of us could anyway." One of the problems in this case is that the operations of an ISP in setting up the Web site fall within the notion of a black box. The business has little idea of how the process operates, and probably even less now that they have spoken to the ISPs.

Nonimpact of the Internet Connection

For this business, the potential Web site could not be translated into a form where it could be adopted; it was not suitable for adoption from the viewpoint of the actors involved. The main accountant was the prime motivator in attempting to define the problem and to discover the solution: he defined the problematisation, but not well enough to gain acceptance of the innovation. Other human actors in the business failed to see that there was a problem at all, which made the process difficult from the start. The main accountant also was a prime mover in attempting to impose identities and roles on the other actors, by initiating discussions with the ISPs. Attempts at interesting and attracting other human actors in the business by coming between them and the potential Web site failed somewhat. In addition, attempts by the ISP to put themselves between the potential Web site and main accountant failed miserably. There was never much chance of enrolment occurring once the ISPs were involved with the main accountant. He had enough difficulty trying to get other human actors in the business to yield before having self-doubts introduced by the ISPs.

CONCLUSION

In this article we have given two examples of adoption/nonadoption of e-commerce technology and considered how they could be explained by ANT. Each business described was interested in some aspects of e-commerce, but not in all aspects. They each attempted, one successfully and one not so successfully, to translate e-commerce into a form they could adopt. They each attempted to choose some elements and to leave others out: to *translate* the technology into a form suitable for them.

Each of these situations point to the fact that decisions on the adoption of electronic commerce technologies are often made on the basis of more than just the characteristics of the technology, and that in many cases these characteristics are not especially significant in the decision making process, particularly in SMEs. In each instance an actor-network approach therefore offers a useful explanation of why a particular e-commerce initiative was or was not adopted. An innovation diffusion approach to investigating each of the potential adoptions looked for explanations for the uptake, or lack of uptake, primarily in the characteristics and properties of the technology. In our view, the decision to adopt, or not to adopt, has more to do with the interactions and associations of both human and nonhuman actors involved in the project rather with characteristics of the technology.

The main use made of any research approach such as ANT is in the study of past events, and ANT makes no claim to be able to predict what may happen in the future. We suggest, however, that ANT analysis can identify some pointers towards the successful introduction of an innovation, and the change management associate with this. The key to successful change management, it would thus seem, involves allowing for these interactions and for the socio-technical nature of the process.

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KEY TERMS

Actor-Network Theory: An approach to research in which networks associations and interactions between actors (both human and nonhuman) and are the basis for investigation.

Community Portals: Often set up by community groups or based around special group interests, they attempt to foster the concept of a virtual community.

Electronic Commerce: Computers, communications technologies and information systems used by people to improve the ways in which they do business.

Horizontal Industry Portals: Portals utilised by a broad base of users across a horizontal market.

Innovation Translation: A theory of innovation in which, instead of using an innovation in the form it is proposed, potential adopters *translate* into a form that suits their needs.

Small to Medium Enterprise: Those businesses with 1 to 20 employees—small, and 21 to 50 employees—medium.

Web Portal: A special Web site designed to act as a gateway to give access to other sites.

Category: Concepts, Trends, and Challenges

Integrating Conceptual Approaches to E-Government

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INTRODUCTION

In general terms, electronic government (or digital government) refers to the selection, implementation, and use of information and communication technologies in government settings (Dawes & Pardo, 2002; Fountain, 2001; Garson, 2004; Moon, 2002). E-government research is a transdisciplinary endeavor including traditions such as public administration, public policy, management information systems, operations management, and information science.

Partially because of the novelty of the concept, but also because of its multidisciplinary nature, the concept of e-government is still a work in progress. The purpose of this article is to review different definitions and conceptual approaches to electronic government, analyzing their conceptual amplitude and distinguishing characteristics. The article presents a comprehensive definition of electronic government based on current definitions and a well-established theoretical framework in public administration. The article ends with a brief discussion of some future trends in electronic government.

BACKGROUND: UNDERSTANDING THE E-GOVERNMENT CONCEPT

This section contains a literature review from which it was possible to identify three different approaches to defining electronic government. The first approach proposes direct definitions containing the main elements and characteristics of electronic government, while the second de-

Table 1. A summary of the main characteristics found in e-government definitions (Adapted from Gil-García and Luna-Reyes, 2003)

Characteristic		Sources
Use of ICTs	Using electronic means or information technologies	(American Society for Public Administration [ASPA], 2001; Carbo & Williams, 2004; Cook & LaVigne, 2002; Edmiston, 2003; Galindo, 2002; Ho, 2002; LaVigne, 2002; Organisation for Economic Co-operation and Development [OECD], 2003; UNPAN, 2002; Zweers & Planqué, 2001)
	Specifically the Internet	(Choudrie, Ghinea, & Weerakkody, 2004; Edmiston, 2003; Galindo, 2002; UNPAN, 2002)
	Anytime, anyplace	(Zweers & Planqué, 2001)
To support government actions	Provision of information and knowledge	(ASPA, 2001; Ho, 2002; UNPAN, 2002; Zweers & Planqué, 2001)
	Provision of services (including complete transactions)	(ASPA, 2001; Carbo & Williams, 2004; Choudrie et al., 2004; Cook & LaVigne, 2002; Edmiston, 2003; Finger & Pécoud, 2003; Ho, 2002; LaVigne, 2002; OECD, 2003; Zweers & Planqué, 2001)
	Provision of products	(Zweers & Planqué, 2001)
	Governmental actions/daily administration/better government/intergovernmental collaboration	(Cloete, 2003; Cook & LaVigne, 2002; Edmiston, 2003; Ho, 2002; LaVigne, 2002; OECD, 2003; UNPAN, 2002)
To improve relations or citizen engagement	Relations between authorities and citizens	(Galindo, 2002)
	Exert political rights, citizen engagement	(Carbo & Williams, 2004; Fountain, 2003; Galindo, 2002)
Following a strategy oriented to add value	Adding value to participants in transaction	(Zweers & Planqué, 2001)
	Developing strategy to use technology, more important than the technology itself	(Choudrie et al., 2004; Grönlund, 2001)

fines the concept by enumerating different stakeholder-oriented applications of e-government. Finally, the third approach defines electronic government from an evolutionary perspective.

Definitional Approach: Some Characteristics of E-Government

A rich variety of electronic government definitions were found in a review of the existing literature. As shown in Table 1, it is possible to summarize most of the current definitions of electronic government using four basic elements. Electronic government is characterized by (a) the use of ICTs (computer networks, Internet, faxes, and telephones), (b) the support of governmental actions (to provide information, services, products, administration), (c) the improvement of governmental relationships with citizens (through the creation of new communication channels or the promotion of citizen engagement in the political or administrative process), and (d) the following of a strategy oriented to add value to the participants in the process.

Within this same approach, a complementary way to explain electronic government involves classifying applications according to different types of government actions. These applications can be organized in several ways; for example, Perri 6 (2001) uses three main groups of government activities: (a) electronic services, (b) electronic democracy, and (c) electronic governance. Other authors contend the concept of electronic government incorporates four fundamental dimensions of activity: (a) electronic services, (b) electronic democracy, (c) electronic commerce, and (d) electronic management (Cook & LaVigne, 2002).

Electronic services and electronic commerce are associated with the provision of government services by electronic means. Electronic management includes a great variety of elements such as intergovernmental collaboration, government systems development, training, marketing, information management, and citizen-relationship management (e.g., call centers). Public participation and electronic voting characterize electronic democracy. Finally, electronic governance concerns support for policy design and decision making as well as institutional development and administration.

Stakeholder-Oriented Approach: Different Applications of E-Government

Another approach to understanding electronic government consists of classifying e-government applications according to relations among government and other entities (Hiller & Bélanger, 2001; Moon, 2002; Schelin, 2003). In this perspective, electronic government consists of using the Internet as a tool to facilitate and improve governmental interchanges with different constituencies or stakeholders. The three main relations identified in the literature are with citizens (G2C, government-to-citizen), private organizations (G2B, government-to-business), or other governments (G2G, government-to-government) (Hiller & Bélanger, 2001; Holmes, 2001; Schelin, 2003).

Some researchers call for more specificity in interactions due to the importance and peculiarities of certain types of relationships (Hiller & Bélanger, 2001). These authors add (a) government-to-individuals as part of the political process (G2IP), stressing the importance of the democratic process, (b) government-to-companies in the market (G2BMKT), emphasizing economic interchange between government and companies, and (c) government-to-employees (G2E), differentiating the relationship of government with its employees from those with citizens in general.

Evolutionary Approach: E-Government Stages

A third way of understanding electronic government follows an evolutionary approach, identifying different stages of development in e-government initiatives (Hiller & Bélanger, 2001; Layne & Lee, 2001; Martinez-Moyano & Gil-García, 2003; Reddick, 2004; United Nations [UN] Division of Public Economics and Public Administration & ASPA, 2002). Some of these approaches restrict e-government to those projects with a certain extent of development. In the following, we describe two influential models.

Layne and Lee (2001) present a model of four stages that encompass the development of a totally functional electronic government: (a) cataloguing, (b) transaction, (c) vertical integration, and (d) horizontal integration. The first stage (cataloguing) focuses on the classification or cataloguing of government information and its presentation using Web pages. Projects in the second stage (transaction) facilitate interaction between the citizens and the government by providing products and services online. Projects in the stage of vertical integration include the integration of services from governmental organizations at different levels of government that have a common function among their responsibilities. Finally, horizontal integration consists of a radical transformation in government organizations to provide a one-stop window or a vestibule of state that provides all the information, products, and services that citizens require (Gant, Gant, & Johnson, 2002).

The Division of Public Economy and Public Administration of the United Nations and the American Society for

Public Administration (2002) developed another useful evolutionary view of electronic government. They suggested a five-stage model: (a) initial presence, (b) extended presence, (c) interactive presence, (d) transactional presence, and (e) totally integrated presence. Initial presence and extended presence both refer to information presentation with different levels of size and complexity (similar to cataloguing). Interactive and transactional presence consist of the existence of a portal that organizes and presents services and information offered by several government agencies in terms of citizen needs (similar to transaction). A totally integrated presence is closely related to both vertical and horizontal integration.

AN INTEGRATIVE VIEW TO THE E-GOVERNMENT CONCEPT

After a review of the main approaches to the concept of e-government, the main goal of this section is to briefly assess the strengths and weaknesses of each approach.[1] Taking into consideration a well-established theoretical framework in public administration, the section finishes with an e-government view based on previous approaches and their mapping onto the theory.

The evolutionary approach to e-government is described in terms that limit the e-government concept mainly to Web applications. In addition, some evolutionary approaches imply that only projects with a certain level of development can be considered electronic government. Although it is true that most computer-based e-government applications will be housed within a Web environment, we think it is very important to extend the concept of e-government to any use of ICTs.

The stakeholder-oriented approach considers mostly external relationships (i.e., from the government to another entity outside the government). Although many applications are oriented to improve the way in which government relates to other entities, e-government applications can also serve to improve internal operations and management as well as citizen engagement and public accountability.

From our initial description of each approach, it seems the definitional approaches include a wider spectrum of e-government applications in a less restrictive way. Given the limitations of the evolutionary and stakeholder-oriented approaches described in previous paragraphs, we consider the definitional approach to be the most adequate to understand the concept of e-government. However, the comprehensiveness of this approach makes it difficult to select which elements are theoretically and practically important.

Nearly all the authors address the improvement of government services as a fundamental element of electronic government (e-services). A smaller number of academics and practitioners consider ICT's potential to improve and change internal operations and management as an important element of e-government (e-management). Few of these authors acknowledge the value of information technologies for promoting and preserving democratic values (e-democracy). Finally, almost no one has clearly related electronic government to the design of public policies that facilitate and promote the development of IT initiatives and the information society, that is, electronic public policy (e-policy).

Table 2. Mapping e-government elements to public-administration theory (Adapted from Gil-García and Luna-Reyes, 2003)

Approaches to Public Administration	E-Government Categories	E-Government Elements	Sources
Managerial	E-Services	E-Services, E-Commerce	(6, 2001; ASPA, 2001; Carbo & Williams, 2004; Cook & LaVigne, 2002; Galindo, 2002; Hiller & Bélanger, 2001; Holmes, 2001; LaVigne, 2002; Layne & Lee, 2001; Moon, 2002; OECD, 2003; Schelin, 2003; Scholl, 2002; UN Division of Public Economics and Public Administration & ASPA, 2002; UNPAN, 2002; Zweers & Planqué, 2001)
	E-Management	E-Management, E-Personnel, E-Procurement	(Cook & LaVigne, 2002; Finger & Pécoud, 2003; Grönlund, 2001; Hiller & Bélanger, 2001; Holmes, 2001; LaVigne, 2002; Layne & Lee, 2001; Moon, 2002; OECDE, 2003; Rocheleau, 2003; Schelin, 2003; Scholl, 2002; UNPAN, 2002)
Political	E-Democracy	E-Democracy, E-Participation, E-Voting, E-Transparency	(6, 2001; Carbo & Williams, 2004; Cook & LaVigne, 2002; Fountain, 2003; Galindo, 2002; Hiller & Bélanger, 2001; OECDE, 2003; Scholl, 2002)
Legal	E-Policy	E-Policy, E-Governance	(6, 2001; Finger & Pécoud, 2003)

According to Rosenbloom (1998), there are three relatively distinct approaches to public administration: the managerial, political, and legal. Each of these views emphasizes different but complementary aspects of government. By mapping e-government elements to this theoretical framework, most of the elements can be grouped into e-management and e-democracy as corresponding to the managerial and political views (see Table 2).

However, it seems necessary to also include the legal view (e-policy). Governments also create regulatory and legal frameworks for the information revolution to happen. In addition, information-technology policies have been identified as key factors in the success of e-government initiatives (Dawes & Nelson, 1995; Fletcher, 2004).

Although applying Rosenbloom's (1998) framework to e-government applications would include e-services as a part of the managerial view or e-management, we would like to separate out e-services because of the customer orientation of the New Public Management perspective, which makes them different from managerial concerns. In the e-commerce arena, e-services are actually forming a new paradigm that transforms the way industries provide services, where the customer is at the center and technology constitutes an enabler for organizational transformation. The e-services view looks to the outside (customers) instead of the inside (technology and management) (Rust & Kannan, 2003), searching for the organizational transformation that allows a one-stop government-integrated service (Wimmer, 2002).

A definition of electronic government that claims to be useful for academic research and governmental policies and actions must take into consideration at least the previous four elements: e-services, e-management, e-democracy, and e-policy (as shown in Table 2). Thus, electronic government is the selection, implementation, and use of information and communication technologies in government to provide public services, improve managerial effectiveness, and promote democratic values and mechanisms, as well as the development of a regulatory framework that facilitates information-intensive initiatives and fosters the knowledge society (Gil-García & Luna-Reyes, 2003). Accordingly, e-government policies are not only about IT projects in government, but also about creating the conditions for their successful development.

Although this definition is still a work in progress, it accounts for most of the theoretical elements found in the literature; it is also sufficiently pragmatic to guide e-government strategy and policy development.

FUTURE TRENDS

Current trends in electronic government research are associated with increasing the adoption of e-government by citizens (Carter & Belanger, 2004). Some research related to this adoption process explores the importance of citizen trust in government as an adoption factor (Warkentin, Gefen, Pavlou, & Rose, 2002), but also studies the problem of citizen access to ICTs and information resources, known as the digital divide (Compaine, 2001; Luna-Reyes & Maxwell, 2003). Future trends in the digital-divide research arena will focus not only on the existence of the gap and how to close it, but also on the true benefits related to its closing (Jackson, Von Eye, Barbatsis, Biocca, Fitzgerald, & Zhao, 2004).

Current emerging trends in e-commerce research and practice will also impact the future of e-government such as user orientation and service quality (Aichholzer, 2004; Roy, 2003) or outsourcing (Chen & Perry, 2003). Some of these trends are related to the definition of e-services as a new commerce paradigm. From these new perspectives, a Web service "supports direct interactions with other software agents using XML [extensible markup language] messages exchanged via Internet-based protocols" (Ferris & Farrell, 2003, p. 31). Research about other technical standards (Borras, 2004; Landsbergen & Wolken, 2001) and open-source alternatives (Butler, Feller, Pope, Barry, & Murphy, 2004) is also taking place.

In this way, e-services will be based on reducing costs and increasing efficiency (Brown, 2001; La Porte, Demchak, & Friis, 2001), but also on building a profitable customer relationship (Rust & Kannan, 2003). E-services are mobile (PDAs [personal digital assistants], cell phones, etc.), flexible, and interactive (i.e., a series of interactive building blocks that help a customer to do the task) so as to allow the creation of sets of interacting applications around service areas (Hoffman, 2003).

In the future, this trend will facilitate the organization of government services as multichannel delivery (Aichholzer, 2004) in terms of life events such as getting married or moving to make one-stop government a reality (Wimmer, 2002), requiring complex interorganizational collaboration (Dawes & Préfontaine, 2003). However, the impacts of these trends on e-commerce have to be carefully considered by the public manager because of differences in customer relationships and IT investment between the public and private sectors (Rocheleau & Wu, 2002). Finally, security and privacy are also important challenges for the current and future development of e-government (Aichholzer, 2004) and e-democracy applications (Weinstein, 2000).

CONCLUSION

The dynamic nature of ICTs has greatly affected the development of the e-government concept. From the first use of mainframes and minicomputers to increasingly powerful networks and Web-based applications, governments have attempted to obtain benefits from the new technologies while avoiding problems. This evolution and increased complexity have been reflected in the terms used to refer to the relationships between government and ICTs. Public information systems, government information management, and e-government are some examples of a trend in which concepts attempt to capture the essence of emergent technologies.

It seems clear this tendency will continue in the near future so that the e-government concept and its definition will soon be in transition. Understanding the dynamics and complexity inherent to e-government as a concept and reality is very important for both the development of sound theories and the implementation of successful e-government projects. The research community continues a fruitful discussion and debate that will surely contribute to the strengthening of e-government as a distinct field of study.

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KEY TERMS

E-Government: The selection, implementation, and use of information and communication technologies in government to provide public services, improve managerial effectiveness, and promote democratic values and mechanisms, as well as the development of a regulatory framework that facilitates information-intensive initiatives and fosters the knowledge society.

E-Government Internet Security: Technological tools, standards, policies, and other decisions concerning the security of the information and systems used by government organizations or in public-sector settings.

E-Government Portal: An interagency or intergovernment Web site that integrates information and services at a single point of entrance and can be customized according to different constituencies.

E-Government Stages: In an evolutionary approach, e-government stages are the different steps in the development of e-government. Normally, they follow a logical progression of increased technological sophistication over time.

ICTs: Information and communication technologies include hardware, software, and networks as well as the social and organizational structures needed to support their adequate functioning.

Public Services: Information and services provided by government agencies and other organizations working within the public sphere.

Web Service: "Software application identified by a URI, whose interfaces and bindings are capable of being defined, described and discovered as XML artifacts" (Ferris & Farrell, 2003, p. 31).

ENDNOTE

1 It is important to clarify that this integrative approach to e-government is conceptual in nature. Readers interested in implementation issues and success factors can consult Basu (2004), Dawes and Pardo (2002), Gil-García and Pardo (in press), Kaaya (2004), Kaylor, Deshazo, and Van Eck (2001), Martin and Byrne (2003), Mittal et al. (2004), Swedberg and Douglas (2003), or Vriens and Achterbergh (2004).

Category: Applications of E-Technologies

Intelligent Product Brokering and Preference Tracking Services

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BACKGROUND

It has been projected that electronic commerce conducted via mobile devices such as cellular phones and PDAs will become a whopping $25 billion market worldwide by 2006 (Frost & Sullivan, 2002). Some of the driving factors behind mobile commerce (m-commerce) have been attributed to the compactness and high-penetration rate of these mobile devices.

Despite all the hype and promises about m-commerce, however, several main issues will have to be resolved (Morris & Dickinson, 2001; Nwana & Ndumu, 1996, 1997). Clumsy user interfaces, cumbersome application, low speeds, flaky connections, and expensive services have soured many who have tried m-commerce, and security and privacy concerns have also dampened enthusiasms for m-commerce.

Taking these concerns into account, the developers will have to offer something unique. One of the potential killer applications for m-commerce could be intelligent programs that are able to search and retrieve a personalized set of products from the Internet for their users. These programs are called software agents. Agent-based e-commerce has emerged and software agents have demonstrated tremendous potential in conducting transactional tasks via the Internet.

According to the model from the Maes's group (Guttman & Maes, 1999), the consumer buying behavior (CBB) can be divided into six stages, namely, need identification, product brokering, merchant brokering, negotiation, payment and delivery, and product service and evaluation. Among these stages, product brokering plays an important role. It involves gathering product or service information, filtering information, recommending products, and so forth.

A user searching for a particular product on the Internet will normally have to use popular search engines and enter keywords that describe the product. These search engines will process these keywords and generate a large number of links for the user to visit. Neither the search engine nor the Web site knows the preference of the user and therefore might provide information that is irrelevant to the user. Hence, user preference tracking becomes one of the fundamental tasks of product-brokering agents.

Agents act on behalf of their users by carrying out delegated tasks automatically. A product-brokering agent will search for the products in the background with minimal user intervention, thereby allowing the user to concentrate on other aspects of the transaction, such as product purchase, bidding, negotiation, and so forth. The agent could be programmed with the user's preferences in mind and filter out irrelevant products automatically. The agent could also detect shifts in the user's interests and adjust accordingly to suit the user. Personalized product-brokering agents require a profile of the user in order to function effectively. The agent would also have to be responsive to changes in the user's interests and be able to search and extract relevant information from outside sources.

At MIT Media Labs, Maes and Sheth (Maes, 1994; Sheth & Maes, 1993) came up with a system to filter and retrieve a personalized set of USENET articles for a particular user by creating and evolving a population of information filtering agents using genetic algorithms (Holland, 1973). Genetic algorithms have been widely used in various applications (Chen & Shahabi, 2002; Farhoodi & Fingar, 1997a). Their superior and flexible performance has motivated their use in software agents.

Some keywords will be provided by the user that represents the user's interests. Weights are also assigned to each keyword, and the agents will use them to search and retrieve articles from the relevant newsgroups. After reading the articles, the user can either give a positive or negative feedback to the agents via a simple GUI. Positive feedback increases the fitness of the appropriate agents and also the weights of the relevant keywords (vice versa for negative feedback). In the background, the system periodically creates new generations of agents from the fitter species while eliminating the weaker ones. Initial results obtained from their experiments showed that the agents are capable of tracking its user's interests and recommend mostly relevant articles.

Whereas the researchers at MIT required the user to input their preferences into the system before a profile could be created, Crabtree and Soltysiak (1998) believed that the user's profile could be generated automatically by monitoring the user's Web and e-mail habits, thereby reducing the need for user-supplied keywords.

Crabtree and Soltysiak's approach was to extract high-information-bearing words that occur frequently in the documents opened by the user. This is achieved by using a text summarizer that can generate a set of keywords to describe the document and can also determine the information value of each keyword. A clustering algorithm is then employed to help identify user's interests, and some heuristics are used to ensure that the program could perform as much of the classification of interest clusters as possible.

However, they (Crabtree & Soltysiak, 1998) have not been completely successful in their own experiments. The researchers admitted that it would be very difficult for the system to classify all the user's interests without the user's help. Nevertheless, they believed that their program has taken a step in the right direction by learning user's interest with minimal human intervention.

Widyantoro, Ioerger, and Yen (2003) proposed a method to keep track of changes in user interests from a document stream. Their method integrates a pseudorelevance feedback mechanism, an assumption about the persistence of user interests, and incremental method for data clustering. They claimed that their method significantly improves the performances of existing user-interest-tracking systems without requiring additional, actual relevance judgments. Kiss and Quinqueton (2001) also presented a machine learning method designed to predict preference knowledge in a multiagent context.

A new product-brokering agent usually does not have sufficient information to recommend any products to the user, and therefore it has to get product information from somewhere else. A good source of information will be the Internet. In order to do that, a method suggested by Pant and Menczer (2002) involves inplementing a population of Web crawlers called InfoSpiders that searches the World Wide Web on behalf of the user. Information on the Internet will be gathered based on the user's query and will then be indexed accordingly. These agents initially rely on traditional search engines to obtain a starting set of URLs that are relevant to the user's query. The agents will then visit these Web sites and decode their contents before deciding where to go next. The decoding process includes parsing the Web page, looking at a small set of words around each hyperlink, and giving a score based on their relevance to the user. The link with the highest score is then selected, and the agent visits the Web site.

DESCRIPTION OF INTELLIGENT PRODUCT-BROKERING AGENTS

Intelligent product-brokering agents, a new design and implementation of product-brokering agents, is briefly presented here (Guan, Ngoo, & Zhu, 2002, 2003). The intelligent ontology-based product-brokering agents implemented are capable of providing a personalized service for their users. They learn user preferences over time and recommend products that might interest the user. This work has two main features: One feature is that the product brokering is closely integrated with user preference tracking, and the other feature is that a genetic algorithm is used to adjust parameters to track user preferences.

Some assumptions have been made about the system, such as that the user is a rational person and will select a product rationally and that the value a user places on a product can be calculated, such as the price of product. Before the product brokering agent is able to explore the Internet and retrieve product information for the user, the agent needs to have some prior knowledge, such as the URL of some relevant Web sites, keywords, or some quantifiable attributes that can be used to describe the product. It could be tedious if the user has to enter such information into the agents when he or she wants to search for a particular product. An alternative to this is to create a product ontology, which involves defining the meaning of each term that is used to describe the product, their valid range of values, and their relationship with one another.

In this design, each agent will have an evaluation function that will be used to calculate the value of each product. Products that have a higher value will have a higher chance of been recommended by the agent. This evaluation function has some tunable parameters that characterize the user's preferences for a particular category of products.

Before recommending a product to the user, the agent should first be able to evaluate which product would best fit the user's requirements. A proposed method is to use some quantifiable attributes, such as performance, cost, and so forth, to evaluate the products. As an example, two weights—perf_weight (the weight of the performance of the product) and cost_weight (the weight allocated to the product cost)—represent the weights that the user could give to each attribute. These two parameters are actually used to represent the user's preferences and are incorporated inside the agent. If perf_weight has a higher value, it means that the user place more emphasis on the performance of the product. Likewise, if the user has a higher value for cost_weight, it means that the user is more concerned about the cost of the product.

When an agent is created, these two weights will be initialized based on some heuristics and would be used to calculate the value of each product found in the agent's database. The agent will then rank the products according to their values and select the top products to be presented to the user. The two weights will be allowed to change during agent evolution.

During user feedback, each agent in the system will select the top products in its database and adds them into a recommended list. A sorting function is implemented to allow the user to sort the list according to his preferences. When the user selects a product that he likes, all the agents in the system will be informed about the user's selection.

The agents will take note of the product that the user has selected and searches for that product inside its own database. At this stage, each agent would have already assigned a product value to each product in its database. To determine the amount of points to award to an agent, it will be asked to rank the products in an ascending order according to this value.

The agent's fitness is obtained by averaging the number of points earned by the agent in the previous generations. A new agent would start off with some default fitness. To keep track of the agent's performances, each agent will have a fitness history list that used to store the fitness of an agent for each generation. Hence, after an agent has been awarded some points, it will calculate its new fitness and inserts the value into the fitness-history list.

During the evolution process, weaker agents will copy over all the parameters of the fitter agents. Then, they will try to adjust the newly acquired parameters to better reflect the user's requirements. First, it will use the newly acquired parameters to reevaluate all the products found inside its new database. Then the agent will select the best product based on these new parameters. If it is the same as the user selected product, no further changes will be required but some small and random mutations in the parameters will be allowed.

IMPACT OF INTELLIGENT PRODUCT BROKERING AGENTS

To evaluate the performance of the implemented system, some experiments have been conducted to see if the system is able to detect a change in the user's preference and how fast the system will be able to respond to these changes. This could be observed by looking at the average fitness of all the agents in the system. The average fitness of all the agents should remain high if the system is able to track and respond to the changes effectively. The detailed results can be found in Guan et al. (2003). It has been found that the implemented system is capable of tracking the gradual changes in users' preferences.

CONCLUSION

With the development of software-agent technology and soft-computing techniques, agent-based e-commerce has attracted more interests. With the assistance of the intelligent agents, product brokering on the Web will become more accessible, and users may benefit from some killer applications. The GA-based product-brokering agent described in this article can intelligently track user preferences and adjust the parameters to track the preferences. Experiments have shown that the evolutionary intelligent agents are capable of tracking changes in user preferences. One weakness of the GA-based agent approach, however, is the incapability of the agent to know generic user interests, such as preference for a lighter color, for instance, which has not been preprogrammed into the agent.

Furthermore, the system is also user friendly in that the agent will learn user preferences through the user-feedback process. Although the user may not necessarily know his or her own preferences in the beginning, through agent recommendation, the user will make his or her choices, which helps the agent learn.

Further work on this topic includes care for security issues when the agents are distributed over a network. Also important is the capability of an agent to track drastic and dramatic changes in user preference. The application of fuzzy decision making to agents is another important future research direction as this will enable an agent to evaluate subjective and intangible products.

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KEY TERMS

Electronic Commerce: Electronic commerce, or e-commerce, consists of the buying, selling, marketing, and servicing of products or services over computer networks. The information technology industry might see it as an electronic business application aimed at commercial transactions.

Genetic Algorithms: A genetic algorithm (GA) is a heuristic agent used to find approximate solutions to difficult-to-solve problems through application of the principles of evolutionary biology to computer science.

Intelligent Programs: Programs that are intelligent in some sense, using learning, adaptive, or evolutionary algorithms.

M-Commerce: M-commerce, or mobile commerce, stands for electronic commerce made through mobile devices.

Product Brokering: In commerce, a product broker is a party that mediates between a buyer and a seller. A broker who also acts as a seller or as a buyer becomes a principal party to the deal.

Relevance: Relevance is a score assigned to a search result, representing how well the result matches the search query. In many cases, a result's relevance determines the order in which the result is presented to the user.

Software Agents: A software agent is a piece of autonomous, or semiautonomous proactive and reactive, computer software. Many individual communicative software agents may form a multiagent system.

Category: Concepts, Trends, and Challenges

Interaction Standards in E-Business

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INTRODUCTION

A standard is a framework of specifications that has been approved by a recognized standards organization (de jure standard), is accepted as a de facto standard by the industry or belongs to the open standards (Hawkins, Mansell, & Skea, 1995). According to Rotem, Olken, and Shear (2001), there are two types of communication standards encountered in the e-business: infrastructure type standards and interaction type standards. Infrastructure type standards such as TCP/IP are important for almost any application that uses the Internet and are not the focus of this chapter. Interaction type standards address communication content and interfaces between e-business systems with the goals of facilitating system interoperability and process integration. These standards cover issues such as data dictionaries, message structure, and remote object invocation.

BACKGROUND

E-business interaction standards began in the 1980s with the emergence of electronic data interchange (EDI). EDI's structured document format enabled the systems of one firm to directly communicate with those of other firms. This earlier form of business-to-business (B2B) e-commerce, however, was difficult for small-to-medium enterprises to adopt due to its high cost and complexity (Chau & Jim, 2002).

With the growth of the Internet-based e-commerce, there was increasing need for business systems to be able to communicate with each other over the Internet. The need for systems of different organizations to interact with each other in ways beyond just sending structured documents also emerged. For instance, the systems of one organization may need to invoke the processes of systems of another organization. With the increasing reliance on the Internet as a medium for conducting business, it is likely that interaction standards will become an important element in e-business systems. This article provides an overview of these standards.

E-business partners have interactions at different levels of society. Accordingly, e-business standardization can happen from individual level and company level to industry or association level and national level (Verman, 1973). Due to the huge number of these standards bodies, this article has chosen standards bodies or groups at international level as its discussion targets.

TYPES OF INTERACTION OF STANDARDS

Most e-business interaction standards can be categorized into one of the following five categories: message structure, data dictionary data guidelines, remote object invocation, registries/repositories, and business processes. The following describes each of these areas and some of the main standards that have been developed in them.

Message Structure

Despite the emergence of successors, traditional EDI continues to be widely used. An EDI message consists of a series of data elements, each representing a single fact, such as a product ID or price, separated by a delimiter. The entire series is called a data segment. One or more data segments framed by a header and trailer form a transaction set. This is what is sent via EDI and is equivalent to a message. This message would tend to consist of what would normally be contained in a typical business document.

The main version of EDI used in the United States follows the ANSI Accredited Standards Committee (ASC) X12 standard developed by the Data Interchange Standards Association. Since 1987, chartered by ANSI, the Data Interchange Standards Association (DISA) has served as the secretariat for the X12 standards development process. ASC X12's strategy direction is to "embrace collaboration with domestic and international organizations while continuing to forge ahead to ensure ASC X12 member companies' electronic data interchange (EDI) requirements are met" (Cover, 2003). A closely related international standard UN/EDIFACT was developed by the United Nations Centre for Facilitation of Procedures and Practices for Administration, Commerce and Transport (UN/CEFACT). ASC X12 and UN/EDIFACT are closely coordinated standards.

ebXML (electronic business XML) is an emerging, open and Internet-based standard that is supplanting traditional EDI. ebXML is intended for the exchange of business documents globally among firms of any size, and in any location, by securely exchanging of XML-based messages (Chiu, 2002). ebXML is the result of a project that was jointly launched by UN/CEFACT and the Organization for the Advancement of Structured Information Standards (OASIS, 2005). OASIS is a not-for-profit international consortium of vendors, users and specialists whose membership includes 75 companies, including major IT vendors and trade associations throughout the world.

Since ebXML uses existing standards such as HTTP, TCP/IP, MIME, SMTP, FTP, and XML, it can be deployed on virtually any platform. This, along with the use of the Internet instead of proprietary networks makes ebXML relatively inexpensive and easy to use.

BizTalk, an alternative to ebXML is a result of an industry initiative headed by Microsoft to promote XML as the data exchange language for e-commerce and application integration on the Internet. While not a standards body per se, the group is fostering a common XML message-passing architecture to tie systems together. In the BizTalk Framework, a message is embedded inside an envelope that includes additional information such as origin, purpose, and destination.

Data Dictionaries

Data dictionary standards may include guidelines about how specific elements are represented or which segments of data may coexist, or are mutually exclusive. Such guidelines appear in the EDI and RosettaNet message standards. The following are some standards related to data dictionaries:

1. ASC X12 data element dictionary represents the collection of basic building blocks on which all electronic data interchange (EDI) transaction sets are constructed.
2. The UN/EDIFACT data dictionary defines each data element and its cross-reference to all UN/EDIFACT messages in which it's used, including all available codes and attributes.
3. RosettaNet is a nonprofit consortium dedicated to the development and deployment of standard electronic business interfaces (Hamilton, 2004). These standards include common partner interface process (PIP) and data dictionaries. RosettaNet encodes messages as well-formed XML documents. RosettaNet was formed in 1998 by leading companies in the electronic sector, is a nonprofit consortium of more than 500 organizations working to create open e-business standard. Because RosettaNet is widely supported by companies in the IT industry, its standards are expected to be widely adopted. Once adopted, there is some evidence showing that interaction standards such as RosettaNet have considerable potential for altering the way firms in industries interact with each other (Malhotra, Gosain, & El Sawy 2005).
4. The Open Applications Group (OAG) has developed the business object document (BOD) architecture that provides the framework to communicate messages or business documents. BOD consists of two major components: control layer and business data layer. The OAG work group has provided the specification to develop a set of OAG-compliant document type definitions (DTDs) to support their eXtensible Markup Language (XML) messaging requirement. Both the XML messages and its DTDs make up the BOD.
5. The ebXML core components project team is working on a method to develop a common business data dictionary. The goal is to develop a syntactical neutral data dictionary where it can support numerous syntax such as XML, X12, EDIFACT, etc. This is a work in progress.

Remove Object Invocation

Trading partners often need interoperability among their systems. The dominant standards in these areas are Microsoft's component object model (COM) and COM+, common object request broker architecture (CORBA) by OMG, and Sun's Enterprise JavaBeans (EJBs).

SOAP (simple object access protocol) provides methods for a program running under one operating system to communicate with a program in the same or another operating system using the hypertext transfer protocol (HTTP) and XML as the mechanisms for information exchange (Alexander & Zhang, 2005). SOAP specifies how to encode an HTTP header and an XML file so that a program in one computer can call a program in another computer and pass it information. It also specifies how the called program can return a response. Because HTTP requests normally are allowed to pass through firewalls, SOAP communications are typically able to communicate with programs anywhere.

Registries/Repositories

These can be viewed as large databases of information about schemas, DTDs, and services offered. Examples of registry standards are UDDI, Total-espeak by HP, and ebRIM, the ebXML registry information model (Rotem et al., 2001).

UDDI (universal description, discovery, and integration) for example, is based on XML. It provides a registry for businesses to list themselves on the Internet. Its goal is to simplify transactions by helping companies to find each other on the Internet, and increase the interoperability of their systems (Newcomer, 2002). UDDI can be viewed as an online version of a telephone book's white and yellow pages. UDDI allows businesses to list themselves by name, product, location, or the Web services they offer. Efforts to develop UDDI were led by the firms Microsoft, IBM, and Ariba.

Also based on XML, WSDL (Web services description language) is a language for describing services offered by businesses. WSDL provide a mechanism for accessing these services electronically. WSDL is used by UDDI for businesses to describe themselves.

Business Processes

A tighter integration is sometimes required among complete business processes or workflows. For example, a purchase order workflow at Company A needs to invoke an acknowledgment process and inventory search process at Company B.

In addition to its involvement with data dictionary standards, RosettaNet is also involved in standards for defining business processes. Its partner interface processes (PIPs) defines business processes between trading partners. PIPs fit into seven Clusters, or groups of core business processes, that represent the backbone of the trading network. Each cluster is broken down into Segments—cross-enterprise processes involving more than one type of trading partner.

STANDARDS BODIES

It has been noted that several industry lead standards organizations or "forums" have been formed (Mähönen, 1999). This indicates a tendency towards standardization carried out by different industry groups in the field of e-business. Table 1 shows some of the major standards setting bodies and some of the standards each is involved in.

FUTURE TRENDS

Today's XML based e-business starts from 80s EDI. At that time, many big companies intended EDI to integrate business functions for automatically delivery of the data. EDI based on ASC X12 and UN/EDIFACT currently has a large installed base; the volume of EDI transactions and integration with core business processes will continue to make it a widely implemented standard for e-business. The introduction of the XML in late 90s point e-business in a new direction. XML-based e-business standardization begins with an ambitious vision: to transform all information system into interpretable ones to business partners or even the society. Newer interaction models, usually based on XML appear in a number of

Table 1.

Organization	Representative standards work
ISO International Standards Organization	Works on EDIFACT and ebXML
The ANSI Accredited Standards Committee (ASC)	X12 EDI Standards—chartered DISA–Data Interchange Standards Association
United Nations Centre for Facilitation of Procedures and Practices for Administration, Commerce and Transport (UN/CEFACT)	UN/EDIFACT, and ebXML (jointly with OASIS & ISO)
Organization for the Advancement of Structured Information Standards (OASIS) A not-for-profit international consortium of vendors, users and specialists.	ebXML (jointly with UN/CEFACT) ebXML committee—representatives of UN/CEFACT and OASIS: oversees continuing work on ebXML
Open Applications Group (OAG) A nonprofit consortium founded by 8 leading enterprise application software, now has about 50 members.	OAGIS—open applications group integration specification OAMAS——open applications group common middleware API specification: OAGIS and OAMAS deliver plug and play solution in the form of business object document (BOD) to allow easier integration of BB and application to application software components for e-business
RosettaNet	RosettaNet

standards that have reached different levels of maturity and adoption. The ebXML framework, for instances, does not seem close to "critical mass" status for e-business yet. The status of other XML-based e-business standards is also not yet stable. The mature, stable form of some has yet to appear; their ultimate levels of adoption are anything but certain. A problem with adopting these standards is the fact that since they are not yet stable, their adoption can be risky. Additionally, in many cases, the related technology could have become almost antiquated by the time the standard is published (Egyedi, 2000; March & Olsen, 1989).

CONCLUSION

It is worthwhile to note here that the standardization of e-business is a combination of vision and action. Beginning with EDI, e-business interaction standards are developing through newer standards largely based on XML These standards by and large address interactions between companies or organizations. The standards groups often had problems to define their scope in the same terms because of the larger scale or volume of activity required to justify the expense of the systems to support these standards. Collaboration or coordination among standards groups are therefore strongly encouraged by the industries and proved to be a good approach to facilitate the convergence of e-business standards. As relationships between parties become redefined, standards groups also need to consider broadening the scope of their standards to include both intra- and inter-enterprise transactions. With companies outsourcing more administrative functions, these internal exchanges can become intercompany messages almost overnight (Kotok, 2001).

According to Rotem et al. (2001), there are really two strategies to deal with multiple e-business standards and their standards bodies. The firms can either choose a set of standards to support natively in all applications and systems and expect the rest of the world to comply as RosettaNet did or they have to build a translation capability that allows the organization to accommodate multiple evolving standards.

Whichever strategies the company chooses seems to be strongly affected by the industry structure it exists. Mature industries tend to have already converged on a set of dominant standards—either official or de facto. Emerging industries tread on shifting sands and new standards come and go like the wind. For companies whose business network extends across industry boundaries, they face a mess of standards; for example, semiconductor manufacturing industry will need to accommodate multiple standards as they transact with the automotive, aerospace, and consumer goods markets.

Some industries can have one or a few dominant player that can dictate standards to suppliers (e.g., Boeing in aircraft, Wal-Mart in retail, and the big three in automotive). For the rest players of those industries, the best strategy will be following dominant players to gain second move advantages. In other industries without dominant players, it may be possible for firms to influence standards development by creating the structures to work together collectively in order to gain influence (Reimers & Lee, 2005).

Similarly, if there is a single or a consortium of, dominant IT vendors that serve the industry, it or they may be able to drive standards adoption. The adoption of the same standards has also been quick in some instances and slow in others. ebXML, for instance, has been adopted by the automotive industry as e-business exchange standards. But in semiconductor industry, due to the existence of RosettaNet, the shifting to ebXML is expected to be slow. Furthermore, the role of government in a heavily regulated industry can not be ignored.

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KEY TERMS

DTD (Document Type Definition): Provides guidelines about how specific elements in a document are represented or which segments of data may coexist, or are mutually exclusive.

ebXML (Electronic Business XML): An EDI standard intended to supplant X12 and UN/EDIFACT. Based on eXtensible Markup Language (XML) and using standard Internet protocols, it is expected to lower the cost and difficulty of setting up and using EDI, thereby expanding its use to small and medium sized enterprises.

EDI (Electronic Data Interchange): A standard, structured format for exchanging business data.

Interaction Standards: Interaction standards are primarily used in business transactions. These standards address communication content and interfaces in e-business.

RosettaNet: Open e-business standards, encompassing data dictionaries, implementation framework, and XML-based business message schemas and process specifications.

SOAP (Simple Object Access Protocol): A standard for remote object invocation that uses HTTP and XML.

UDDI (Universal Description, Discovery, and Integration): Provides a registry for businesses to list themselves on the Internet. It functions as an online version of a telephone book's white and yellow pages.

UN/EDIFACT: An international EDI standard that is similar to, and based on X12. Its syntax is somewhat different from X12's but it follows the same basic principles and architecture.

WSDL (Web Services Description Language): Describes services offered by businesses, providing mechanisms for accessing these services. WSDL is used by UDDI.

X12: The X12 EDI standard defines the data structure and content for business transactions transmitted between information systems with dictionaries that specify name, length of data field, description, data type, and meaning.

Internet and Access to Scholarly Publications

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INTRODUCTION

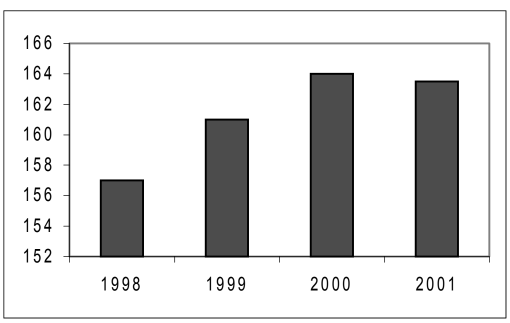
"If I have seen further it is by standing upon the shoulders of giants." The famous statement of Sir Isaac Newton demonstrates that the progress of science relies on the dissemination of discoveries and scientific knowledge. Even though scientific progress is not strictly cumulative (Kuhn, 1970), information sharing is the heart of this progress.

In the Gutenberg era, researchers had no alternative: Publishers were the only way to reach readers. The development of e-commerce and of digital networks led to the post-Gutenberg era, and offers a powerful alternative that can lead in the long term to a new organization of scientific publications (Harnad, 1999). As well as e-commerce is revolutionizing the distribution of cultural goods (particularly music), the distribution of scientific knowledge through the Internet should contribute to the emergence of a new economic model.

BACKGROUND

The growing complexity of modern science induces a growing need of knowledge-dissemination media. The number of academic journals is very difficult to estimate, but according to "Ulrich's International Periodicals Directory" (http://www.ulrichsweb.com), there were about 164,000 scientific periodicals in 2001 in all disciplines (see Figure 1).

Figure 1. Number of periodicals (thousands) published worldwide from 1998 to 2001 (Source: "Ulrich's International Periodicals Directory")



The largest publishers like Elsevier-Reed, Blackwell, or Wiley own most of these journals. Over the last 20 years, commercial firms—especially the largest ones—have raised prices at a rate that cannot be justified by cost or quality increase (McCabe, 2000). The evolution of the median cost of serials is summarized in Table 1; it is now 3 times higher than it was in the mid-'80s.

Former president of the University of California, Richard C. Atkinson, recently stated, "University librarians are now being forced to work with faculty members to choose more of the publications they can do *without*" (Atkinson, 2003, p. 1). As a consequence, in the USA, Figure 2 shows the following.

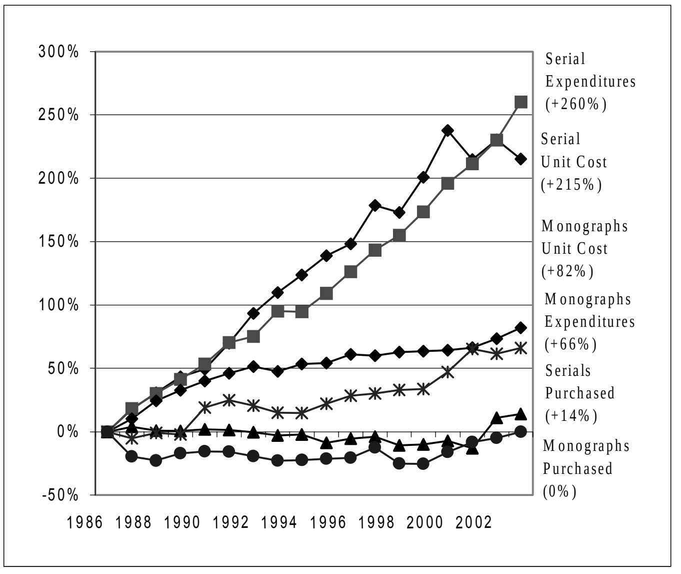
1. Acquisition expenditures have tremendously grown.
2. Part of the budgets had to be reallocated from monographs to journals.

The rise of journal prices has multiple origins, one of the most important being provisions to invest in electronic publications (Chartron & Salaun, 2000). The electronic publication, which should reduce costs, is now a source of cost increase. These provisions are nevertheless insufficient to explain the current prices. Elsevier-Reed's gross-profit margin is estimated at 32% (Wellen, 2004). Such Microsoft-like margins are very unusual and demonstrate the inefficiency of the scientific-publication market. There are four main reasons for this inefficiency.

Table 1. Evolution of the median value of serial unit cost from 1986 to 2003 (Source: Association of Research Libraries (ARL, 2004))

Year	Serial Unit Cost	Annual Percentage Changes	Cumulative Percentage Changes
1986	$ 89.77	N/A	N/A
1988	$ 117.25	10.94%	30.60%
1990	$ 134.09	4.18%	49.36%
1992	$ 173.67	13.93%	93.46%
1994	$ 200.85	6.67%	123.72%
1996	$ 222.89	3.95%	148.28%
1998	$ 245.05	-1.97%	172.96%
2000	$ 303.19	12.30%	237.73%
2001	$ 282.54	-6.81%	214.72%
2002	$ 296.50	4.94%	230.27%
2003	$ 283.08	-4.53%	215.32%

Figure 2. Monograph and serial costs in ARL libraries from 1986 to 2003 (Source: ARL, 2004)



- Researchers publish to popularize their works and to improve peers' recognition (which has a great impact on their careers). They are "giveaway authors" (Harnad, 2001) and do not receive any royalties or fees. Furthermore, they do not have to pay to access to scientific information since all the expenses are paid by academic libraries. Authors are then not concerned with the prices of journals; they only consider the reputation and the citation impact of the journals they publish in.
- The demand is price inelastic (that is, prices have few impact on the volume of the demand) since prices are not important for researchers, and journals are not easily substitutable.
- Libraries evolve on a commercial market, but do not have any commercial approach. They buy up to their budget limit and not according to any price equilibrium.
- The multiplication of mergers among publishers has strongly contributed to the increase of prices (McCabe, 2000).

Moreover, commercial publishers now have a growing aggressive commercial attitude with, for example, journal bundling that obliges libraries to buy journals they do not need if they want to subscribe to prestigious must-have journals. The Big Deal (Frazier, 2001)—an online aggregation of journals—is so expensive and restrictive that prestigious universities like Stanford or Cornell created sensation in late 2003 by canceling their Big Deal subscriptions (Wellen, 2004).

Symptomatic of this evolution, the new CEO (chief executive officer) of Elsevier-Reed previously worked in firms operating in highly competitive markets like Procter & Gamble and Guiness (Wellcome Trust, 2003).

In this context, public research institutions pay twice for scientific knowledge. They pay researchers who publish freely, and publishers to have access to journals (Anderson, 2004).

The growing conflict between researchers, who aim at disseminating their works as widely as possible, and libraries, which have a limited budget on the one hand, and publishers, who mainly have financial objectives on the other hand, gave rise to the accelerated development of the practice of open access to electronic publications. Governments concerned about research budgets are more and more interested in that movement and try to support it. At the end of January 2004, OECD ministers "recognized that fostering broader, open access to and wide use of research data will enhance the quality and productivity of science systems worldwide. They therefore adopted a Declaration on Access to Research Data from Public Funding" (OECD, 2004). One of the principles of this declaration is to promote openness, that is, open access to public-funding research.

THE OPEN-ACCESS MOVEMENT: TOWARD A NEW ECONOMIC MODEL OF SCIENTIFIC PUBLICATIONS

According to Harnad (1999), the new organization of scientific publications will be based on open access to electronic publications. Beginning with self-archiving and repositories, the open-access movement is now moving toward free electronic publications.

Self-Archiving

From the very beginning, scientists have exchanged information, consulted peers about a given idea, or tested colleagues' reactions to an innovative concept. Up to the second half of the last century, the main transmission tool was private correspondence via postal mail. With the development of the Internet and electronic communications, informal exchanges have exploded since it is now easy and very common to contact a researcher by e-mail to ask him or her for a copy of a given work.

In order to ease informal exchanges and to increase their visibility, many researchers have used the Internet for a long time to self-archive their works, that is, to make either preprints (before refereeing) or postprints (after refereeing) available on their own (personal or institutional) Web site.

Due to the pressure of the open-access movement, the copyright policy of journals and publishers has changed a lot over the last years. Project RoMEO (Rights Metadata for Open Archiving, http://www.lboro.ac.uk/departments/ls/disresearch/romeo/) lists publishers' copyright-transfer agreements. Figure 3 shows that 83% of the 10,673 journals listed in September 2004 now accept at least preprint archiving. This percentage was only 55% in 2003.

Self-archiving undoubtedly increases visibility but, since these archives can only be found through usual search engines, their access is very difficult without the knowledge of the existence of a given work.

Repositories

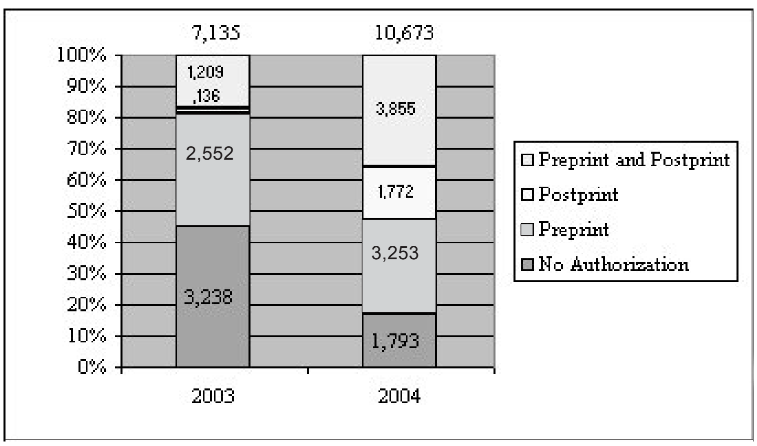
The success of self-archiving and the difficulty to find self-archived works led Paul Ginsparg, then physicist at the Los Alamos National Laboratory, to initiate in 1991 the *arXiv* archives (http://www.arXiv.org). It aimed at centralizing and easing access to free electronic publications by asking researchers to archive their works in *arXiv*. With such tools, publications are no longer dispersed among many Web sites and are available at once. There are now more than 300,000 articles in *arXiv* with a submission rate of about 3,500 papers per month.

Following this pioneer, other high-level archives emerged. Some of the most important being the following.

- **Cogprints** (http://cogprints.ecs.soton.ac.uk) specialized in cognitive sciences.
- **PubMed Central** (http://www.pubmedcentral.gov/) specialized in life sciences.
- **Repec** (http://www.repec.org/) and **WoPEc** (http://netec.mcc.ac.uk/WoPEc.html) specialized in economics.
- **Math-Net** (http://www.math-net.org/) specialized in mathematics.
- **NCSTRL** (http://www.ncstrl.org/) and **CiteSeer** (http://citeseer.ist.psu.edu/) specialized in computer science.

The development of repositories and self-archives led to a standardization need, and the proliferation of repositories induced the need of services permitting search across multiple repositories. Repositories also

Figure 3. Evolution of journals' self-archiving policies from 2003 to 2004 (Source: Project RoMEO)



needed capabilities to properly identify and copy articles stored in other repositories (Lynch, 2001). These needs, identified by Herbert van de Sompel, led to the Open Archives Initiative (OAI, http://www.openarchives.org), initiated by P. Ginsparg in 1999 with The Santa Fe Convention of the Open Archives Initiative. The Open Archives Initiative designed specific metadata tagging standards to make archives easily harvestable. Even though the Open Archives Metadata Harvesting Protocol is mainly used by free repositories, it is also employed by servers housing commercial products (the term open refers to the technical architecture, not to free contents).

Specific directories like OAIster (http://www.oaister.org) or Eprints.org (http://www.eprints.org) now provide lists of OAI-compliant archives. This initiative has known tremendous success, notably because the implementation of a repository is technically relatively easy (Crow, 2002). In February 2005, OAIster managed more than 5 million records originated from more than 400 institutions.

Online Journals

Considering the success of e-commerce and e-distribution, a great deal of publishers has decided to make their journals available online. Apart from their usual paper editions, these journals try to improve their diffusion and reputations.

Some publishers or institutions also decided to adopt a more radical solution, that is, purely electronic journals. Considering the prices of printing and postal diffusion, electronic publications can reduce the cost of journals (Wellcome Trust, 2003). Publishers only have to support the organization of the review process and the cost of diffusion tools (software and hardware).

Access to electronic articles originated in classical or electronic journals is usually reserved to subscribers, but a growing number of them are now free on certain conditions (such as time-delayed release). In February 2005, the *Directory of Open Access Journals* (http://www.doaj.org) listed more than 1,400 journals in all disciplines.

One of the reasons of the growing success of open-access journals is that open-access articles have a greater citation impact than others. Studying 119,924 conference articles in computer science and related disciplines, Lawrence (2001) found that the number of citations of open-access articles was 2.6 times greater than the number for off-line articles. A recent study based on the ISI CD-ROM citation database concluded that for the year 2001, the citation impact in all physics fields was 5.5 times higher for open-access articles (Brody, Stamerjohanns, Vallières, Harnad, Gingras, & Oppenheim, 2004).

The Search for a New Economic Model

The transition to electronic journals reduces the costs but is of course insufficient to economically validate the open-access model. Apart from subsidy-based free journals, a growing economic model is based on the payment by the authors' institutions. An author-paid model is substituted for the classical subscriber-paid system.

A recent study by the Wellcome Trust (2004) tries to compare the costs of classical subscriber-paid journals and electronic author-paid journals. The results are summarized in Table 2.

The structure of fixed costs is similar for both types of journals (editorial costs, review costs, articles preparation, etc.), but fixed costs are estimated higher for author-paid journals because they have to cover the administration of the charging system to authors. Variable costs differ since the marginal cost of electronic distribution is very low. According to Wellcome Trust (2004, p. 4):

In terms of costs of production, system costs and the implication of those for levels of fees, the author-pays

Table 2. Estimates of journal cost: (a) Eight articles reviewed for each article accepted; (b) Two articles reviewed for each article accepted (Source: Wellcome Trust, 2004)

Cost Element	Subscriber-Paid Journal Cost in U.S. $		Author-Paid Journal Cost in U.S. $	
	Good to High Quality Journal[(a)]	Medium Quality Journal[(b)]	Good to High Quality Journal[(a)]	Medium Quality Journal[(b)]
First-Copy Costs per Article	1,500	750	1,500	750
Fixed Costs per Article	1,650	825	1,850	925
Variable Costs per Article	1,100	600	100	100
Total Costs per Article	**2,750**	**1,425**	**1,950**	**1,025**

model is a viable option. Open-access author-pays models appear to be less costly and to have the potential to serve the scientific community successfully.

One of the first author-funded journals was the *New Journal of Physics* (NJP) launched at the end of 1998 (Haynes, 1999). This journal requires authors of published papers to pay a publication fee of £300. The beginnings were difficult since online journals were not considered as 100% serious, but NJP is now ranked 14 of 68 titles in the physics-multidisciplinary category of ISI's *Journal Citation Reports* (Haynes, 2004).

The most prestigious initiative yet is that of the Public Library of Science (PLoS, http://www.plos.org) founded in October 2000 by Nobel Prize recipient Harold E. Varmus, Patrick O. Brown from Stanford University, and Michael Eisen from the University of California, Berkeley. They received a $9 million grant from the Gordon and Betty Moore foundation and launched a high-level journal, *PLoS Biology*, in October 2003. *PLoS Biology* charges authors about $1,500 per accepted article, but, thanks to an equalization system, publications in *PLoS Biology* can be affordable for any laboratory in developing countries (Delbecq, 2004).

The NJP as well as *PLoS Biology* do not cover their direct costs yet with author fees and strongly rely on subsidies. The NJP should increase the number of published articles by 150%, the proportion of authors paying articles from the present 60% to 95%, and the fee from the present £400 to £600 in order to cover its costs (Haynes, 2004).

The economic model of free publications then remains to be constructed. A pure author-paid system cannot be implemented immediately. Prosser (2003) proposes a transition model in which journals would give authors two options.

- To pay for publication and the article will then be freely available.
- Not to pay for publication and the article will only be available to subscribers.

According to Prosser, the numerous advantages of open access, particularly in terms of visibility and citation frequency (Harnad, 2004), should lead to a growing share of author-paid articles.

Prosser's model as well as the propositions of the Open Society Institute (Crow & Goldstein, 2004) remain to be validated. No open-access journal covered its fixed costs yet, and the solutions to bring them to financial equilibrium are still to be invented. Furthermore, the open-access model undoubtedly has undesired effects.

- Many scientific societies live on their publications. These nonprofit organizations use the publication incomes to finance conferences or scholarships. The development of open access could threaten their activities.
- By succeeding, the open-access movement may threaten the largest publishers. They should be tempted to concentrate their publications on core collections. Loosing economies of scale from successful publications, the cost of marginal highly specialized journals could explode (Okerson, 2003).
- The author-paid model could result in a simple shift from library subscription to research budgets. In 2003, Duke University published about 4,500 papers. If authors had paid $1,500 per article, the total cost of $6.75 million would have been close to the current budget for journals, which is about $6.6 million (Guterman, 2004).
- Author-paid journals will inevitably be tempted to accept a growing number of articles in order to cover their fixed costs; the global quality of these publications could then decrease.
- Authors who do not have the budget to finance a publication might look to think tanks and corporations to find extra funding. These scientific works will paradoxically be more influenced by political and commercial agendas (Wellen, 2004).

FUTURE TRENDS

Open access is by no way a panacea. It is not economically viable yet and could have important undesired effects. Nevertheless, the pressure induced on commercial publishers is now very high and they no longer can ignore this movement. It is now very difficult to imagine that in a decade or more, commercial publications will disappear and be replaced by free publications, but the open-access movement will undoubtedly brake the exploding dynamic of prices. The future equilibrium will inevitably associate commercial and open-access publications, opening the way toward a more efficient market of scholarly publications.

CONCLUSION

The *Journal of Comparative Neurology* costs $18,000 a year; *Brain Research* costs about $21,000 and *Nuclear Physics A* and *B* more than $23,000 (Guterman, 2004). Such exploding prices explain the growing conflict between academics and publishers. The development of the open-access movement is then not the mere consequence of the diffusion of the Internet, but also a clear symptom of the inefficiency of the current market. The debate on free publications remains very passionate and is not always rational, but its great merit is to raise an important issue. By modifying the balance of power between researchers and publishers, the success of the open-access movement and the development of e-commerce and e-distribution will ease scientific knowledge dissemination, reduce the information gap between wealthy and low-budget institutions, and help the advent of an efficient market.

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KEY TERMS

Big Deal: Online aggregation of journals offered by publishers. Big Deal can oblige libraries to subscribe to marginal journals to have access to must-have journals.

Metadata Tagging Standards: Standard format of keywords used while self-archiving to identify, classify, and retrieve the archived works.

OAI-PMH: The Open Archives Initiative Protocol for Metadata Harvesting provides a standard framework for metadata harvesting.

Open Access Journals: Freely available online scholarly journals. Some of them are purely electronic journals, and others are classical ones offering a free electronic version (http://www.doaj.org).

Open Archives Initiative: Initiated by the American physicist P. Grinsparg in 1999, the OAI designed metadata tagging standards (http://www.openarchives.org).

Postprint: Scientific work modified after peer review.

Preprint: Scientific work before peer review.

Public Library of Science: Organization founded in October 2000 committed to make scientific literature a freely available resource. Nobel Prize recipient Harold E. Varmus is cofounder and chairman of the board of PLoS (http://www.plos.org).

Repository: Database where researchers self-archive their works, either preprints or postprints. The Open Archives Initiative proposes standards to allow access to different repositories.

Self-Archiving: Consists of depositing researcher works in a repository. The researcher is generally responsible for the format of the deposit and particularly for its conformance to the archive standards.

Category: Dot-Com Experiences

Internet in a Commodity Mining Company

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BACKGROUND OF THE BUSINESS

On August 16, 1999, the world's first Internet commodity exchange-traded metals sale took place when WMC, an Australian resources company, sold five tons of cobalt at $18.25 a pound. Some metal traders had been buying and selling steel through Web sites, however, commodity exchange-traded metals had lagged behind the steel industry in the use of e-commerce, with most nonferrous companies and exchanges offering only information on products and services through the Web while continuing to trade using standard processes. WMC had introduced electronic commerce to one of the world's oldest industries and became the first metal producer to use the Internet to support the marketing of nonferrous metals. This was only the beginning for WMC.

In the mid- and late 1990s, high-technology e-stocks boomed. There were excited discussions about a new economy that was commonly presumed to be immune to the cyclical problems that confronted the resource sector. As the resource shares were declining, commentators were talking about an Internet gold rush. A new-economy gold fever had gripped investors. Mining companies were treated as relics of an old economy. They were seen as old-economy companies using rusting-edge practices that reflected their dinosaur-sized machinery. It seemed inconceivable that a mining company could sell a larger tonnage of product over the Internet than Amazon.com and make a profit that Amazon had not yet achieved.

DESCRIPTION OF THE BUSINESS

WMC was Australia's third-largest publicly listed resource company.[1] Established as an Australian gold-exploration and -mining company in 1933, WMC Limited became a major global minerals explorer and producer with business interests in 16 countries. It had four competitive and world-class core businesses: copper and uranium, alumina, nickel, and fertilizers. The 2000 annual report (http://www.wmc.com.au) recorded 3,483 employees, and with contractors, the total number of staff was 5,212. At the end of the 2001 financial year, it had a market capitalization of approximately $10 billion.

Selling Cobalt in the New Economy

In 1999, Peter Johnston was 4 years into his role as executive general manager of WMC's nickel division and was frustrated with a problem endemic to the world cobalt market. The Metals Bulletin, a London mining magazine, had for decades provided the only publicly posted cobalt price. However, the published price was rarely current when a deal was done so the cobalt market lacked transparency and as a result pricing was an issue. Then London-based marketing executive Roger McSweeney presented Johnston with a "brainwave," a radical suggestion to sell cobalt over the Internet. The mining sector, mired in tradition, had not embraced e-commerce. Initial discussions had started on developing e-marketplaces for suppliers to the industry, but these had not progressed.

It was the result of a recent restructuring that placed Johnston in the joint role of head of WMC's nickel division as well as head of information technology, which enabled informal discussion about the advantages of Internet enabling WMC's business practices to occur. There was a volley of e-mails between WMC technology experts in Perth and senior executives in different parts of the world, and buoyed with the assurance "We can do it in 4 weeks," Johnston decided to champion the idea. He felt that the project had little strategic risk as cobalt was a niche market for WMC. In 1999, they produced only 700 to 800 tons a year as a nickel by-product.

Internet selling of commodity items was common in other industries, so it was quickly decided that it was technically feasible and that a viable pilot could be mounted for $100,000. Overcoming mild skepticism by Hugh Morgan, WMC's CEO (chief executive officer), it was decided that this initiative could be accomplished in a short time frame and might offer WMC some strategic advantage. The decision was made to test cobalt sales on the Internet. Within days of posting cobalt on a hastily created Web site, WMC not only sold all the cobalt it was offering, but had also increased its customer base. Customers who had previously dealt with metal brokers were now dealing directly with WMC.

Is There Any Money in This?

Starr (2003) considers the operations-management aspects of e-business from a retailing perspective. In order to do this, he has considered the cost of B2C (business-to-consumer) Internet operations and used Webvan as a case study, in which the operating costs simply precluded that company from achieving a break-even point, leading it to bankruptcy. While very many companies were burning cash fast on their e-initiatives, WMC was moving forward with sensible business strategies that made use of these Internet technologies.

Like many mining companies, WMC was dominated by strategies that aim to enhance cost efficiency. Competition in such commodity markets is traditionally seen as being based on cost. However, the Internet pilot quickly led to an expansion in WMC's strategic thinking. Senior management rapidly realized that the Internet created an opportunity for a resource company to differentiate on customer service. This customer-service focus also minimized the historical role and cost of intermediaries. This insight gave birth to what WMC was later to call its e-WMC initiative. At this stage, a full e-strategy was not formulated, but it soon emerged organically. The first step in this growth was Johnston's realization that one Internet success could be followed by another.

Four weeks after the first cobalt Internet sale, WMC posted its surplus nickel on the Web site and had a similar response. In 1999, WMC was selling about 60,000 tons of nickel a year under long-term contracts and an additional 10% to the on-the-spot market. WMC was also getting up to 3% more for the nickel sold on the Internet than nickel sold to a metal trader. The degree of success of the WMC Web site, particularly with North American customers, came as a surprise. It also surprised the entire metal world, and WMC was quick to take advantage of this success. The opportunity was not only to sell products to customers more efficiently, but also to change the nature of its customer relationships.

There was little downside to the initiative. The London Metal Exchange (LME) was supportive because WMC used it for benchmark prices, and 90% of its business is in trading financial derivatives anyway. WMC's customers were very happy because Internet-sourced sales cut transaction times down to about a minute since availability, pricing, and shipping details that had formerly been negotiated over the phone could now be posted online. However, metal traders who brokered the transactions for the on-the-spot market, and had previously been paid commission on these transactions, were not as happy. They were being disintermediated.

Initially, it had been assumed that long-term contractual customers would not be interested in using the Internet. This assumption was soon proved wrong. Long-term contractual customers started to use the Web site to top up their requirements and to make requests for additional information. By 2000, this pilot project had caused a change in WMC's strategic thinking. The new strategy was to gain leverage from an initiative started 5 years before.

Getting Ready without Really Knowing It

In 1995, WMC started an information-integrity program. At the time there was no indication that 5 years later this initiative would become a key building block of its e-commerce strategy. The program used an SAP platform to establish a standard system and consistent language for the management of information within WMC. Unlike many mining companies, it would remove a host of legacy systems that had been used in different locations, businesses, and countries worldwide. SAP was chosen to be the common platform across all its operations worldwide.

In September 1996, WMC started the implementation of its information-integrity program group-wide. The aim was to implement standard processes throughout the entire group underpinned by SAP. Even while it was being installed, WMC was able to cut its level of inventory and gain a better understanding of the operations of its plant and equipment. One of the earliest advantages was the consolidation of the group's contracts with various suppliers.

Like many organizations, different divisions within WMC used disparate information systems. This presented problems in product ordering and inventory control since the systems at each of the sites coded inventory in its own manner. This effectively guaranteed that an integrated overview of inventory throughout the group was next to impossible. The advantages from being part of a group were not being realized. Not only did WMC realize stock control and inventory efficiencies with a central inventory-management system for the entire group, it also centralized stock ordering and received direct financial savings. Its inventory-management flexibility also improved the movement of goods between WMC's Australian sites since the common system automatically updated values in the financial-accounting, asset-accounting, and control databases.

Through SAP, ERP (enterprise resource planning) was seen as having the potential to be a key building block for WMC's e-commerce strategy. In early 2000, it was unclear how the pieces of this e-commerce strategy jigsaw would come together, however by 2001, what would be called e-WMC was beginning to take shape.

e-WMC Customers

Rotondaro (2002) points to the importance of understanding the clients' or customers' expectations in designing the offer, particularly the e-business offer. This applies to both B2C and B2B (business-to-business) applications and focuses on the items that create and satisfy customer satisfaction.

The e-WMC initiative applies Internet technologies to facilitate business between WMC and third parties. It allows collaboration with customers and suppliers to achieve specified business objectives such as reducing administrative costs and extending the opportunity for supplier participation. In the area of sales and marketing, WMC recognizes that the Internet is a major tool in communicating with the marketplace, strengthening relationships with existing customers and helping to form relationships with new customers.

The e-WMC initiative started with the Cobalt Open Sales System (COSS) Web site in mid-1999. Subsequently, it established the Nickel Internet Marketing System (NIMS), the Copper Sales Information System (CopperSIS), and an Internet tendering site, and it was also one of the founding companies of the metals and mining procurement initiative Quadrem (http://www.quadrem.com).

From its trial in August 1999, the Cobalt Internet sales site developed into WMC's COSS to provide customers worldwide with quick and easy access to its cobalt product and prices. The current availability for WMC's products is updated daily. The provision of a spot market for small sales had resulted in continued premium prices for WMC. By 2002, this site had emerged globally as a leading cobalt price indicator and industry reference.

Similarly, the nickel Internet site matured into the NIMS. The site aims to provide buyers with quick and easy access to the availability and premiums for WMC's refined nickel products by location. Through NIMS, WMC is able to actively participate in the on-the-spot and near-term nickel market, and to expand its nickel customer base by reaching nickel consumers worldwide via the Internet. It is able to post details of product type, quantities available, and premiums by location.

WMC's CopperSIS was commissioned in June 2000. The strategy behind CopperSIS is to offer customers information instantaneously that is of value to them while at the same time reducing transaction costs for WMC and the customer. CopperSIS enables customers with direct access to real-time data affecting their own copper deliveries 24 hours a day, 7 days a week, overcoming time-zone constraints. Access to CopperSIS is restricted to WMC's current copper customers and controlled via individual user-name and password protection.

The aim of CopperSIS is to provide WMC's copper customers access to their own contracts, and delivery, shipping, and billing records live from data stored within WMC. CopperSIS also provides online availability of uncommitted spot copper quantities to the existing customer base, LME pricing records, and copper-industry news stories supplied by Reuters. This site allowed WMC to leverage the capabilities of WMC's SAP system. WMC's experience with CopperSIS, especially how it can integrate its e-WMC strategy with its information-integrity initiative, became a key building block for its next development in e-business.

During 2001, as part of WMC's growing e-capability, its fertilizer business also made significant progress with two e-business projects. The first was creating a new WMC fertilizer Internet site. This site supports the Queensland Fertilizer Operations (the wholesale sales group), the Aussie Gold product range, and HiFert (the retail sales group). The customer-management system provides a secure portal that enables wholesale customers to

- view product specifications,
- view current product prices,
- update demand forecasts,
- view current delivery plans, and
- view live contract, order, delivery, and billing information from WMC's SAP system.

The second project is an online system for HiFert agents to enter orders directly into WMC's system. This will eliminate the need for HiFert personnel to manually enter orders from some 100,000 faxes a year. Completed in December 2001, the system was rolled out to 60 agents in 2002.

E-Procurement in the Mining Industry

Cagno, Di Giulio, and Trucco (2004) point out procurement savings through e-procurement to be worth 7 to 10% of cost reduction in overall purchasing costs. They also point out that this can represent 60% of the company's annual revenue as a saving. The procurement is, according to Cagno et al. (Cagno, 2004, p. 25), "[l]ikely to lead to profound restructuring of operational practice and management of internal processes."

In the late 1990s, the metals industry, along with many other industries, saw the opportunities that e-commerce could provide. At this time there was also plenty of venture capital to back e-commerce ventures, which led to the establishment of several metal-trading sites spanning from copper to steel and offering different grades of metals. Since then, quite a few online ventures have closed down due either to a lack of funding or to a lack of trading volume.

Aluminium.com, which specialized in the online trading of all grades of aluminum, closed operations in June 2001 after its venture capitalist Divine InterVentures stopped funding. MetalSpectrum, an online marketplace for aluminum, stainless and carbon steel, copper, brass, and other specialty metals, was launched in May 2000 with the financial backing and participation of several leading metal-industry companies. Reasons given for MetalSpectrum's failure were market conditions and slow user adoption.

WMC was one of the 14 founding shareholders of Quadrem, also known as the Mining and Metals Procurement Marketplace. In 1999, this market was estimated to be worth $200 billion. The Web site provides product search, requisitioning, order tracking, tendering, contract options, and data warehousing, as well as sophisticated and consolidated management of contracts and logistics.

Carter (2003) has suggested that innovations that are made possible via e-commerce have led the industry to substantially embrace more efficient e-business-based practices. He points to the success of Quadrem, which is a global e-marketplace for the natural resources sector transacting more than $1.5 billion of business in 2003 and involving 1,800 trading partners with an annual growth rate of 30% in the past year. Quadrem involves 3,500 suppliers and a large number of mainstream mining procurement activities.

The original vision of the Mining and Metals Procurement Marketplace was to create a platform to bring together mining, metals, and minerals producers and suppliers in more than 100 countries, and to provide unrivaled access to procurement sources worldwide. The Mining and Metals Procurement Marketplace was to be a global, Internet-based marketplace that delivers procurement solutions to the mining, minerals, and metals industry. It aimed to reduce costs and improve efficiencies across the supply chain while simultaneously eliminating the costs inherent in proprietary or disparate information technologies. Similar to Aluminium.com and MetalSpectrum, the goal of the Marketplace, as it was then called, was to generate sustainable value for all participants through streamlined transaction and business processes.

In June 2000, Accenture was selected as the launch phase consultant, and 35 senior executives were seconded to Los Angeles from Quadrem's 14 foundation organizations to start buyer outreach efforts. In July 2000, they undertook a global technology review, and in August 2000 selected Commerce One and SAP as the preferred technology vendors and begun building the e-marketplace platform in September of that year. The Mining and Metals Procurement Marketplace initiative spurred Commerce One and SAP to form a strategic partnership in September 2000, whereby SAP would use Commerce One technology and integrate it into its enterprise software. In October 2000, the Mining and Metals Procurement Marketplace initiative changed its name to Quadrem. Some commentators thought that with the change of the name, the concept had gone the same way as Aluminium.com and MetalSpectrum.

Mackay, Altmann, and McMichael (2003, p. 51) suggest that the "dominant form of adoption of E business strategies is to be found in the business to business forms of e-commerce." They point to the importance of customer relationships and customer intimacy through the sharing of information and stock replenishment practices as important factors in Australia's development of e-commerce strategies. WMC was clearly approaching e-business to achieve both marketing and procurement advantages.

In 1999, Quadrem's aim was highly ambitious: to have 2,500 suppliers worldwide by the end of 2001. Although the early targets proved overly optimistic by April 2002, there were 1,050 signed suppliers and 21 buying organizations. A number of suppliers joined Quadrem because their existing customers were some of the 14 founding members. Suppliers were concerned by about reverse auctions or group buying on Quadrem.

WMC has used Quadrem, which had cost it about $20 million by the middle of 2001, to increase data accuracy and reduce transaction, inventory, and associated costs. It has also improved sourcing and logistics, and reduced the cost of inputs such as chemicals, commodities, and services. With the increasing integration of Quadrem with its SAP ERP system, WMC can place an order in its in-house system and route it through Quadrem, and then the supplier can pick up the orders from its company mailbox on the site. However, often suppliers still process their orders manually.

WMC is increasingly using Quadrem for sourcing supplies for major capital projects. This can represent 20 to 30% of their annual purchases. Part of their procurement savings has come through the standardization of mining components by the Quadrem shareholder group. It has enhanced communications and knowledge sharing among the Quadrem shareholder group, its employees, and the market participants.

In addition to Quadrem as a procurement channel, WMC also has its own online tendering site to provide suppliers with online access to information regarding future tenders, current open tenders and expressions of interest, and tenders that have been closed and awarded. The site aims to facilitate the tendering process by ensuring that information and tender documents are available immediately, submissions are made online, and the processing time of retrieval, evaluation, and notification of tender awarding is reduced.

WMC's Next Steps

WMC has continued to develop its Web-based capabilities and further integrate customers and suppliers into its business, aiming to take out costs and create customer value. SAP, which has been seen as a traditional ERP company, and Commerce One, which has been an e-procurement and marketplace-building specialist, have had a long association with WMC: SAP since 1995 as part of WMC's information-integrity initiative and Commerce One as a consultant on its Internet sites. Since 2000, both Commerce One and SAP were also preferred technology providers to Quadrem. As a result of Quadrem and other projects, SAP and Commerce One have developed Enterprise Buyer Professional, a high-end procurement application, though some commentators are concerned about the long-term viability of this relationship. As SAP expands its interest in e-procurement integration, it is enabled to overcome problems that have confronted ERP companies.

WMC's SAP e-procurement goes beyond simple catalog ordering to automating all stages of a business transaction over the Internet for both ad hoc and strategic purchasing. Business intelligence tools help to optimize procurement policies and strategies, and provide a strong basis for negotiating with suppliers. By automating the entire procurement cycle from requisition to payment, WMC will reduce the cost of goods procured as well as processing and production costs while also increasing purchasing efficiency. This will occur because fewer employees will be required to check and process invoices. WMC will also be able to consolidate contracts with vendors, negotiate lower prices, and cut the paperwork required for orders, as well as reducing order lead times.

With the adoption of Enterprise Buyer Professional, WMC will be able to build on its existing SAP systems, which are integrated worldwide, and extend its existing e-commerce capabilities, including the following:

- **Streamlined procurement.** Users can automatically generate and approve purchase orders using the robust work-flow engine and reconcile purchase transactions with accounting in real time.
- **Strategic sourcing.** Users can centralize contract management to support global purchasing activities and to manage strategic suppliers. Purchasing departments can automatically implement global purchasing agreements while the execution of day-to-day procurement responsibilities shifts to employees, simultaneously increasing purchasing power and reducing procurement costs.
- **Competitive online bidding.** Users can solicit competitive bids from new and established suppliers anywhere in the world, enabling companies to obtain the highest quality goods and services at the lowest prices.
- **Sophisticated integrated analytics.** Extensive reporting capabilities, such as monitoring and analyzing vendor and cost-center trends, allow for more effective negotiation of agreements and the rapid adjustment of buying patterns.
- **Integration of buying and selling sites.** The real-time integration of buyer-side and seller-side applications allows users to manage every step in the requisition-to-payment process from within a single, Web-based environment.
- **Mobile access.** This function allows the strategic procurement of goods and services from almost any mobile device.

LESSONS LEARNED

WMC's 1999 Internet cobalt sale success developed its belief that discovering and developing market opportunities for its businesses was a way of adding value. Like many mining companies, WMC was dominated by strategies that aimed to enhance cost efficiency. Competition in such commodity markets is traditionally seen as being based on cost. However, the pilot quickly led to an expansion in WMC's strategic thinking. WMC realized that the Internet created an opportunity for a resource company to differentiate on customer service. This customer service focus also minimized the historical role and cost of intermediaries. The Internet, if used well, could enhance both its customer-service focus and also its cost efficiency. This insight gave birth to what WMC would call its e-WMC initiative. No full e-strategy was formulated at that stage, but it quickly emerged organically and was able to build on an earlier data-integrity initiative.

WMC aims to broaden the geographical spread of sales by ensuring that it is a preferred and preeminent supplier, providing excellent service and quality products. It also believes the most successful companies will be those that effectively leverage the Internet to automate, streamline, and integrate their business processes to enhance customer relationships. As part of its cost efficiency strategy to position unit-production costs in the lowest quartile, WMC is building and using Internet-based communication systems to improve operational performance, reduce costs, and create new value for stakeholders. Nevertheless, it is conscious of cost efficiency and has set itself with the ongoing task of conducting rigorous reviews to determine which of the rapid technological developments in e-business delivers real benefits.

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KEY TERMS

Disintermediation: Going around a player in a supply chain, as in rendering that player redundant.

E-Procurement: Using the Internet and related technologies to facilitate procurement.

E-Strategy: The use of the Internet and related technologies to add power to or reconfigure a business strategy.

Intermediary: A party that acts as an agent in transactions or markets.

Old Economy: The economy from before, or not using the Internet and related technologies to exchange information or value.

Portal: Way of entering into an Internet site.

Procurement: Arranging for the supply and purchase of goods or services.

ENDNOTE

1. It has since split into two separately listed entities: WMR and Alumina.

Category: Concepts, Trends, and Challenges

Internet Pharmacies

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INTRODUCTION

The advent of Internet technology has affected the pharmaceutical industry in at least two ways. First, *existing* companies have implemented Internet solutions for efficiency and performance reasons. These solutions may convey benefits across the entire manufacturer—wholesaler—pharmacy supply chain (e.g., inventory tracking and management), or focus at one level (e.g., providing customer information from a pharmacy Web site). Second, *new* businesses have been established to capitalize on the opportunities made possible by Internet technology. The new businesses may be related to others, as in the case where storefront pharmacies have established online companies to expand their market scope.

Two other new business types represent more radical change and are controversial. The first uses the Internet to deliver information about specific drugs through spam (unsolicited commercial or bulk e-mail). Relatively little is known about such pharmacies, although they account for a large and growing proportion of all spam (PRWeb, 2004). They often promote dubious products and cures, may not require a prescription, and actual delivery is not assured (Barrett, 2001). Some customers buy from such pharmacies in spite of these problems. Because there is a dearth of research on pharmacies using spam, and given that their ethics and standards are at best highly questionable, they are not considered here.

A second type of pharmacy has gained prominence since 1999. The Internet pharmacies in question are start-ups that operate wholly online and have no connection to existing pharmacies. For the most part, these Internet pharmacies export prescription drugs from a lower cost country to one or more where higher costs prevail. In North America, many Internet pharmacies have sprung up in western Canada to supply drugs to U.S. consumers. International trade in prescription drugs is also seen elsewhere, again motivated by different price levels.[1] The North America experience is discussed next.

Canadian Internet pharmacies have achieved success since 1999, but face an uncertain future. Their emergence is traced below and the major points of controversy identified. The analysis reveals that the application of Internet technology in these pharmacies was quite straightforward. More problematic is the complex, political environment in which Internet pharmacies operate, and the fact that the strategy adopted challenges established legal and ethical standards. These issues are addressed in the final sections where the future of Internet pharmacies is examined.

BACKGROUND

When price differences exist between markets, new supply channels sometimes emerge to exploit the opportunity. This practice is labeled "gray marketing" or "parallel trade." This section begins by defining these terms and explaining why price differences for prescription drugs exist between Canada and the United States. Then attention turns to the exploitation of these price differences through technology. Canadian entrepreneurs have combined Internet and other technologies to enable U.S. customers to buy their prescription drugs in a simple, efficient and secure manner.

Pricing Differences

Gray marketing involves the selling of trademarked goods through channels of distribution that are not authorized by the trademark holders (Duhan & Sheffert, 1988, p. 76). In order for gray markets to work, there must be a source of supply, easy access from one market to another, and sufficient price differentials to make the business profitable (Eagle, Kitchen, & Rose, 2003). Gray marketing is a growing problem in many industries and locations (Mathur, 1995), imposing costs on the affected parties, including a dilution of exclusivity, free riding, damage to channel relationships, undermining segmented pricing schemes, reputation, and legal liability (Antia, Bergen, & Dutton, 2004, pp. 65-66). Parallel trade is the term frequently used when gray marketing is international in its scope.

Prescription drugs lend themselves to gray marketing/parallel trade. For the most part, they are readily available, ship easily, and are priced differently in proximate markets. North America provides a good example of this situation. The drugs on sale in Canada are essentially the same branded products as those offered in the United States. The high value-to-weight ratio means that distribution of the product is straightforward. In fact, many of the prescription drugs available in Canada are manufactured in the United States and shipped to Canadian wholesalers for onward distribution to pharmacies. Yet Canadian and U.S. prescription drug prices vary significantly. This results from different regulatory regimes. In the US, drug manufacturers are essentially free to set their prices without interference from government. In Canada, governments influence prices. At the federal level, the Patented Medicine Prices Review Board (PMPRB) ensures that drug prices charged by manufacturers are not excessive. In 2001, PMPRB reported that drug prices were 69% higher in the United States than Canada (Gross, 2003). Canadian provinces also influence prices through a formulary, which list drugs that are reimbursable under Pharmacare programs.[2] In this way, provinces provide incentives for pharmaceutical companies to set prices at levels that are financially attractive for inclusion in the formulary. Thus, the necessary conditions for parallel trade in prescription drugs—a ready supply, good access, and sharp price differences—exist in the case of Canada and the United States.

Internet Pharmacies

How have Canadian entrepreneurs capitalized on the opportunity described above to sell prescription drugs to U.S. customers? Recognizing that this would require customer change, they designed business processes to make interactions simple, efficient, and secure. E-commerce technology plays a vital role, but the fax machine, mail and courier systems are also important, particularly in the transmission of prescription and medical information and in product shipment.

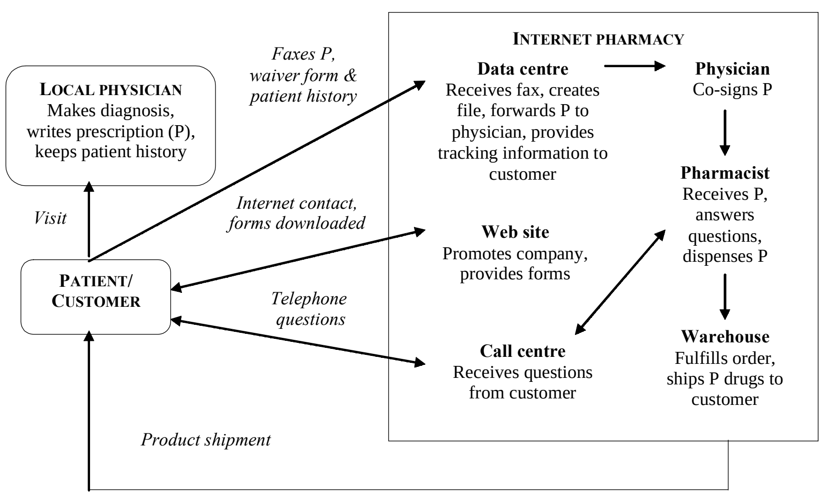
Customer contact is usually made through a Web site that provides information about the pharmacy and a searchable product database. After finding the prescription drug required and downloading the necessary documents, the customer mails or faxes a completed order form, liability waiver and prescription to the Internet pharmacy (see Figure 1). The information is transmitted from the pharmacy data centre to a physician (licensed in Canada and paid by the pharmacy) to review the information and write a Canadian prescription. This step is a legal requirement. The prescription then goes to the pharmacist to be dispensed. New prescriptions usually take two to three weeks to fill and be delivered, whereas refills take 1 to 2 weeks. Any questions are handled through the pharmacy call centre. Internet pharmacies source the drugs they sell through the normal supply chain. In other words, they purchase product from pharmaceutical wholesalers in Canada, which are supplied by multinational manufacturers.

The number of Canadian Internet pharmacies has grown from four in 1999, to 120 in 2003. The new industry is particularly associated with the province of Manitoba (55 pharmacies), with others located in Alberta and British Columbia. It is estimated that Internet pharmacies' sales to U.S. consumers in 2003 were in the $566 to $605 million range, more than twice those achieved in 2002 (Hollis & Anis, 2004).

STAKEHOLDER ISSUES

Attention now turns to the response of various stakeholders to Internet pharmacies and their parallel trade operations. Reactions of the following groups are described—U.S. customers, pharmaceutical companies, legal and political groups, medical and pharmacy bodies,

Figure 1. Prescription drug transaction process (Adapted from Janega, 2003)



and local communities. This is followed by an assessment of the current position faced by Internet pharmacies.

U.S. Customers

Although some U.S. citizens knew that it was possible to buy cheaper prescription drugs in Canada and made purchases on trips across the border, the Internet has increased knowledge and buying. The Web sites of senior citizen groups, advocacy organizations, politicians, and others, provide useful information and document the contrasting prices for prescription drugs. The Web sites of Internet pharmacies have also contributed to changed purchasing, especially among older, poorer and uninsured Americans seeking lower prices. U.S. senior citizens are reported to account for 89% of the sales of Internet pharmacies in Manitoba (Manitoba International Pharmacists Association, 2005). However, even though Canadian Internet pharmacies have expanded sales to U.S. customers sharply, this business is a small fraction of the $200 billion spent annually on prescription drugs in the United States (Hawaleshka, 2004).

Pharmaceutical Companies

The success of Internet pharmacies has provoked a strong response from pharmaceutical companies. GlaxoSmithKline plc (Glaxo) was the first to take action, arguing that imported drugs were illegal, potentially unsafe, and provided no legal recourse in the event of a problem. The company's view was that questions of drug affordability were better handled through changes to Medicare rather than by imports from other countries. Glaxo cut off supplies of its more popular drugs to Canadian Internet pharmacies that were suspected of exporting to U.S. customers (Zehr, 2003a). Other manufacturers[3] followed Glaxo's example, so that by 2004, five of the world's largest 11 pharmaceutical manufacturers had taken action against Canadian Internet pharmacies.

This response was criticized in some quarters. Noting that half of the pharmaceutical industry's sales and most of its profits were generated in the U.S., some saw these actions simply as an attempt to protect a critical market (Harris, 2003). Consumer groups, in particular, viewed the financial returns and spending of the pharmaceutical industry to be excessive (Alliance for Retired Americans, 2003). The industry defended its profit record, explaining that drug research was expensive and risky and required substantial investment.[4]

Legal and Political Groups

Technically, the parallel trade described above contravened the U.S. Food Drug and Cosmetic Act. However, the Food and Drug Administration (FDA) seldom cracked down on prescription drugs moving by mail or courier.[5] Given the discrepancy—between what the U.S. Food Drug and Cosmetic Act said, and what the FDA did at the border—U.S. customers did not think they were doing anything wrong.

The cross-border trade in prescription drugs provoked differing political responses over time. Initially, most governments and politicians saw it as a minor disruption of normal business patterns. Later, the trade was seen to be a reaction to the health care situation in the United States and, as government officials paid greater attention to this problem, Internet pharmacies gained greater prominence.

At the federal level, President George W. Bush identified Medicare as a priority item to be dealt with prior to the 2004 presidential election. Medicare does not cover prescription drugs and, given high and escalating prices, this was seen as a problem. Two similar versions of a bill to change Medicare were passed through the House of Representatives and Senate in June 2003. Effective 2006, prescription drug coverage would become available to seniors either directly through Medicare or via a private insurer (Toner & Pear, 2003). An amendment added to the bill was the Pharmaceutical Market Access Act of 2003. This was a final bargaining chip in the political maneuvering that took place towards the end of the Medicare debate. The amendment permits imports from 25 nations, including Canada. However drug import bills had been approved in the past but never implemented (Zehr, 2003b).

State and city governments were also concerned about drug prices. Medical coverage (including drugs) for the poorest Americans was provided through Medicaid, which was largely funded by states. These costs were proving very difficult to finance given the worsening budget situation of many states. States and cities also had employee and retiree benefit programs to finance. Accordingly, several states and cities were examining different ways to control drug spending, including buying from Canadian Internet pharmacies. These were difficult decisions for, while no elected official could ignore vulnerable groups (such as senior citizens and the uninsured), the drug industry was a powerful force.[6]

Health Canada is the federal government department responsible for the approval and review of drugs in Canada. Until 2004, it took no position on the Internet pharmacy issue. If there was a problem in the U.S., its position was that this should be dealt with by appropriate import regulations.

Medical and Pharmacy Bodies

The activities of Internet pharmacies were of interest to numerous medical and pharmacy bodies in Canada at both national and provincial levels, including Colleges of Physicians and Surgeons, Colleges of Pharmacists, associations representing physicians and pharmacists, and regulatory organizations. Perhaps most important were the Colleges that governed medical and pharmacy professionals. These ensured that appropriate standards of practice were maintained through functions such as policy setting, licensing, monitoring, and investigating complaints.

Pharmacy groups viewed Internet pharmacies differently. At the national level and in some provinces, the cross-border trade in drugs was felt to be illegal and raise questions of consumer safety. In other provinces, however, a contrasting view was apparent, making for a mixed response to Internet pharmacies across Canada. Some saw the response to be "soft" (reflecting a confused and conflicted position on the part of pharmacists) and "slow" (showing that associations were unable to keep pace with entrepreneurs).

Physician associations in Canada were also implicated in Internet pharmacy developments. Once again, different regulations made for a variety of responses. Generally, provincial Colleges of Physicians required that patients be examined before prescriptions could be written. In Alberta, British Columbia and Manitoba, however, any registered Canadian physician was permitted to sign a prescription. This enabled Internet pharmacies to recruit physicians to review and co-sign prescriptions for US customers quite widely.

Local Stakeholders

Internet pharmacies deliver many benefits to the communities in which they are located. In Manitoba, for example, Internet pharmacies employed 1,500 people and had annual sales of $400 million (Manitoba International Pharmacists Association, 2005). The Manitoba government strongly supported the industry, viewing it as a prime example of how innovation and entrepreneurship could generate wealth and jobs. However, others claimed that Internet pharmacies had created shortages of certain drugs locally, driven up pharmacist salaries, and hired away pharmacists from local hospitals.

Stakeholder views about Internet pharmacies are polarized. On the one hand, many U.S. customers and some pharmacists, physicians, and politicians strongly support Internet pharmacies. On the other hand, the pharmaceutical industry, as well as other pharmacists, physicians, and politicians are vocal in their opposition to the practices of these organizations. In 2004, Internet pharmacies came under increasing pressure. These developments are outlined next.

FUTURE TRENDS

The future prospects for Canadian Internet pharmacies became increasingly unclear in 2004. Several developments conspired against Internet pharmacies. The first development was strictly financial. The U.S. dollar depreciated by about 20% against the Canadian dollar over a 2-year period from January 2003. Thus, when Internet pharmacies translated their prices from Canadian to U.S. dollars, the posted drug prices were more expensive and somewhat less attractive to U.S. customers. A second development was commercial and involved supply cutbacks by pharmaceutical manufacturers. These restrictions had more impact over time as the number of participating companies grew. The restrictions meant that (a) it was harder for Internet pharmacies to source some drugs, (b) when drugs were secured from nontraditional and more distant locations (e.g., Europe and Asia) they were invariably more expensive, and (c) out-of-stock situations were sometimes experienced. A third development was the stronger regulatory stance taken by medical and pharmacy bodies, which began to censure physicians and pharmacists who did not comply with professional standards. A fourth development was that the Canadian federal government was taking a more active interest in Internet pharmacies. The initial "hands-off" stance appeared to be changing. A new Minister of Health spoke about the ethics of physicians co-signing United States prescriptions, and about the importance of ensuring adequate supplies of drugs for Canadians. The U.S. government continued to argue that parallel trade in drugs created safety risks for consumers. Officials pressed this point during President George W. Bush's visit to Ottawa in the fall of 2004.[7] By January 2005, it was reported that the Government of Canada was developing policy that would essentially close down Internet pharmacies. Whether this would involve new or changed regulations was important since the former would prove more difficult for Prime Minister Martin's minority government to enact (Associated Press, 2005).

The response of Internet pharmacies to the uncertainties of late 2003 and 2004 varied. With business proving to be more difficult, some business had closed while others consolidated their operations. The experiences of the last few years had alerted some companies to the need for contingency planning. In some cases this meant planning to source much more from overseas suppliers, while others were considering moving operations totally outside of Canada (McAfee, 2004). Some Internet pharmacies continued to believe that Canadian regulators and governments would not bring an end to an industry that employed Internet technology to satisfy the prescription drug needs of disadvantaged U.S. consumers.

A final comment deserves mention. The debate about Internet pharmacies would benefit from greater research attention. The major contributors to the extant literature are journalists and various interest groups. With the exception of a number of government reports (e.g., GAO, 2004), few attempts have been made to examine this new industry in a systematic and scientific manner (e.g., London School of Economics, 2003; Schmidt & Pioch, 2003; Yang, Peterson, & Huang, 2001).

CONCLUSION

The emergence and early development of Internet pharmacies has been traced. Price differences and Internet technology made it possible for Canadian entrepreneurs to sell prescription drugs to U.S. customers. Although Internet pharmacies have grown quickly by satisfying a need for less expensive drugs, the sustainability of their operations is in doubt. Several factors explain this situation, including the complex and political nature of the health care environment, the power of pharmaceutical manufacturers, and the fact that Internet pharmacies use a business model that technically contravenes the law and professional standards for physicians and pharmacists.

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KEY TERMS

Formulary: A list of drugs that are approved for use under a given health insurance program.

Gray Marketing: Occurs when products are sold through nonauthorized channels of distribution.

Internet Pharmacy: A pharmacy that has no storefront presence and where the Internet is a key technology for serving customers.

Medicaid: A U.S. federal and state health insurance program designed to provide access to health services for persons below a certain income level.

Medicare: A U.S. federal health insurance program designed to provide health care for the elderly and the disabled.

Parallel Trade: Occurs when a product is purchased by an intermediary in one country (at a low price) and then exported to another (high price) country.

Pharmaceutical Manufacturers: Companies that are involved in the discovery, production and marketing of substances used in the treatment of disease.

Pharmacy: A retail store where drugs are dispensed.

Prescription Drugs: Drugs that require written direction and authorization from a physician.

Spam: Unsolicited e-mail that is sent to large numbers of people to promote products or services.

Wholesaler: A business that distributes manufacturers' products to retailers (pharmacies) and other distributors.

ENDNOTES

1 Europe is a good example. Different pricing levels, proximate markets, and the European Union's "free movement of goods" policy means that cross-border sales of prescription drug have boomed. The European literature in this area emphasizes activity at the wholesale level (i.e., exporters selling to importers) whereas the North American literature focuses on retail activity (i.e., Canadian pharmacies selling to U.S. consumers).

2 Although the extent varied, seniors and social assistance recipients in all Canadian provinces received drug coverage.

3 These companies and their industry rank (by 2003 revenues) are Pfizer (1), GlaxoSmithKline (2), Merck (3), AstraZeneca (6), and Wyeth (11) (Contract Pharma, 2005).

4 High drug prices in the United States financed the research and development activities of the pharmaceutical industry. Some observers argued that by restricting prices, other developed western nations (such as Canada) were essentially "free riders" (Graham, 2003).

5 Nor did customs officers confiscate prescription drugs purchased by U.S. citizens for personal use on trips to Canada.

6 Governments competed to get drug companies to locate within their jurisdiction since their operations were viewed as "clean" and health care was expected to become a key driver of economic growth. The pharmaceutical industry also made large political donations (Harris, 2003).

7 In spite of the Bush Administration's opposition to drug imports, some state and city governments in the United States had begun doing business with Canadian suppliers. Further, should the Pharmaceutical Market Access Act of 2003 be approved by Congress, President Bush would face the difficult decision about whether to sign the bill.

Internet Search Engines

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INTRODUCTION

In the context of the Internet, a search engine can be defined as a software program designed to help one access information, documents, and other content on the World Wide Web. The adoption and growth of the Internet in the last decade has been unprecedented. The World Wide Web has always been applauded for its simplicity and ease of use. This is evident looking at the extent of the knowledge one requires to build a Web page. The flexible nature of the Internet has enabled the rapid growth and adoption of it, making it hard to search for relevant information on the Web. The number of Web pages has been increasing at an astronomical pace, from around 2 million registered domains in 1995 to 233 million registered domains in 2004 (Consortium, 2004). The Internet, considered a distributed database of information, has the CRUD (create, retrieve, update, and delete) rule applied to it. While the Internet has been effective at creating, updating, and deleting content, it has considerably lacked in enabling the retrieval of relevant information. After all, there is no point in having a Web page that has little or no visibility on the Web.

Since the 1990s when the first search program was released, we have come a long way in terms of searching for information. Although we are currently witnessing a tremendous growth in search engine technology, the growth of the Internet has overtaken it, leading to a state in which the existing search engine technology is falling short.

When we apply the metrics of relevance, rigor, efficiency, and effectiveness to the search domain, it becomes very clear that we have progressed on the rigor and efficiency metrics by utilizing abundant computing power to produce faster searches with a lot of information. Rigor and efficiency are evident in the large number of indexed pages by the leading search engines (Barroso, Dean, & Holzle, 2003). However, more research needs to be done to address the relevance and effectiveness metrics. Users typically type in two to three keywords when searching, only to end up with a search result having thousands of Web pages! This has made it increasingly hard to effectively find any useful, relevant information.

Search engines face a number of challenges today requiring them to perform rigorous searches with relevant results efficiently so that they are effective. These challenges include the following ("Search Engines," 2004).

1. The Web is growing at a much faster rate than any present search engine technology can index.
2. Web pages are updated frequently, forcing search engines to revisit them periodically.
3. Dynamically generated Web sites may be slow or difficult to index, or may result in excessive results from a single Web site.
4. Many dynamically generated Web sites are not able to be indexed by search engines.
5. The commercial interests of a search engine can interfere with the order of relevant results the search engine shows.
6. Content that is behind a firewall or that is password protected is not accessible to search engines (such as those found in several digital libraries).[1]
7. Some Web sites have started using tricks such as spamdexing and cloaking to manipulate search en-

Table 1. Search engine issues and challenges

Major Challenges and Concerns	Detail
Spamdexing and cloaking	These tricks are used by Web sites to manipulate search engines to display them as the top results for a set of keywords.
Privacy and security	Search engines index all the content available on the Web without any bounds on the sensitivity of the information.
Information explosion	The Web is growing at a fast rate, with Web pages being updated very frequently, presenting challenges to search engines to index frequently and intensely.
Categorization and representation	Search engines are facing the challenge to categorize and represent the information to the user within the top few matches. The traditional sequential listing of results is posing some challenges.

gines to display them as the top results for a set of keywords. This can make the search results polluted, with more relevant links being pushed down in the result list. This is a result of the popularity of Web searches and the business potential search engines can generate today.

8. Search engines index all the content of the Web without any bounds on the sensitivity of information. This has raised a few security and privacy flags.

With the above background and challenges in mind, we lay out the article as follows. In the next section, we begin with a discussion of search engine evolution. To facilitate the examination and discussion of the search engine development's progress, we break down this discussion into the three generations of search engines. Figure 1 depicts this evolution pictorially and highlights the need for better search engine technologies. Next, we present a brief discussion on the contemporary state of search engine technology and various types of content searches available today. With this background, the next section documents various concerns about existing search engines setting the stage for better search engine technology. These concerns include information overload, relevance, representation, and categorization. Finally, we briefly address the research efforts under way to alleviate these concerns and then present our conclusion.

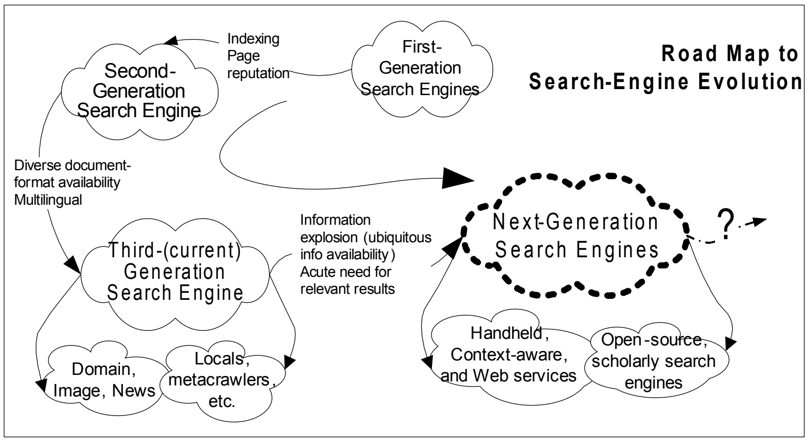
BACKGROUND OF SEARCH ENGINES

Search engines have developed from just being research projects in the early 1990s (e.g., Archie, Gopher, Veronica, and Jughead) to some of the most visited Web sites such as Google, Yahoo!, and AskJeeves (Marckini, 2001). We classify search engines as first, second, and third generation (Nobles, 2003) as a guide for discussion and not to deduce much from the classification.

First-Generation Search Engines

This generation includes the early entrants in the search domain. Search engines existed even before the invention of the World Wide Web. Search tools such as Archie and Veronica searched using FTP (file transfer protocol) and gopher protocols long before HTTP (hypertext transfer protocol) came into play. Search technology was very primitive. With Archie one could search for file names, while with Veronica, one could search for text files and file names. The World Wide Web and its standards enabled the development of robots and crawler or spider software that "wandered" around the Web to index all the links it could find to perform a search on them later. MIT's World Wide Web wanderer's launch in 1993 was the first of many spiders such as RSBE, WWWworm, and Jumpstation. ALIWEB (Archie-Like Indexing of the Web) debuted in 1994; instead of relying on a Web spider to create an index, it relied on webmasters of participating Web sites to post their own index information for each Web page that they wanted to be listed. Thus, ALIWEB gave webmasters their first opportunity to use META tags to position their sites on a search tool. This gave birth to the META tag within the HTML (hypertext markup language) header of a Web page. The popularity of the Web and introduction of Web browsers such as Netscape and Internet Explorer gave rise to the development of search engines with Web interfaces such as Yahoo!, WebCrawler, Lycos, and Galaxy. This in turn gave rise to the second generation of search engines, discussed next.

Figure 1. Search-engine evolution



Second-Generation Search Engines

The development of metasearch engines improved the efficiency of searches by indexing the Web and providing effective searches based on page reputation. Other major components include link-click popularity, temporal tracking, and link quality. These components resulted due to the outburst in the number of Web pages that appeared on the Web. There was a major shift from search engines simply being rigorous in searching the Web to providing relevant results to the user. Thus, the major change in the second-generation search engines involved the use of algorithms to display the ordering of results that are relevant. This also saw the rise of term vectors, stats analysis, cache data, and context in which two-word keyword pairs were extracted from a Web page to better categorize it. PageRank is an algorithm used by Google to rank Web pages to match a given search string (Brin & Page, 1998). It computes a recursive figure of merit for Web pages based on the weighted sum of the pages linked to them. PageRank thus derives from human-generated links and correlates well with human concepts of importance. Previous keyword-based methods of ranking results relied solely on the number of times the term appeared on the Web page. Similar algorithms are used by other search engines such as Yahoo!, AltaVista, Infoseek, and AskJeeves.

Third-Generation Search Engines

The third generation of search engines includes search engines that exhibit the capability of performing domain-specific searches such as searches for news, directories, images, newsgroups, and deals and prices. The search is also extended to search documents other than HTML pages to document formats such as .pdf, .doc, .xls, .ppt, and .ps, among several others. Personalized searches are gaining attention as envisioned by Amazon's A9 and AskJeeves' MyJeeves. Third-generation search engines also have the capability to perform multilingual searches on Web pages. In the next section, we elaborate further on these third-generation search engines and the related terminology. We further drill down on the third or contemporary search engine technology to give readers a feel of what can be achieved with the existing search technologies.

CONTEMPORARY STATE OF SEARCH ENGINE TECHNOLOGY

This section provides a brief discussion on various content searches possible with contemporary search engines. Search engines traditionally searched the text on Web pages. This obviously limited the searches as most Web pages today have a number of pages that are in different file formats such as .pdf, .ppt, and .doc, to name a few. The search engines today search the text within all these and other file formats that were not accessible earlier. The search has also expanded to other domains such as images, news, newsgroups, and directories.

Images

Image search engines look for images that are relevant to certain criteria. The search engine usually analyzes the text adjacent to the image, the image caption, and other criteria to identify the image content. An image search facility is provided by many search engines including Google, Yahoo!, MSN, and AskJeeves. There are also beta 3-D image search engines available. The commercial availability of such search engines and 3-D content could allow researchers and designers from across the world to look for design documents rather than creating them anew (Bergstein, 2004).

News

News search engines look for news Web sites around the world. The articles from Web sites that are recognized as news Web sites by the search engines are searched according to the relevant keywords in them. Topics are updated continuously throughout the day so that new stories appear at the top of the results. Also, features such as the ability to sort by date or relevance offer extra flexibility to the user to sort the results according to his or her preference.

Locals

A search restricted to a particular physical location is called a location-specific search. This is useful when one needs to find stores and services around a particular neighborhood. In this case, the search engine analyzes the content in its index of Web pages and combines this information with yellow-pages data to provide the local search experience. For example, if a user says, "I need an Italian restaurant that is close to where I live," the search engine can provide the user with information on Italian restaurants' addresses, phone numbers, ratings, and, more importantly, their distances from where the user lives. This is done by combining information from the yellow pages and the zip code. Recently, Amazon's search engine A9 introduced similar yellow-page searches with images of the actual location of the store.

Apart from the ones mentioned above, there are numerous other searches provided by contemporary search engines, including searches that are specific to universities, languages, catalogs, deals and public services, maps, research articles, specific file formats, and so forth.

SEARCH ENGINE CONCERNS

In the following subsections, we discuss various concerns that should be taken into consideration and addressed to provide and locate relevant search results for the increasingly information-ravening Web users.

Information Overload and Relevance

While search engine technology has improved over the years, making searches and finding information relatively effortless, the pace of information explosion has endlessly surpassed the improvements made in search engine technologies. Increasingly, people from all over the world are getting access to the Internet and realizing the potential of it. Many of them have now started to bring their businesses online to gain visibility in this highly competitive and dynamic business world. Furthermore, as a result of various technological advances, the retrieval, production, and distribution of information has become easier than ever. This has certainly led to an enormous increase in the amount of information available to the consumers of a search engine, and often times it has led to irrelevant, unclear, and inaccurate data fragments. It is common knowledge that in today's information age, information and knowledge are power and having more of them is considered a good thing. However, with the unprecedented rate at which new Web pages are added to the World Wide Web on a regular basis, even the most tech-savvy user groups find it almost difficult (if not impossible) to sift through the search results to identify relevant information. This concern has been accurately captured in the recent Delphi survey (Delphi Group, 2002) of knowledge workers:

[Business] professionals typically spend at least 25% of their day searching for information and 61% of them believe they have a less than 75% chance of finding the information they need. The main impediments to finding this information are poor tools (28%) and concerns about the volatility or rate of change of the information (35%).

Ackoff (1967) quite accurately identified this phenomenon of the overabundance of irrelevant information decades ago while critiquing the assumptions behind most management information systems. Information overload is becoming a challenging problem to address as we reach the point of saturation. Effects of too much information include anxiety, poor decision making, difficulties in memorizing and remembering, and reduced attention spans resulting in poor performance of the task at hand (Delphi Group, 2002). This suggests that search engines need to continuously evolve their search strategies to keep up with information overload. From the earlier discussion on the generations of search engines, it is apparent that search engine developers have been proactively taking steps to identify new and more effective strategies to optimize search results.

Categorization and Representation

Currently, most search engines display their results sequentially, with the most relevant results at the top of the list while the least relevant results are at the bottom toward the end of list. Search engines determine the relevance of the search results based on various criteria such as keyword matches and page ranks. This approach does not truly take into consideration the context of the user to provide the ranking of the search result. The daunting task of locating a relevant page and related result categories is left to the user.

Furthermore, currently, most popular search engines do not provide any categorization or clustering of search results, which adds to the difficulty of locating a relevant Web page from a plethora of apparently pertinent Web pages. Search engines such as Vivisimo and Kartoo take an interesting approach to the categorization and representation of search results. Kartoo is a metasearch engine that presents its search results visually on a map represented by more or less important Web pages depending upon their relevance. When the pointer is moved over these pages, concerned keywords are highlighted and links connecting the highlighted page to other relevant pages are displayed. Similar techniques of displaying result categories visually can be used for mobile devices to alleviate the problems caused by smaller screen sizes.

In the next section, we extend this discussion by alluding the reader's attention to context-aware searches that can help achieve highly relevant searches.

FUTURE POTENTIAL OF SEARCH ENGINES

While extant search engines serve the basic purpose of searching and finding desired information on the Web, it is apparent that there is still some room for improvement. There has been a growing amount of interest in the applicability of context-aware technologies in the field of search engines. Users rarely search in isolation, but rather always in some context; hence, the search results returned by the search engines need to be appropriate to particular places, times, people, schedules, usage patterns, and preferences. Context awareness refers to the properties of the system that make it aware of this contextual information from its surroundings and help the search engine adapt its behavior accordingly. Heer, Peddemors, and Lankhorst (2002) break down the contextual indicators into the following categories: the spatial, the temporal, environmental information and social situations, nearby resources, the availability of resources, physiological measurements, the user's current task and the overall task information, the user's information need, the user's model of information seeking, and historical context patterns (Jones & Brown, 2004).

With contextual indicators acting as filters, one can potentially retrieve a much better set of relevant results. Currently, the most popular contextual information being used for the same purpose is the user profile. However, we believe that by making use of a much richer set of contextual information, more effective searches can be performed. This context-aware search problem becomes interesting with the increasing popularity of handheld devices that have limited resources in terms of screen size, and battery and computing power. Handheld devices have been primarily used to support more task-oriented uses and to perform highly specific information-retrieval tasks (Syed, 2004). Thus, when performing searches using such devices, the need to obtain more relevant results is acute to enhance the mobile user's experience. The mobility of the handheld user provides for a much richer contextual setting, which, when taken into consideration, can help filter a number of irrelevant search results (Syed). Based upon the context of the search, the same word may have different meanings in different contexts. Thus, a search engine should be able to incorporate such contextual semantic information in order to improve the effectiveness of the search results retrieved.

Finally, before concluding, we would like to point the reader's attention to open-source search engine technology (e.g., Buntine et al., 2004; Hook, 2003), which is becoming a serious competitor to commercial search engines. Additionally, there are several attempts under way by the leading search engine giants, publishers, libraries, and academics to make scholarly literature easily accessible and searchable (Summann & Lossau, 2004).

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KEY TERMS

Cloaking: Another means of spamdexing in which sites provide a different page to the search engine spider than the one that will be seen by human users.

Context: Everything—social, cultural, political, and historical factors—that surrounds a particular event. These are the forces of influence at play when the event actually occurs. Greater knowledge of the context of a thing leads to a deeper understanding of and a more balanced perspective on its nature.

Information Overload: The availability of excess information beyond that which is desired or needed by a user, requiring nonproductive processing.

Metasearch Engine: A search engine that sends search keywords to different search engines and blends together the search results from these search engines as one resultant list.

PageRank: An algorithm that Google uses to rank Web pages that match a given search string.

Spamdexing: The promotion of irrelevant commercial pages by taking advantage of the search algorithms used by search engines.

ENDNOTE

1 The absence of those relevant results may mislead users to assume the nonexistence of any such results.

Category: Concepts, Trends, and Challen ges

Internet Technologies in Factory Automation

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INTRODUCTION

One of the most important changes in the technological and economic environment of industrial firms is the increasing diffusion and strongly increasing commercial use of Internet technologies in manufacturing. Both formal and empirical studies verified the significant increase in productivity through intraorganizational applications of modern information and communication technologies in manufacturing processes (Barua & Lee, 2001).

Early industrial applications of Internet technologies were limited to single, unconnected solutions for distributed Computer-Aided Design (CAD) systems or telecooperation. Now Internet technologies may reach into the automation and control levels of every assembly line. Therefore, it is not surprising that applications of Internet technologies in production processes on the shop floor increase, and automation-technology suppliers combine Internet technologies more and more into their products. While production concepts, such as lean production, world-class manufacturing, and agile manufacturing, inevitably disregard this development, new production concepts arise that fundamentally consider the application of Internet technologies on the shop floor.

BACKGROUND

Internet Technologies for Manufacturing

Usually the term Internet technologies is understood in the context of the well-known Internet as the technological basis of a global information and communication network. Often, there is no differentiation between company internal and external applications. Indeed, the WWW (World Wide Web) is the most popular, and for almost everyone an observable application of Internet technologies. However, the term Internet technologies does not prejudge an external relevance. Yet, the internal application of these technologies focuses on intranets for office information systems. In the future, the main industrial application area of Internet technologies is in field-area networks (FANs).

FANs are real-time, capable networks on the field level (shop floor) of industrial firms' communication systems for the interconnection of automation devices, for example, assembly lines, production cells, or single machines (e.g., Schnell, 2003). Requirements for the FAN are, in particular, real-time ability, a high transmission speed, high reliability, and electro-magnetic compatibility. Depending on the nature of the business and the underlying technological concept, different types of FANs are applied. For our purposes, we can differentiate two major groups of FAN: (a) a FAN that is based on field buses, and (b) a FAN that is based on Internet technologies. Field buses are a substitute for the individual wiring of sensors and actuators within automation technologies. They offer a continuous communication infrastructure on the field level. Those that are well known include, for example, systems such as Profibus, DeviceNet, CAN Open, and SERCOS. The second group represents the industrial application of Internet technologies and is mainly based on (industrial) Ethernet.

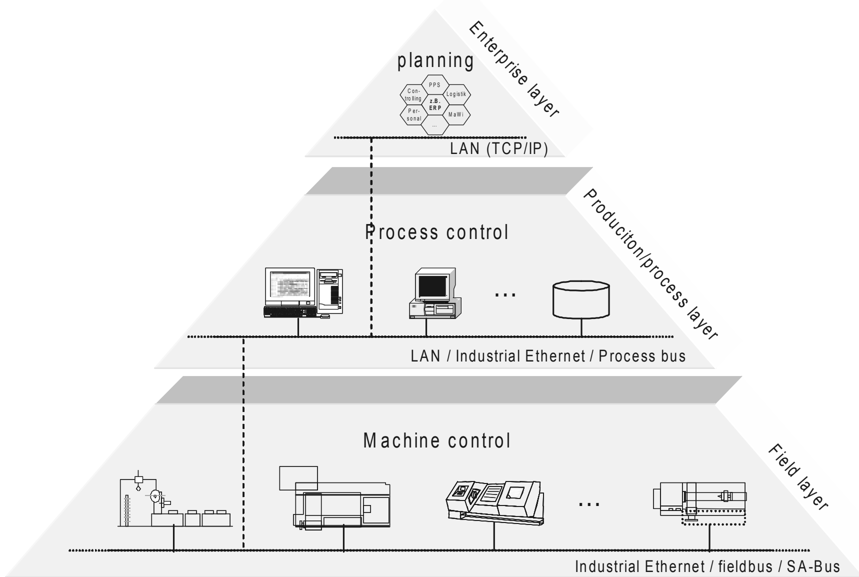
INDUSTRIAL APPLICATION OF INTERNET TECHNOLOGIES

Applicability of Internet Technologies

For the research of the network infrastructures in production environments, a hierarchical arrangement has to be carried out on the implemented network and/or bus systems on the different layers of the enterprise. An automation pyramid most adequately represents this hierarchical arrangement. Although there are automation pyramids with up to seven layers in engineer-scientific literature (e.g., Schnell, 2003), the three-layer pyramid in Figure 1 provides a good overview of the different industrial applications of Internet technologies.

The highest layer is the enterprise layer, in which the enterprise planning occurs, for example, within an enterprise resource planning (ERP) system. In this environment that is mainly dominated by office applications, local-area networks (LANs) are applied, for example, based on Ethernet and the TCP/IP (transmission-control protocol/Internet protocol) suite. This layer is cross-linked with the production and/or process layer. On this layer,

Figure 1. Automation pyramid (Blecker, 2005)



manufacturing execution systems (MESs), for example, are applied to provide a logical connection between the planning and production process layers. Furthermore, production-near dispositive tasks are processed by the production control. Control centres are implemented here. Industrial field-bus systems (process busses) are employed as the network infrastructure. From a technical viewpoint, Ethernet networks and/or the local-area networks of the office environments are also purposeful on the production or process level (Schnell, 2003). Recently, Internet technologies were implemented based on the industrial Ethernet. The real-time equipment on the field level are cross-linked often with the aid of field buses, for example, the different variants of ProfiBus.

Yet, field buses as a traditional network technology are still dominating in production processes, for example, the ProfiBus concept of Siemens Automation & Drives Group. In the future, Internet-based FAN will complement or even replace field buses. Since 1985, industrial firms have utilized Ethernet on the shop floor. Industrial Ethernet especially reduces the technological limits that have existed up to now to the applicability of Internet-based FAN or even the replacement of field buses. Industrial Ethernet is based on the relevant international standards (e.g., IEEE 802.3). It is adjusted to the specific environmental conditions, for example, regarding electromagnetic compatibility, shaking, moisture, and chemical resistance. In some sectors, Ethernet and industrial Ethernet are already the de facto standards, for example, in the automotive industry, process industry, and plant engineering.

The technological improvement of industrial Ethernet and/or Internet technologies in general does not necessarily enable a total replacement of field buses. On the one hand, some applications or existing machinery still need FANs that are based on field buses. On the other hand, field buses such as ProfiBus evolve toward a convergent, interconnective infrastructure, for example, as in ProfiNet. Hence, even where Ethernet cannot replace field buses, Internet technologies connect the different assembly lines together and transfer detailed data from the shop floor to the office and vice versa. Internet technologies are especially useful for the networking of production lines with each other, as well as for the data transfer from the technical systems in the production to the enterprise systems in the administration and vice versa as it is shown by numerous initiatives in factory automation. Consequently, a comprehensive application of Internet-based FAN enables the expansion of existing intranets in office automation to all production processes, especially manufacturing. Enabling technologies, such as Web services, active technologies, and industrial frameworks (based on .NET or Sun ONE), will support intelligent manufacturing technologies and a homogeneous network from offices on the enterprise level to manufacturing devices on the field level. These platforms have an enormous potential to reduce (transaction) costs within the production system (Blecker, 2005). Therefore, Internet technologies become a ubiquitous network: an omnipresent information infrastructure in the complete industrial firm.

Industrial Applications in Practice

Siemens Automation & Drives Group propagates today a communication network for automation control that not only allows a networking within the production processes, but also a networking of the field level with the office environment. This network also provides the accessibility of single machines and plants. This approach is called SIMATIC NET. It should guarantee the continuity of industrial communication networks in an enterprise, and provide possibilities for teleservice and control of machines and plants. Furthermore, Siemens and other providers strive for acquiring the ability to employ the existing facilities without modifications. For this purpose, the fieldbus-centred ProfiBus approach was developed toward the integrative concept ProfiNet based on industrial Ethernet (e.g., Profibus International, 2003a, 2003b).

A further example was introduced under the name Interface for Distributed Automation (IDA) in the year 2000. This hierarchy-free network on the field level is based on (industrial) Ethernet and the TCP/IP suite. IDA cross-links automation technologies with each other as well as systems of the office environments, a potential intranet and even Internet when it is appropriate (Schnell, 2003). In spite of its decentralized organizational structure, it enables distributed problem solving on the field level as well as upright integration that reaches the enterprise level in terms of enterprise application integration (EAI).

A competing but promising approach of Internet technologies in manufacturing is the most often implemented standard Modbus TCP/IP of Schneider Electric SA (Volz, 2003). This approach is also based on the application of Ethernet and TCP/IP in the automation technology. Modbus TCP/IP uses its own well-specified port within the normal stack. It was introduced by the regulation authorities (Internet Engineering Task Foce [IETF]) of the Internet as an official standard for Internet technologies. From this it follows that in all worldwide relevant operating systems, a protocol is applied automatically that was developed for automation technologies of industrial processes (Schnell, 2003). Therefore, it is theoretically possible to cross-link every computer with networks in manufacturing, the last step being the convergence of office applications and production networks. In the future, a further essential advantage may result through the fusion of the IDA group and the Modbus organization to a common group by October 2003. They try to define hierarchy-less, decentralized networks on the field level, which allow a very flexible communication infrastructure with high interconnectivity both inside and outside the company. Schneider Electric SA presents a first commercial solution under the name Transparent Factory or Transparent Ready.

Further examples from practice that illustrate the application of Internet technologies are the pilot systems of the Control Web approach of KUKA GmbH, Bosch GmbH, Trumpf GmbH & Co. KG, and other factory-automation suppliers. The essential features of this approach are the comprehensive use of Ethernet at the field level, the application of personal computers for automation control, and the integration of Web servers based on embedded systems into the automation systems. In order to ensure communication and/or operate the system, Web browsers are used. The first plants in the automotive industry that consistently utilize Internet technologies in manufacturing according to the approach developed by KUKA and the others were implemented by 2005 (Ebert & Klüger, 2003).

Recapitulating, the technological shift from traditional FAN such as Profibus to Internet-based FAN may connect office information systems with the automation and control level of every assembly line. It is not surprising that applications of Internet technologies in production processes increase, and that many suppliers of automation technology combine Internet technologies into their products. This leads to a convergence of the traditional production systems and Internet technologies (Blecker, 2005). It explicates the unification of technologies with different features to a homogeneous service bundle, thereby requiring the revision of traditional production concepts or even the development of new ones. For example, the interconnection of assembly lines as well as the sharing of detailed data with corporate Ethernet networks leads to a direct communication between ERP and production planning and control (PPC), MESs, and automation technologies in the sense of EAI. Because of the resulting high availability of real-time data from the shop-floor equipment, new (production) planning and control mechanisms as well as continuous information and communication structures between administrative and production systems arise.

EMERGING ISSUES OF INTERNET TECHNOLOGIES IN PRODUCTION CONCEPTS

The application of Internet technologies at the field level leads to an interconnection and networking of automation infrastructure (e.g., machine controls) on the shop floor, and information systems (e.g., ERP) that are involved in the production process. However, in order to profit from the potential benefits of Internet technologies in manufacturing and to achieve competitive advantages, adequate production concepts must be applied (Blecker & Graf, 2003a). Early examples of Internet-based or Internet-oriented production concepts are Atherton's (1999) idea of Java-based applications in factory automation, the concept of information-based manufacturing (Shaw, 2001), the e-factory (Beavers, 2001), and so forth. A more recent approach is the concept of Web-integrated manufacturing, which describes the general application of Internet technologies in manufacturing, for example, agent-based systems, Java, Jini, and Service Object Access Protocol (SOAP). It was developed during the international research project Plant Automation Based on Distributed Systems (PABADIS, 2001) that uses this approach as a theoretical basis and aims at the development of decentralized, distributed systems of office communication within the machine control on the shop floor. This is supposed to lead to highly flexible, adaptive, and simply reconfigurable production systems (Huang & Mak, 2003). Reconfigurable production systems combine the advantages of high-productive and highly flexible systems because they can be adapted immediately regarding their structure, functionality, and capacity, as well as their inherent technology, to changing demands.

A more comprehensive concept of Internet-technology applications in production processes has to focus on a more consistent and continuous application of Internet technologies in industrial firms. Furthermore, it has to deal with the current evolutions of the production technique as well as operations management. We mainly expect that such a concept does not solely focus on the consequences of Internet technologies for the shop floor. It has to take into account the new options of Internet technologies in operations management and their effects on the strategic and operative management of industrial firms, too. Such a concept is Web-based manufacturing (Blecker, 2005). It is based on the continuous and global application of multimedia Internet technologies in the technical and managerial processes concerning industrial production, and it reaches from the office into the automation level.

Web-based manufacturing assumes that it is generally necessary to change over from obsolete computer-integrated production concepts (Computer Integrated Manufacturing [CIM]) to Internet-based ones. A major difference between both philosophies is that CIM focuses on a centralistic integration of different, dislocated subsystems of planning and operation of production processes. The intense application of Internet technologies in the production processes and/or their combination with automation technologies reduces the central coordination and control as well as the formerly forced heteronomy of the actors in production processes. Instead, decentralized coordination and operation mechanisms as well as an at least partial self-determination of the actors become possible. This means that industrial firms can apply already-known concepts of decentralized PPC and partially autonomous automation technologies more effectively.

FUTURE TRENDS

Three main future trends should be pointed out. First, Internet technologies will increasingly penetrate manufacturing processes and technologies. The projects and approaches developed by the IDA group and the Modbus organization will especially lead to the convergence of production and Internet technologies. For example, Modbus has its own port in the TCP/IP stack so that worldwide every personal computer with access to the Internet can be interconnected via this automation-technology approach. A second trend is that Internet technologies will be directly implemented on the shop floor, for example, in networking dislocated assembly lines, and will allow an interconnection of manufacturing systems with supporting management systems, e.g., PPC. Due to this evolution of direct IP-supported networking (down to the machinery level), an increase of distributed services in production processes and a convergence of the traditional production and operation systems and Internet technologies are possible. From this follows the third trend. In the resulting convergent Internet-based infrastructure, it is possible to implement multiagent systems on the shop floor that will replace the manufacturing execution systems that are up to now often applied (e.g., PABADIS, 2001). In addition, both multiagent systems and Internet technologies on the shop floor are considered to be key factors of a mass-customizing production system (Baker, Van Dyke, & Kultuhan, 1999; Blecker & Graf, 2003b).

CONCLUSION

Internet technologies and the potential fields for their applications in production processes evolve very rapidly. Internet technologies will increasingly replace the traditional field buses in the coming years. Therefore, the intraorganizational application of Internet technologies will be the generic networking infrastructure for production processes in the future. Web-based manufacturing especially opens new options for enterprises and creates sustainable competitive advantages.

From a technical point of view, the realization of Web-based manufacturing is already possible without problems as it can be shown through the high number of practice-relevant projects and implemented island solutions. The combinations of robotics and Internet technologies have been demonstrated for a long time. Additionally, the importance of Internet technologies in automation systems as a crucial basis for the achievement of a competitive advantage and the realization of new manufacturing concepts is undisputed at least within engineering. Even industrial practice confirms the high potentials of Internet technologies in production processes. Many firms recognized that the usage of Internet technologies could contribute to an improvement of their competitive positions, and have already developed the first approaches of Internet-based production concepts. From the point of view of business administration, the development of the already-known approaches to a comprehensive concept of Web-based manufacturing is necessary.

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KEY TERMS

Convergence: Uniting the functions of heterogeneous technologies with different features to form a homogeneous service bundle.

Enterprise Application Integration: Application of aligned processes, software and hardware tools, methodologies, and technologies aimed at interconnecting and consolidating all computer applications, data, and business processes in order to achieve a friction-free network that allows real-time data exchange as well as easy management and (re)configuration activities.

Field-Area Network: Real-time network on the field level (shop floor) of industrial firms' communication systems for the interconnection of automation devices, for example, assembly lines, production cells, or single machines. Depending on the nature of the business, different types of FANs are applied, which are either based on field buses or Internet technologies. Well-known FANs are, for example, Profibus, DeviceNet, CAN Open, and SERCOS.

Industrial Ethernet: Special type of Ethernet for field-area networks based on the relevant international standards (e.g., IEEE 802.3). It is adjusted to the specific environmental conditions in industrial production systems, for example, regarding electromagnetic compatibility, shaking, moisture, and chemical resistance.

Internet Technologies: Family of technologies suitable for exchanging structured data through package-oriented transmissions on heterogeneous platforms, in particular, protocols, programming languages, hardware, and software.

Manufacturing: Specific form of production processes based on mechanical technologies and activities.

Production: Function of (industrial) firms consisting of creating a transformation system and combining internal and external resources by applying technological and conceptual procedures in order to generate goods and services for further possessing and/or as a marketable output for serving the customer.

Production Concept: In theory, a well-founded guiding idea based on empirical knowledge, where it is appropriate, on the organization, planning, control, and evolution of production systems with the main objective of enhancing the competitiveness of the firm.

Production System: Subsystem of the enterprise for the transformation of input factors, for example, goods and services, into output factors, for example, tangible goods and services, in order to satisfy a customer need. The production system itself consists of two basic subsystems: the management subsystem and the operation subsystem. These subsystems are interconnected and interwoven by an information system. The operation subsystem deals with the original transformation processes and includes all facilities, machines, logistical equipment, and employees (blue-collar workers). The management subsystem is responsible for the short-run (operational) design, planning, and control of the entire operation subsystem.

Web-Based Manufacturing: Production concept aiming at easily reconfigurable, highly flexible production systems based among other things on the comprehensive application of Internet-based field-area networks and convergent automation technologies (Blecker, 2005).

Category: Concepts, Trends, and Challenges

Internet-Based Marine Maintenance Information System

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INTRODUCTION

The Marine Region of the Hong Kong Police Force is responsible for policing the waters and 262 islands that lie within the 1,651 square kilometers of the Hong Kong Special Administrative Region (HKSAR). In addition to routine policing, the Marine Region has responsibilities in other diverse areas like quarantine, immigration, conservancy, and also port and maritime regulations (Hong Kong Police Force, 2005). The Region is now managing a police fleet of over 140 vessels of various classes. A modern police vessel is a complex, technologically advanced, and highly automated machine. As such, the Marine Region Support Bureau (MRSB) insisted that it must be maintained at the highest possible levels of operational availability while its life cycle operating and maintenance costs should be kept at a minimum. To achieve this aim, this article addresses the need to effectively implement a marine maintenance information system.

Traditionally, the defects and maintenance data of the fleet were collected and recorded by the crew in writing, and then the maintenance records were used as the basis for maintenance decisions by the MRSB and the Hong Kong Government Dockyard. With the paper-based recording procedure, the following problems often occur:

- There are missing data due to unintentional negligence or uncertainty about the nature of the equipment failure or damage,
- errors occurred during the coding of failure information, and
- there is difficulty in deciding whether repair tasks performed were routine servicing or corrective maintenance.

To minimize such problems, it was decided that the processes of crew logbook entry and failure coding procedures would be replaced by direct input to the desktops of MRSB and the Government Dockyard through portable communication devices such as personal digital assistants (PDAs) and laptops, which can easily be obtained at reasonable costs locally.

Currently, virtual private networks (VPNs) provide one of the most cost-effective ways for users to access organization networks while in Hong Kong waters. They are also an effective way of joining together the main office with remote depots using the public Internet. Three types of VPNs are being used.

1. **Intranet VPN:** This VPN can securely connect the desktops of the MRSB and the HKSAR Government Dockyard over the intranet, with all data traffic being encrypted.
2. **Extranet VPN:** Besides the functions provided by the intranet VPN, this network provides access to the MIS to preferred maintenance contractors. Data are accessible only over secure encrypted connections, with all contractor users authenticated.
3. **Remote-Access VPN:** For this network, authorized users are able to access the MRSB and HKSAR Government Dockyard MIS anytime from anywhere. With the aid of wireless PDAs, this facilitates decision making on the spot and is limited to decision makers such as the police superintendent.

A preliminary attempt at developing a Web-based maintenance management information system was carried out for a small fleet of patrol vessels (Wong & Chan, 2002), and due to the nonmodular structure, a major difficulty was found in the modification and extension of the system framework. Recent advances in VPN technology indicate that VPN WANs (wide area networks) are now faster, cheaper, and more reliable than traditional WAN technologies. For a successful implementation of the IMIS, an efficient framework is needed to achieve the automaton of diagnostic processes and the integration of inspection and maintenance information under a secure communication infrastructure. Prior to an elaboration on the design of the proposed model, a brief review of object-oriented technologies (OOTs) is shown in the following section.

OBJECT-ORIENTED TECHNOLOGIES

Many object-oriented methods have been proposed over the years. In an object-oriented paradigm, a system is defined in terms of objects. The object-oriented method represents a model of a system that is based on real-world entities. Objects can represent systems, defects, or functions that individuals or organizations play. OOTs employ the principle of inheriting characteristics or attributes from superclass objects. The inheritance mechanism of an OOT supports the reusability of software and simplifies design. In the literature, various object-oriented approaches to design, model, and develop management information systems have been noted.

The concepts and methodology of an architecture for developing agroenvironmental models based on reusable components are proposed by Papajorgji, Beck, and Braga (2004). The unified modeling language (UML) is used to specify the system model and components at a high level of abstraction. UML interfaces are used to define the behavior of components that can be implemented using standard object-oriented programming languages such as Java. Distributed components can be created using the common object broker architecture (CORBA), remote method invocation (RMI), or Web-services technologies, which enable components at different geographic locations to communicate.

Accumulated information about design and process failures recorded through failure mode and effect analysis (FMEA) provides detailed knowledge for future product and process design. However, the way the knowledge is captured poses considerable difficulties for reuse. Teoh and Case (2004) have contributed to the reuse of FMEA knowledge through a knowledge-modeling approach. An object-oriented approach has been used to create an FMEA model. The FMEA model is assisted by functional reasoning techniques to enable automatic FMEA generation from historical data. The reasoning technique also provides a means for the creation of new knowledge.

Dynamic simulations of energy systems are essential when it comes to the transient analysis and design of complex plants. In their work, Wischhusen and Schmitz described the advantages of the transient simulation method in the optimization process of energy systems (Wischhusen & Schmitz, 2004). The object-oriented model of a heat exchanger is presented utilizing the modeling language Modelica.

In software reuse, which is an important approach to improving the practice of software engineering, many factors may hinder reusing software artifacts. Among those factors are the availability of software artifacts at a different level of abstraction and a method to classify and retrieve them. Ali and Du (2004) proposed an approach based on a faceted classification scheme for the classification and retrieval of software design artifacts, namely object-oriented design (OOD) models, thus facilitating their reuse. Six facets—domain, abstractions, responsibilities, collaborations, design view, and asset type—have been defined to constitute the classification and retrieval attributes. Each of the facets describes one aspect of an OOD model. It contains a number of predefined terms chosen through the analysis of various software systems specifications. The selected terms of each facet are arranged on a conceptual graph to aid the retrieval process.

Amongst all possibly desired endeavors for e-commerce, research has shown that the effective management of customer relationships is a major source for keeping competitive differentiation. In their work, Lin and Lee (2004) has proposed an object-oriented analysis method for the development of such a customer-relationship management information system (CRMIS). The approach starts with the identification of prospect customers and their desired behaviors under preferable execution environments, and ends with the specification of the system—the internal objects and entities that collaborate to satisfy these behaviors and environments. The method used is the case-driven approach with UML utilized and extended as its tool.

Role-based access control (RBAC) provides flexibility to security management over the traditional approach of using user and group identifiers. In RBAC, access privileges are given to roles rather than to individual users. Users acquire the corresponding permissions when playing different roles. Roles can be defined simply as labels, but such an approach lacks the support to allow users to automatically change roles under different contexts; using a static method also adds administrative overhead in role assignment. In e-commerce and other cooperative computing environments, access to shared resources has to be controlled in the context of the entire business process; it is therefore necessary to model dynamic roles as a function of resource attributes and contextual information.

Afgan, Coelho, and Carvalho (1998) describe the development of an expert system for detecting boiler-tube leakage. The leakage-detection expert system is designed in a knowledge-base environment, comprising the knowledge base containing facts, information on how to reason with these facts, and inference mechanisms able to convert information from the knowledge base into user-requested information. The knowledge base is based on the object-oriented structure with the definition of the object Leakage. The object class Leakage is composed of subclasses Sensor and Cases. The inference procedure uses a set of procedural processes in the preparation of diagnostic variables reading for the decision-making process. A fuzzification process is used for the conversion of actual diagnostic values into semantic values.

Shi and Deng (2000) intend to develop a construction scheduling and planning method, named the object-oriented resource-based planning method (ORPM), for meeting the different requirements at various planning stages. Object-oriented representation is adopted for modeling construction activities. Each object has attribute values to detail the required conditions to construct the activity, such as logical dependency and the resource demands.

In their paper, Lim and Chiang (2004) propose an object-oriented global data model that can accommodate attribute and relationship instance heterogeneities in integrated databases. The proposed model has been designed to allow database integrators and end users to query both the local and resolved instance values using the same query language throughout the derivation and evolution phases of database integration. Coupled with the suggested model, they also define a set of local-to-global database mapping rules that can detect new heterogeneities among databases and resolve instance heterogeneities if situations permit.

Chudoba, Butenweg, and Peiffer (2004) describe concepts used in the development of a technical information system for supporting the collaborative material research of textile-reinforced concrete (TRC). The technical information system works as a database-powered Internet server with a transparent definition of the product and process model. These models have been formally specified by using the unified modeling language (Fowler, 2004) and implemented by defining class hierarchies and methods in an object-oriented database system employing the technique of object-relational mapping.

In functionally decentralized organizations, operational data are usually dispersed in individual departments; thus, the departmental decisions are made separately on the basis of limited information and perspective. Huh and Kim (2004) propose an object-oriented data model for developing a collaborative model management system that facilitates not only the sharing of mathematical models among multiple departments, but also the coordinating and propagating of ongoing changes in the models on a real-time basis. A prototype system is developed at KAIST for a commercial object-oriented database system called ObjectStore using the C++ programming language.

DESIGN OF INTERNET-BASED OBJECT-ORIENTED MODEL

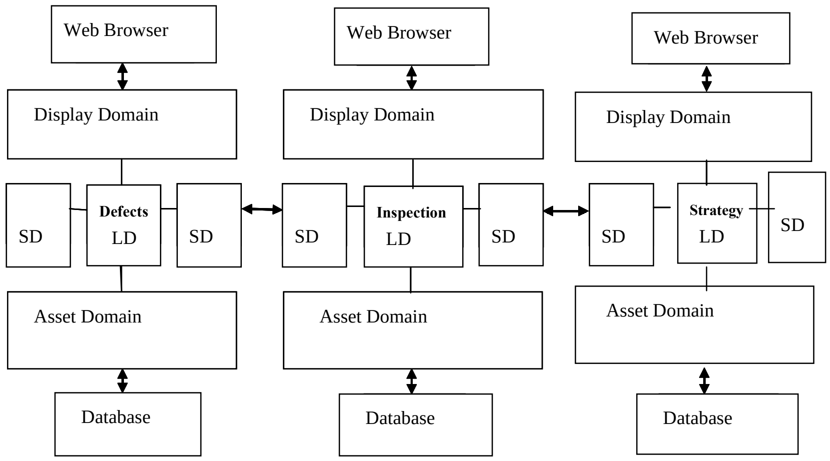
In this study, the authors modified the implementation of the HPD-OO model (K. C. Ng, Ip, & Lee, 1999) with Internet-based technology, which they called the Internet-Based Object-Oriented Model (IBOOM). IBOOM provides the framework and the interface necessary to build the marine police-fleet MIS. By using advanced development techniques, the IBOOM model, which provides an integration solution for all the objects of an MIS, is developed. The proposed architecture adopts object-oriented technology, which aims to enhance the scalability and configuration of the system. The proposed IBOOM model comprises four main object domains: (a) the logic domain (LD), (b) asset domain (AD), (c) display domain (DD), and (d) service domain (SD). The four domain-specific objects of the architecture are characterized by their high degree of flexibility, taking advantage of the object technology. The high level of integration of the individual applications assures the security and consistency of data throughout the Internet. Each object will carry out a unique and complete operational function. For example, an inspection system is a single object. Diagnostic procedures and essential test data such as the temperature, pressure, corrosion rates, and so forth are all defined within that object. Another object such as the Strategy object can interchange information with the Inspection object through the interface provided by the SD.

The IBOOM model is divided into two distinct layers. These are the real-object layer that defines the user's conceptual view and the application layer that defines the MRSB resources view. The real-object layer belongs to the display domain while the application layer exists in the logic domain. The user's conceptual model of an object is not a direct reflection of the application model. The application model is represented as an IDEF model (J. K. C. Ng & Ip, 2003). The IDEF model is a master blueprint defining all of the maintenance entities, relationships, and attributes that must be maintained to preserve the integrity of the MRSB information resources.

The DD is concentrated on the interaction with the user and on managing the user's interface. The LD is focused on managing the MRSB resources (e.g., physical-asset registers) that users share, in particular, the application logic. Only the LD can directly interact with the asset domain. The AD is an interface to the relational database server (e.g., Informix, Oracle, SQL Server, etc.) that manages the storage of data. This domain is also responsible for the preparation of maintenance reports, graphs, or queries. The following sections describe the key elements of the proposed system architecture.

A feature of the proposed model is that each IBOOM object shows only the portion of the master blueprint that is relevant to the maintenance activity in which the user is engaged. The conceptual model of an IBOOM object takes the shape of a hierarchical composite object that is identified by the root subject entity. Each function in the MIS system can be modeled with a single IBOOM

Figure 1. Interaction between three IBOOM objects: Defects, Inspection, and Strategy



object. In Figure 1, three IBOOM objects are illustrated, including the Defects object, Inspection object, and Strategy object. The internal communication of these three objects is by the means of message passing through the SD. The most up-to-date marine police-fleet information, such as routine servicing dates, is shown on the user's Web browser by the DD. In order to retrieve the real-time data, the LD requests the DD to extract all the necessary data from the MRSB database engine by the database query generated from the LD. The function and features of the model components are elaborated in the following sections. All the data passing through the database server and Web browsers are being secured by encryption.

MODEL IMPLEMENTATION

Logic Domain

The LD is the central processing unit of the model. Functions of this domain include the following.

- Generating display mimics
- Providing program logic
- Communicating and synchronizing with databases
- Processing service requests from the service agent
- Routing regional requests to the request agent

The application components of the LD are entities, relationships, elements, transactions, and databases. The LD also acts as the interchange between the Web server on the open network and the database server on the private network. It is used to manage the MRSB database, maintain its integrity in order to maximize the usefulness of it, and provide program logic to cater for the maintenance operation. This domain is designed to retrieve data in a variety of useful ways and update the database in a safe and controlled manner. It also ensures that the event-driven processes are triggered and the users obtain up-to-date data in their workstations. The implementation of the IDEF model is the backbone of the LD architecture. The entities of the object and relationships object receive a message, process it, and return a reply. The relationship object in the LD is also responsible for spreading the event-driven maintenance process. It also provides a query method that will produce a list of the systems' relationships. The query specifies which column to include, the task requesting criteria, and the quality specification. Moreover, the relationship object can assign the sequential key to the entity by querying the database. The relationship object can also be used to resolve concurrency locks and register interest.

Asset Domain

The AD is a standard interface for accessing the physical-asset databases. It is the only interface in the system that is responsible for retrieving, manipulating, and updating data directly to and from the database system through a transaction object, which is the controller of all database updating activities. The function of a transaction object is to ensure that the database is always recoverable to a logically consistent state. The transaction agent can be aborted at anytime and the updates can be rolled back when an error signal is detected by any object. The AD is used to provide multiple and different database systems support. It isolates the LD from the physical asset database so different asset database systems can cooperate seamlessly and simultaneously. Moreover, the AD acts as the only channel for database access that separates the physical-asset database from the Internet connection such that the asset database is protected from illegal access and security is achieved.

One of the major advantages of the AD is to allow scalability; the systems developed by system integrators who make use of the model have the advantage of universal database support, ranging from personal file-mapping databases to high-end client-server database engines. This domain is also responsible for preparing reports, graphs, or queries. It comprises three components, namely, the presenter, extractor, and analyzer. The presenter is used to display all the reports, graphs, or queries to the user through all available media (e.g., screen, printer). The extractor can communicate with the LD through a database object by calling the database management system (DBMS) to perform all SQL operations. The analyzer assimilates the data and prepares them for presentation. All of the calculation and sorting operations for a report are performed by this component.

Display Domain

The DD is mainly concentrated on the manipulation of the Internet-based user interface and on the interaction with the user, that is, the Web browser. The DD is the standard man-machine interface employed by the Web browser. The concept of this domain is simple: The DD uses a Web browser as the client to access all applications. Texts, graphics, animations, multimedia effects, charts, and dynamic data are all presented with the help of a Web browser. This design is based on a thin-client architecture.

This means that no application resides on the client; all application development is performed on the server. This architecture reduces the application maintenance effort and the total cost of ownership of the MIS system, and it allows worldwide maintenance service providers to be connected to the system with no configuration effort.

Service Domain

The SD consists of two agents; they are the service provider agent and the demand agent. The service provider agent is an external communication interface that enables the LD to release its public services for another MOOM object. Another object can request a service from the supply agent of any object through its own demand agent. Generally, the supply agent together with the demand agent provides a standard communication protocol for interobject communication. An important reason for having the supply agent is that it can help to facilitate the model. The supply agent is the only channel through which another object can make a request. Hence, it is easier for system integrators to develop their own services on top of the standard architecture. The demand agent is an external communication interface that enables the IBOOM objects to request information from global objects. Once a maintenance request is made, the demand agent will seek for the information through an intelligent routing mechanism based on the client-server II technology. The demand agent can be considered as an intelligent router for information interchange. The intelligent agent is used to determine load balancing; heavy loading services can be downsized into concurrent services on the Internet or intranet. This approach can highly reduce the server hunting condition. It also provides manageability since services are now treated as global objects. With the help of the client-server II technology, the system integrator can develop his or her own services without knowing the details and physical location of the dependent services.

FUTURE TRENDS

The capabilities of PDAs will advance rapidly. Based on the current rate of technology advances, the expected capabilities of PDAs can be estimated. Advances in computers, communications, networking, and consumer electronics technologies will make the PDA capabilities 5 to 10 times better than current products in several years. Most PDAs will have e-mail and Internet access and other communication capabilities. Connection to corporate networks via VPNs will be standard for office PDAs. Short-range wireless capabilities via Bluetooth and/or IEEE 802.11 are especially important because they will provide wireless broadband access to PDAs. Many PDAs will have a digital camera for low-end video conferencing and to take still pictures. Some PDAs will also have scanners for collecting printed information or scanning bar codes. PDA memory size will grow by 16 to 32 times in several years. Processor performance will improve by at least 5 times, and more like 10 to 20 times for PDAs. All these technological forecasts will certainly lead to the further development of MIS implementation frameworks.

CONCLUSION

This article emphasizes the importance of automating marine-equipment diagnostic processes and the integration of inspection and maintenance strategy information under a secure communication infrastructure. With the aid of object-oriented technologies, an Internet-based maintenance model named IBOOM was developed for the Hong Kong Marine Police fleet. Object-oriented systems have a natural structure for modular design: objects, subsystems, frameworks, and so on. Thus, OO systems are easier to modify since changes are neatly encapsulated. It is anticipated that through such an Internet-based OO maintenance approach, the performance of transportation fleet such as police vehicles, hospital ambulances, container trucks, and so forth can be greatly enhanced. Such a practical application in the logistics sector illustrates one of the significant contributions of ICT research and developments to the society (Khosrow-Pour, 2003).

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KEY TERMS

Class: A class is a blueprint or prototype that defines the variables and the methods common to all objects of a certain kind.

Inheritance: A class inherits its state and behavior from its superclass. Inheritance provides a powerful and natural mechanism for organizing and structuring software programs.

Interface: An interface is a contract in the form of a collection of methods and constant declarations. When a class implements an interface, it promises to implement all of the methods declared in that interface.

Message: Software objects interact and communicate with each other using messages.

Object: An object is a software bundle of related variables and methods. Generally, something is an object if it has a name, properties associated with it, and messages that it can understand. Object-oriented programming involves modeling the software system as a set of interacting (conceptual) objects in object-oriented design, then implementing (coding) the design using an object-oriented programming language with (programming-language) objects.

Superclass: A class that is used to derive other classes. A superclass is also called a parent class or base class. The classes that are derived from a superclass are known as child classes or derived classes. A superclass allows for a generic interface to specialize functionality through the use of virtual functions.

Knowledge Creation in Online Communities

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INTRODUCTION

The emergence of online communities has brought a profound impact on human interaction and methods of information exchange in society. More than one-third of all U.S. Internet users have turned to mass, large-scale communication systems such as e-mail, mailing lists, instant messaging, chat rooms, Web stores, customer service sites, and threaded discussion systems such as USENET (Preece, 2002). Reflecting this prominent phenomenon, there have been a considerable number of studies focused on online communities and communications. This article focuses on the factors and dynamics of the knowledge creation process in online communities, relying on Nonaka's Socialization-Externalization-Combination-Internalization (SECI) Model (1994). Based on that framework, this article discusses the factors that affect knowledge creation and sharing in online communities.

The rest of this article is organized as follows. The characteristics of online communities are discussed in the "Background" section. The section titled "Dynamics of Knowledge Creation and Sharing in Online Communities" reviews the existing concepts and the SECI model of knowledge creation, and extends that model to include the online community context. We further discuss the effects of important factors on knowledge creation and sharing in online communities. The section "Future Trends" suggests further research opportunities in the area. The final section summarizes and concludes the article.

BACKGROUND

Definition and Components

The online community—otherwise known as the "virtual community" or the "cyber community"—has provided efficient and comprehensive ways of communication (Andrews, 2002). It has been proposed that this new form of community is not subject to the same constraints as traditional social structures (Butler, 2001) due to its unique characteristics.

Online communities can be defined as "groups of people who communicate and interact with each other via electronic media" (Romn, Pliskin, & Clarke, 1997). Online communities possess several unique characteristics that offer opportunities for knowledge creation and sharing activities. An online community provides participants with an opportunity to engage in *many-to-many communication.* This allows access to an unlimited number of counterparts, avoiding limitations embedded in face-to-face community contexts (Butler, 2001). In addition, online communities offer *asynchronous communication opportunities* to those who want to reflect, compose, and review correspondence at their own convenience. Asynchronous communication refers to the timing of interaction engagement (e.g., response), without regard to physical constraints such as geographical distance and physical time to deliver information. This kind of asynchronous communication is not an opportunity in a conventional face-to-face community setting (Bieber et al., 2002; Preece, 2002).

An online community creates a unique environment where some of the common interaction methods in the face-to-face communication are eliminated, or replaced with substitutes. In online communities, social presence cues represented by verbal and visual recognition might be eliminated, and *anonymity* takes the place of such cues (Sia, Tan, & Wei, 2002). Anonymity may encourage people to be more open to sharing their feelings and opinions and freeing them from social pressure to follow group norms. In a similar context, Siegel, Dubrovsky, and Kiesler (1986) found that a computer-mediated communication (CMC) lacking communication cues leads to a more equalized participation level among participants than a CMC with high social presence (Siegel, Dubrovsky, & Kiesler, 1986). The anonymity of online communities, hence, results in an increase of membership size. Anonymity leads to increased benefits for community members and positive effects on members' willingness to participate in knowledge creation and sharing with more novel and valid arguments.

DYNAMICS OF KNOWLEDGE CREATION AND SHARING IN ONLINE COMMUNITIES

Knowledge Creation in Online Communities

In order to understand the phenomenon of knowledge creation and sharing in online communities, we rely on Nonaka's pioneering framework of knowledge creation (Nonaka, 1994). Nonaka suggests two dimensions of knowledge; explicit and tacit. *Tacit knowledge* is highly personal and hard to formalize, making it difficult to communicate or share with others, whereas *explicit knowledge* can be expressed in words and numbers, and shared in the form of data, formulae, specifications, and other "explicit" forms of information such that can be readily transmitted between individuals formally and systematically (Nonaka & Konno, 1998). From the combination of these two dimensions, Nonaka proposed four modes of knowledge conversion, *socialization*, *externalization*, *internalization,* and *combination*, and formulated the process of knowledge creation as shifts among these four modes in light of the interactions among organizational members with regard to their levels of knowledge created through such processes (Bieber et al., 2002; Nonaka, 1994; Nonaka & Konno, 1998).

Socialization (from Tacit to Tacit Knowledge)

Socialization involves the sharing of tacit knowledge between individuals. Due to the nature of tacit knowledge, socialization is carried out through "joint activities" among members of an organization, such as working or living in the same environment, rather than through the media of verbal or written expression of knowledge (Nonaka & Konno, 1998). Socialization is an initial stage of knowledge creation in the conventional, offline context, in which tacit knowledge is shared among members. In the online community, however, socialization hardly takes place due to: (1) the anonymity of members and (2) a verbal or written medium as the fundamental communication tool. Both verbal and written media are suitable for explicit knowledge but not for tacit knowledge. In online communities, the advantages of socialization can be substituted by an immediate online accessibility that would be facilitated by anonymity and many-to-many communication characteristics of an online community.

Externalization (from Tacit to Explicit Knowledge)

Externalization is the transformation of tacit knowledge into a form that is comprehensible by others, and at the same time exchangeable with them. (Nonaka & Konno, 1998) Externalization, therefore, involves the process of articulation of shared tacit knowledge in socialization mode, wherein a piece of "shared" tacit knowledge is converted into a piece of "shared" explicit knowledge. This "shared" explicit knowledge is then used as a building block for synthesizing more complex knowledge through the next mode in sequence (i.e., "combination mode").

Externalization is the most prominent mode of knowledge creation and sharing in an online community context. It is the initiating phase in an online context. This is because most knowledge creation and sharing initially take place by either articulating a need for certain specific knowledge, or by converting personal tacit knowledge into communicable explicit knowledge as responses to those needs.

Combination (from Explicit to Explicit Knowledge)

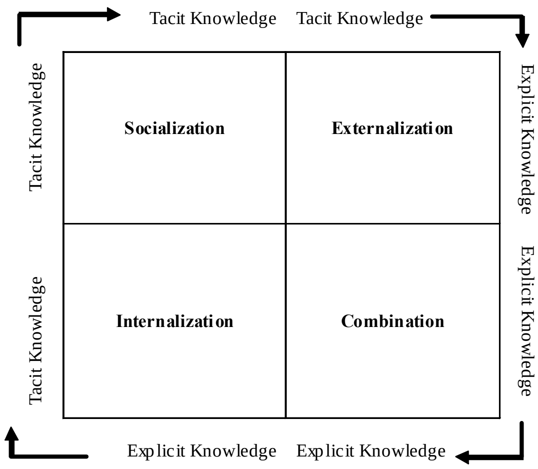
Combination involves creating "newer" explicit knowledge from "new" explicit knowledge generated in externalization mode by reconfiguring existing information through sorting, adding, re-categorizing, and re-contextualizing knowledge (Nonaka, 1994). In other words, combination mode is the stage where explicit knowledge created in the previous externalization mode is systemized, and thus, generates more complex sets of explicit knowledge.

Combination takes place in an online community in the same way as in a conventional physical community. Exchanged explicit knowledge from the previous externalization mode is sorted, added, re-categorized, and re-contextualized through the process of arguing and counter-arguing along the threads of knowledge creation in an online community context.

Internalization (from Explicit to Tacit Knowledge)

Internalization is the process of converting newly created explicit knowledge into tacit knowledge. It requires an individual to identify which organizational knowledge is

Figure 1. SECI model and the four modes of knowledge creation (Nonaka & Konno, 1998)



relevant, which requires finding one's self in a larger entity of oneself (Nonaka & Konno, 1998).

Internalization rarely takes place in an online community due to the nature of the communication tools. This does not necessarily mean that internalization is not happening at individual level in an online context. The conversion of explicit knowledge into tacit knowledge at an individual level still takes place. However, internalization at "organizational level" (e.g., any type of physical social structure such as a department of a company, or the company itself) does not occur since it is neither necessary nor plausible in online communities.

The four modes of knowledge creation are presented in Figure 1. In essence, the SECI model suggests that knowledge creation in an organizational context is represented by an ongoing repeated spiral procedure of interaction between tacit and explicit knowledge. The SECI model provides a useful insight and has implications for the investigation of knowledge creation in online community.

Knowledge Sharing in Online Communities

In this section, we examine the factors that may affect knowledge sharing in online communities. Those are trust, motivation, membership size, and anonymity.

Trust

Trust is the baseline from which socialization of tacit knowledge begins to take place among individuals (Nonaka, 1994). In general, trust can be developed when there is a history of favorable past interactions that lead participants to expect positive future interactions (Preece, 2002). Trust has been emphasized as a pre-requirement of knowledge sharing (Nonaka, 1994). Constructive collaboration involves time-consuming and painstaking interaction for the members to create knowledge through the four modes of knowledge conversion. Without mutual trust among the community members, it would be difficult to facilitate constructive collaboration.

In contrast to traditional face-to-face communications, trust in online communities is in part influenced by anonymity, which is one of the unique characteristics of an online community. As previously stated, anonymity brings the potential of greater group size, thereby bringing a larger potential pool of resources. A lack of trust combined with the comfort of anonymity, however, fosters the temptation to free-ride on the efforts of others (Smith, 2002). Furthermore, most online communities lack the physical social cues of the face-to-face world due to anonymity (Andrews, 2002). Online communities, therefore, need to be supported by technology to attenuate the negative effect of anonymity on trust issues, while maximizing the positive effects of anonymity such as inducing people to be more willing to contribute (Sia et al., 2002).

Figure 2 shows the visualization of social cues in an online community. The visualization tools present a graphical representation of participating members' presence and timeline history as a social proxy (a minimalist visualization of people and their activities). The members in conversation are shown within the circle, and the members logged on but in other rooms are positioned outside the circle. When the members talk or listen, their dots move to the inner periphery of the circle, and then

Figure 2. An example of graphical presentation of social cue (babble system)

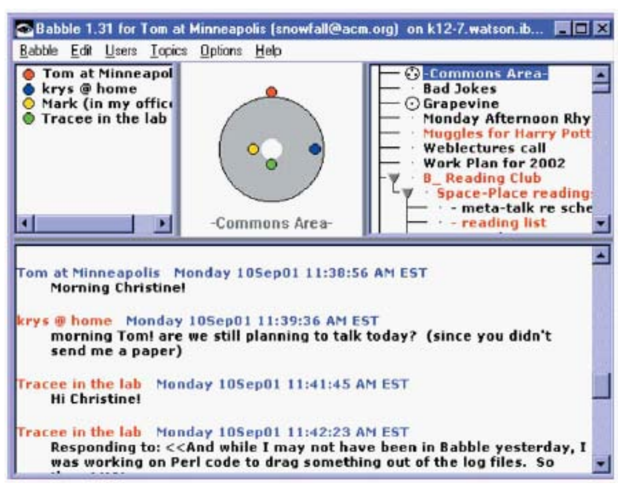


Figure 3. NETSCAN search page (Source:http://netscan.research.microsoft.com)

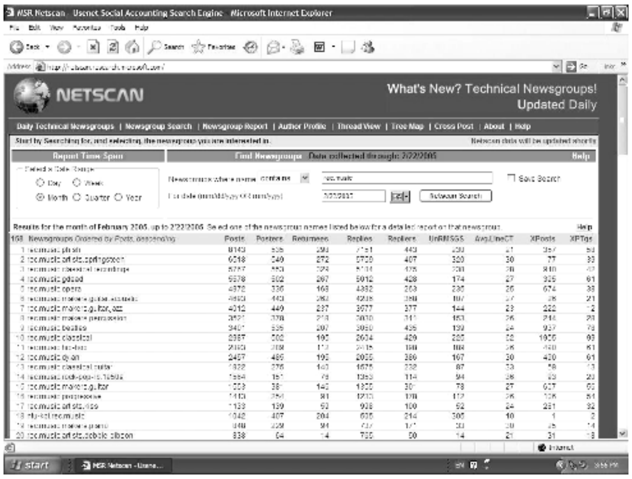
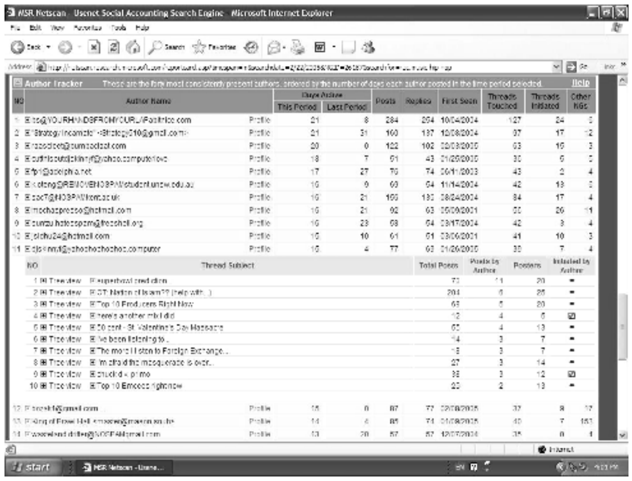


Figure 4. Thread tracker (Source: http://netscan.research.microsoft.com)



gradually drift back out to the edge over. This approach can help with the trust-related drawbacks of online communities. A member may develop trust for others by observing their visualized actions using this tool (Erickson, Halverson, Kellogg, Laff, & Wolf, 2002).

Motivation

Motivation to participate in the knowledge sharing process has emerged as an issue of interest. The SECI Model suggests that a knowledge sharing community can be effective when it is under a certain authority by which a structured compensation to members is arranged based on members' aggregated benefits from, and contributions to, that community. However, in an online community, motivation becomes questionable when a knowledge contributor is unknown to the recipient, and they may never communicate other than online. The usual obligation of reciprocity between two individuals is, therefore, not quite feasible in an online community context. (Wang & Fesenmaier, 2003).

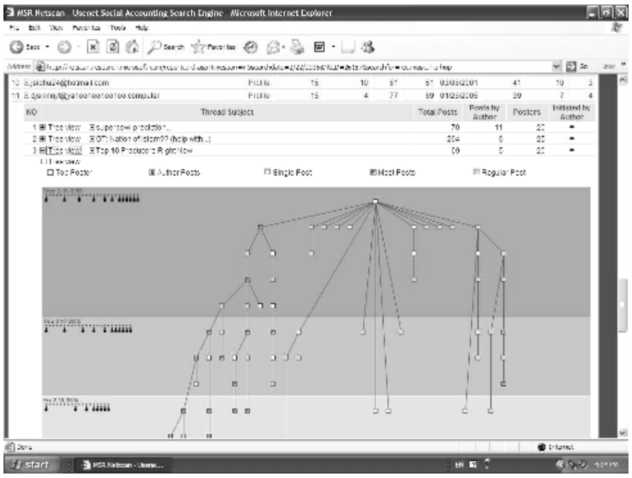
An unstated premise of online communities is that sharing knowledge with an unknown recipient usually involves an implied obligation to repay the favor at some time in the future (Wang & Fesenmaier, 2003). The motivation for members of an online community to participate in the process of knowledge creation and sharing is based on an implied agreement of, "I'll do this for you now, knowing that somewhere down the road you will do something for me" (Wang & Fesenmaier, 2003).

Variety and Membership Size

Since an individual's tacit knowledge forms the basis of knowledge creation, the variety of an individual's experience constitutes one of the most important factors in determining the quality of tacit knowledge (Nonaka, 1994). However, in a large online community, any single individual's experience may be found in other members, and so the significance of any individual's experience may be reduced.

Whether through conventional face-to-face settings or online contexts, social structures can be sustainable when they provide benefits that outweigh the costs of obtaining those benefits (Butler, 2001). In general, the cost of knowledge sharing in online communities decreases exponentially as the number of possible interactions increases (Butler, 2001). But the benefits increase exponentially, and these benefits accrue from a theoretically unlimited number of counterparts—many-to-many communication. As a result, the cost of obtaining knowledge by participating in knowledge sharing in an online community tends to be much lower than that incurred in a traditional face-to-face communication context. For example, the value of knowledge offered to members of an online community is amplified because an unlimited number of people might use or make copies of the information (Wang & Fesenmaier, 2003). The potential benefit from such knowledge is also increased due to the great variety of experiences from a potentially unlimited number of interaction counterparts. The potential benefits are further increased by "asynchronous communication" since

Figure 5. Author Tracker (Source: http://netscan.research.microsoft.com)



the knowledge resource pool can be extended across the time dimension. The benefits from an unlimited interaction counterparts is not restricted to participants concurrently engaged in the communication, but extended to participants from the past (by obtaining knowledge posted in the past), and possibly into the future (by getting replies from participants at a later time).

Since members provide the primary resource for knowledge creation and sharing in an online community, the size of membership may be a meaningful measure of resource availability (Butler, 2001). Greater resource availability from larger memberships provides a motivation for participation, which in turn can lead to an even greater membership size. Hence, membership size affects knowledge creation and sharing in that a greater number of members are associated with more effective and efficient knowledge creation and sharing. However, there are some negative consequences of online communities with very large memberships, because of the complexity involved in managing communications. Various online community technologies such as "thread tracker" and "author tracker" play a role in mitigating the negative effects of the community group size (Smith, 2002). Those applications allow members to obtain relevant information and to track communication history records, thus attenuating the negative effects of membership size and enabling its benefits to be realized (Figures 3-5).

Anonymity

Anonymity is an indispensable property of an online community, which may lead to increases in membership size that, in turn, would lead to the greater success of the community. It has a positive effect on the member's willingness to participate in knowledge creation and sharing. On the contrary, anonymity may have a negative effect on trust. Such negative effects can be mitigated by the use of appropriate Web application programs. The advantages of such technologies in association with trust have been addressed in the previous section (i.e., the "Trust" section).

FUTURE TRENDS

An online community is a form of a socio-technical system (a combination of technologies, people, and social practices) (Bruckman, 2002) that supports knowledge creation and sharing. While specific Internet technologies are useful, more opportunities for successful knowledge creation and sharing exist through efficient community collaboration (Bruckman, 2002). The current article identified four prominent factors that affect knowledge creation and sharing in online communities. Further empirical investigations on the success factors and dynamics of online communities are needed to develop a comprehensive theoretical framework.

CONCLUSION

This article examined the four factors, *trust, motivation, membership size, and anonymity,* that are critical in online communities. This article further addressed the nature and dynamics of the factors involved, and explores knowledge creation and sharing in online communities, relying on the SECI Model. This study offers a fundamental framework for an understanding of the dynamic effects of online communities.

Online communities have been considered a technology or business driven phenomenon. Recently, a number of studies have examined the possibilities and potential of online communities as an alternative way of knowledge creation and sharing. These studies, however, do not address the knowledge creation and sharing activities forming the basis of massive, large-scale knowledge management systems. By examining the important factors and dynamics of knowledge creation and sharing in online communities, this article provides useful insights for both researchers and practitioners.

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KEY TERMS

Anonymity: Anonymity refers to the lack of the identity due to the eliminated social cues (e.g., visual or verbal indication of communication partner's presence in the social interaction circumstance). Anonymity may encourage people to be more open to sharing their feelings and opinions, freeing them from social pressure to follow norms of groups in which they are involved.

Asynchronous Communication Opportunity: The asynchronous communication opportunity refers to the provision of the choice between immediate interaction and asynchronous interaction in terms of the timing of interaction engagement (e.g., response) without physical constraints such as geographical distance and physical time to deliver the information (e.g., such constraints in conventional mailing system).

Computer-Mediated Communication Systems (CMCS): Computer Mediated Communications Systems are computer based systems that enable entry, storage, processing, distribution, and reception of digitized information (Kahai & Cooper, 1999). CMCS include computer conferencing systems, electronic and voice mail systems, group decision support systems, and text retrieval systems.

Explicit Knowledge: A type of knowledge that can be expressed in words and numbers, and shared in the form of data, scientific formulae, specifications, manuals, and the like. This type of knowledge can be readily transmitted between individuals both formally and systematically (Nonaka & Konno, 1998).

Online Community: The Online Community otherwise known as the 'Virtual Community' or the 'Cyber Community' can be defined as "groups of people who communicate and interact with each other via electronic media" (Romn et al., 1997). Online communities possess several unique characteristics that create substantial benefits for knowledge creating and sharing activities; the immediate engagement in many-to-many communications; the opportunity for benefits arising from asynchronous communication, and from anonymous communications.

SECI Model of Knowledge Creation: A knowledge creation model proposed by Nonaka (Nonaka, 1994) in which knowledge creation is viewed as a spiraling process of interactions between explicit and tacit knowledge, and the interactions between these kinds of knowledge lead to the creation of new knowledge. Four modes of knowledge creation are proposed in this model: Socialization, Externalization, Combination, and Internalization (Nonaka & Konno, 1998).

Socio-Technical System: A socio-technical system is a system composed of technical and social subsystems, or a combination of technologies, people, and social practices (Bruckman, 2002). Examples of socio-technical system in a virtual context would be found in online communities such as USENET.

Tacit Knowledge: A type of knowledge that is highly personal and hard to formalize, making it difficult to communicate or share with others. Subjective insights, intuitions, and hunches may fall into this category of knowledge (Nonaka & Konno, 1998).

Category: Concepts, Trends, and Challenges

Lessons from Dot-Com Boom and Bust

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INTRODUCTION

The dot-com industry began in the early 1990s as a collection of startup companies using the Internet as their primary means to conduct business. These companies typically used the ".com" suffix in their company names, such as Amazon.com, and proliferated in the late 90's with the massive investments in Internet-related stocks and enterprises. But with the failure and consolidation of many of these companies their numbers have since dwindled.

The catastrophic collapse of the dot-coms that shook the U.S. economy started in May 2000. More than 210 dot-com companies failed in 2000 (Hirakubo & Friedman, 2002) and a total of 762 dot-coms closed for the period January 2000 to December 2001 (Pather, Erwin, & Remenyi, 2003). Since many of these dot-coms began to lay off their staff, the unemployment rate also increased from 3.9% to 6% by 2002 (Callahan & Garrison, 2003; Howard, 2001).

The dot-com bubble burst because the boom was based on the false premise that new technology would eliminate the need for brick-and-mortar stores as this new business model would supplant the old one, thereby converting the "Old Economy," which is based on the production of physical goods into a "New Economy," which is based on heavy use of information and communication technology (Rauch, 2001). Although a great deal can be learned from examining the dot-com successes, it is equally important to study reasons for the failures. Examining the mistakes made by the dot-coms can provide insight into the evolution of e-commerce as a means of conducting business and furthermore help to form the basis on which new strategies can be developed for the future e-commerce environment.

BACKGROUND

In the 1990s, the commercialization of the Internet started a revolution in the way business is conducted. In particular, the growth of the World Wide Web has offered a unique opportunity for many companies to increase efficiency, forge better customer relationships, and expand their markets through "global visibility" (Medjahed, Benatallah, Bouguettaya, Ngu, & Elmagarmid, 2003). These advantages have led many companies to move their primary operations to the Web. According to CNN and BBC reports, an estimated 20 million Web-based companies came into existence (Pather, Erwin, & Remenyi, 2003). With the flourishing of these companies, the economy faced a new challenge: business transaction over the Internet, or e-commerce. In the early stages of e-commerce, however, the terms Web-based company, Internet-based company, and dot-com company were all used interchangeably to refer to the same sort of online retailer.

As traditional and new companies continued to establish themselves as online retailers, mass media often exaggerated the enthusiasm with such one-liners as "Be Digital or Be Toast!", "Get Web or Be Dead!", and "Dot-Com or Be Gone" (as cited in Pather et al., 2003). At the same time, as the number of Internet users increased exponentially, and online shopping became a popular consumer activity. According to Giga Information Group (2000), it was once estimated that U.S. online retail sales would increase from $26 billion in 1999 to $152 billion in 2002 and $233 billion in 2004. Another prediction suggested that consumers would spend $200 billion on the Internet in 2005 (Chartier, 2000).

Investors also showed their enthusiasm for Web-based companies. In 1999, venture investments in Internet-related businesses exploded, increasing to nearly $20 billion from $3.4 billion in 1998. This was due to the fact that many investors considered technological innovation to be the promising "future value" of a company. Subramani and Walden (2003) confirmed that the public announcement of a company's e-commerce initiative would enhance the market value of that company and thus create value for the company's stockholders. In fact, rather than measuring business performance in traditional ways, many investors demonstrated little concern about gains and losses in profit margins. One recurring comment was that "as long as an e-commerce business 'makes sense' (it does not need to 'make cents'), it may still be backed by numerous investors" (Chan, Lee, Dillon, & Chang, 2001, p. 7).

With the massive investments, the U.S. economy experienced the dot-com boom or dot-com bubble in the late 1990s. The height of the boom was characterized by an enormous increase in stock prices, especially in the prices of Internet-related stocks. Starting in January 1997, the dot-com industry stimulated NASDAQ and thus surpassed expectations with record high after record high. In the period of just one year (1997-1998), America Online's stock rose by 593%, and Yahoo!'s by 584%. Amazing growth occurred in Amazon.com, with a 970% increase. The NASDAQ also showed inflation. Within only six months (September 1999 to March 2000) it showed an 83% increase (Callahan & Garrison, 2003).

However, in early 2000 the stock market witnessed a bubble ready to burst. This burst led to the rapid decline in the value of Internet-related stocks. In the weeks and days that followed the burst, the stock market bounced up and down randomly. For instance, on March 10, 2000 NASDAQ closed above 5,000, but dropped three days later by almost 500 points. On March 22, NASDAQ jumped to 4, 864.75 with a 3% increase and was back to almost 5,000 points at the end of week. However, the overall cycle of NASDAQ during March 10 to April 14 showed a 34.2% decline. More importantly, though, the stock prices for all the 20 leading Internet stocks fell (Cassidy, 2002). For instance, Amazon.com dropped by 29.9%, eBay by 27.9%, Yahoo! by 34.8%, and TheStreet.com by 54.3%.

The first factor contributing to the dot-com collapse was the frenzied buying of Internet-related stocks without serious consideration of whether the companies were actually fiscally sound with strong management plans. This impulsive buying sent the main U.S. market indices (especially the tech-heavy NASDAQ) soaring from a low 1541.80 in late 1998 to a high of 5000 in early 2000.

With this inflation in NASDAQ and in the Dow, many believed that the dot-coms constituted a prime investment opportunity and that technology itself was a good business plan. This idea led to significant growth of the Internet-related sector of the stock market through the overvaluing of stock prices.

The second factor was that investment firms involved in launching IPOs undervalued the initial stock offering, depriving the startups of vital capital resources. For example, Priceline.com went public on March 31, 1999 and initially had an IPO of $16, with an initial public offering of 10 million shares. However, Priceline.com opened the first day of trading at $81.00 with a high of $95.94 and achieved market value of $9.8 billion, the highest first-day ever achieved by an Internet company (Business Magazines & Media Inc., 1999). If the firm had priced the IPO at $30.00, it could have made $300 million instead of $160 million (which it made at the initial IPO). One reason for such undervaluation was the lack of know-how in deciding the true value of dot-coms with complicated situations. Given that Priceline.com had profit and revenues of only $35 million, and there was no justification for predicting the potential market value: "One person who took part in the Prieline.com pricing meeting likened the process of valuing Internet companies to throwing darts" (Cassidy, 2002, p. 216). This scenario was repeated throughout the dot-com industry as billions of dollars were lost in IPOs by the undervaluation of these stocks.

Although the stock market's bounce resulted in many dot-com meltdowns, there are a number of other reasons why many dot-com companies have been unsuccessful at making a profit. One of these reasons is that most dot-com companies did not have a sound business strategy that provided a clear plan.

DOT-COM FAILURES

In some cases, failure was due to financial problems. Most of the so-called B2C (Business to Consumer) companies had spent far too much money marketing themselves to consumers, but had not yet turned a profit. Many dot-coms failed because they spent too much when the company was founded and then simply ran out of money. For instance, Boo.com, founded in 1999, targeted women under 30 who are interested in trendy clothing. The site promised that it would be "working diligently over the next few weeks to position Boo as the ultimate global fashion portal—to deliver all the great things you loved about Boo." But that portal never reached its target audience.

Boo.com's attempt to reach a global community of online "fashion-conscious consumers" made them the first victim in the NASDAQ crash. On May 17, 2000, five months after its Web site launched, Boo.com shut down and filed for bankruptcy. Boo.com's failure was generally credited to its expensive marketing budgets, high technology costs and ambitious Web site. When Boo's Web site launched in November 1999, it was slow because it was graphic heavy as well as inaccessible to some Apple users.

However, one crucial factor leading to Boo's bankruptcy was its failure to make a profit. Boo.com spent $185 million in 18 months to create brand value, but total sales were only $1.1 million in the three months, between February and April 2000 (Cassidy, 2002). In the "old" economy, stock performance correlates with earnings—the more money a company makes, the higher its stock price should increase. But in the "new" economy of the dot-com bubble, investors assumed that market share comes first and profits follow. Boo.com relied heavily on venture capital but revenue did not follow, its failure was inevitable. When NASDAQ began to drop quickly, investors became reluctant to invest in unproven dot-coms (Hirakubo & Friedman, 2002) and these companies failed to secure additional funding.

Another issue for dot-coms was massive spending on media marketing to build e-brand. For instance, Pets.com spent $2.2 million on a 30-second television ad in the 1999 Super Bowl. Another example is the Internet toy retailer, Toysmart.com. Walt Disney Co., the owner of Toysmart.com, spent over $20 million in marketing in 1999 to build the Toysmart brand but the company failed to bring a unique service to their customers and ceased operations on May 19, 2000. Although Walt Disney planned to provide another $25 million before Toysmart.com shut down, this dot-com could not survive under pressure from other toy retailers like EToys.com, toysrus.com and Amazon.com, which all provide wider toy selections.

In some cases, dot-com failures were due to a flawed business model. Many dot-com companies simply failed to create value for their customers and failed to differentiate themselves in a competitive market. Especially apparent was that "over-saturation" became a problem in small markets when companies failed to create a real need for their services (Hirakubo & Friedman, 2002). Wolverton (2000) points out, for example, that there were too many online pet stores with similar names (e.g., Pets.com, Petstore.com, etc.). Such a situation led to a number of collapses among dot-com startups. In November 7, 2000, Pets.com, founded in 1998, announced that it was shutting down its retail operations and laying off at least 255 employees. Pets.com's chairman stated "it is well known that this is a very, very difficult environment for business-to-consumer Internet companies. With no better offers and avenues effectively exhausted, we felt that the best option was an orderly wind-down with the objective to try to return something to the shareholders" (Cassidy, 2002, p. 303). Also, considering that pet food is available at just about any neighborhood grocery store, few people have a reason to shop online. Other online pet stores such as Petopeia.com and PetsMart.com were forced to cancel their IPOs as well.

DOT-COM SUCCESSES

Not all dot-coms were failures during the dot-com crash, and a number of successful dot-coms still exist, including Amazon.com (books, music, movies, and more), eBay.com (online auction), and Drugstore.com (pharmacy, health and beauty aids). The successful companies have learned to modify their business models and to continue finding new ways of making a profit. One of the widely accepted marketing strategies is "relationship" marketing—building relationships with customers. Hirakubo and Friedman (2002) argue that because buyers and sellers are considered as partners in relationship marketing, this partnership promotes long-term growth for the company and increases service satisfaction for customers. These advantages, in turn, bring successful brand management. This scenario is at the core of Amazon.com's success story.

Launched in July 1995, Amazon.com went public in May 1997. Its online sales increased from $66 million in 1997 to $252.9 million in 1998, with a 283% increase. By the beginning of 1999 Amazon.com achieved market value of $6 billion (Saunders, 1999). As a well-branded company, the strength of Amazon.com was in its successfully developing a sense of community among its users, thereby enhancing its relationships with consumers. For instance, Amazon.com encourages customers to write and submit product reviews and allows customers to rate each other's reviews thereby creating a sense of participation. Amazon also uses "suggestive selling". Once a customer sets up an account and starts to make purchases, Amazon.com uses information on those purchases to suggest other products that may be of interest to that customer. For instance, "Recommendation Center" on Amazon.com offers customized products and services by suggesting books by the same author or similar subjects to ones the customer has already purchased. These customer-focused services make possible for the first-time purchaser to be converted to a frequent purchaser. In fact, the loyal customers who repeatedly shopped online generated more than 70% of Amazon.com's sales (Hirakubo & Friedman, 2002).

eBay.com is another example of dot-com success. It was launched in 1995 as the first online auction in the world. Like Amazon, eBay's important assets are its well-known brand and its efforts to build community among customers. For instance, eBay provides online forums where customers (i.e., sellers) talk to and help each other. At www.ebay.com/community, sellers can access hundreds of announcements, join chat groups, and participate in discussion boards and question-and-answer boards where they can exchange opinions and advice with other sellers. Through these activities loyal customers are encouraged to bring in new customers, provide information to the company, and offer assistance to other customers. With such services eBay was profitable from the first month and showed phenomenal growth in revenue over a short time period. eBay went public in September 1998, and its stock rose by 163.2% on the first day of trading (Elms, Bellomo, & Elad, 2005). In twelve months eBay had sales worth $30.5 million and revenue of $1.4 million. In 2002, with an estimated 85% share of the online auction market and 69 million registered users worldwide, eBay made a profit of $250 million (Walker, 2003).

Amazon and eBay survived the dot-com bubble and bust. While many other dot-com failures have been unsuccessful at building their brands, Amazon's and eBay's most important assets are their unique brands. This suggests then that the difference between the dot-com failures and the dot-com successes is that the failures spent too much on marketing themselves to consumers, while the successes promoted relationship marketing.

FUTURE TRENDS

Despite the dot-coms boom and bust, e-commerce sales are reported to be increasing with an extremely promising future. According to reports by the U.S. Department of Commerce (2001-2004), total e-commerce sales continued to increase in recent years. The estimated total e-commerce sales were $32.6 billion for 2001. With an increase of 26.9% from 2001 this figure was $45.6 billion for 2002, $54.9 billion for 2003 (with an increase of 26.3% from 2002), and $69.2 billion for 2004 (with an increase of 23.5% from 2003). Such growth in e-commerce suggests that dot-com survivors from the past moved to the next stage of their life-cycle as the economy has been revitalized.

An important growth trend in the post-dot com age is that organizations have embraced the concept of a portal. As ultimate e-commerce platforms, portals are, generally speaking, Web directory sites like Yahoo!, and have common elements including: reference information, directories of links to topic-related or selected Web sites, and communication channels (e.g., chat, bulletin boards, etc.) and news (O'Leary, 2002).

Corporate marketers are now seeing the potential of their Web sites, and their Web sites are becoming the new portals. Some corporate portals, particularly business-to-consumer portals, demonstrate many creative variations on the basic portal elements. For instance, Pampers.com provides reference and "ask-an-expert" information on babies and parenting. Content using the "community" concept is also popular on corporate portals.

Forums such as bulletin boards, discussion, or live chats are offered as a means to gain users' "stickiness" (i.e., repeated visits by users) on their portal sites.

Despite the dot-com crash there still remains an optimistic expectation that the dot-com industry's "leading edge will take the business to places most have not yet imaged" (Sun Professional Services, 2001, p. 1). Managing complexity—balancing issues of technology and business—will be crucial for success in the dot-com industry. In particular, the growing popularity of portal Web sites among corporations is a new challenge in the current post dot-com age.

CONCLUSION

The late 1990s witnessed the blossoming of e-commerce, as existing and start-up companies were eager to take advantage of the new possibilities. In light of the boom and bust cycle that followed, this period has been dubbed the dot-com boom. Venture capitalist investment, based on inflated estimates of earnings and stock prices, contributed to the dot-com boom. But many dot-com companies running on investment capital without profit met their demise. With the crash of the NASDAQ index, which heavily represented technology stocks in 2000, the dot-com boom went bust.

One important lesson from dot-com "meltdown" is that the Internet cannot save a flawed business model. Many dot-com companies failed because they did not have a business strategy that provided a clear path for making a profit. Despite failures, dot-coms still exist and thus demonstrate that to survive in the rapid growing e-commerce environment companies must follow "consumer-focused" strategies that provide unique products or services and build partnerships with their customers.

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KEY TERMS

Business to Consumer (B2C): One form of e-commerce applications (as opposed to B2B, Business-to-business) in which the seller is a business organization and the buyer is consumer. A typical example is Amazon.com.

Dot-Com Bubble: Refers to the late 1990s during which countless dot-com companies were booming with a frenzy of investment in Internet-related technical stocks and enterprises.

Dot-Com Bust: Refers to the years 2000 to 2002, when dot-com industry collapsed and hundreds of dot-com companies went bankrupt due to the NASDAQ crash starting in March 2000.

Dot-Com Company: A company using the Internet as its primary means to conduct business. The companies typically use the ".com" suffix in company name.

IPO: Abbreviation for "Initial Public Offering." A company's first offering of its stock to the public.

New Economy: Refers to financial and economic infrastructure characterized by reliance on information technologies.

Old Economy: Based on the production of physical goods and unrelated to telecommunications or the Internet, old economy companies have little investment or involvement in the technology industry.

Portals: A Web site or Web directory site considered as an entry point to other Web sites, or relevant resources by incorporating links to subject or topic related. A typical example is Yahoo!

Relationship Marketing: The process of maintaining and enhancing relationships with customers; focusing on customer's needs, this strategy considers customers as important long-term assets.

Venture Capital: A general term to describe financing and investing for startup and early stage businesses.

Leveraging Customer Data Integration for Effective E-CRM Analytics

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INTRODUCTION

A holistic view of the customer is a desirable resource in many organizations today. The findings from a recent DMG Consulting study confirm this reality—possessing integrated customer information is a critical success factor in 11 of the 12 business challenges facing organizations (Kharbanda & Dasgupta, 2001). To achieve a single customer view in today's marketplace often characterized by increasing global competition, shrinking product lifecycles, and decreasing customer loyalty, companies are considering customer analytical technologies to uncover previously unknown and valuable insights. These insights strengthen customer relationships through greater responsiveness and customization, thereby boosting customer loyalty. Many organizations now believe one of the fundamental instruments for creating competitive advantage is deploying information technology that supports and fosters one-to-one relationships with customers (Shoemaker, 2001). This type of customized service can be achieved through customer relationship management (CRM) and electronic CRM (e-CRM) technologies, which enable organizations to maximize their customer relationships and increase profits by leveraging people, processes, and technology for more effective acquisition, retention, and cross-selling/up-selling opportunities.

However, a holistic and integrated customer view remains elusive within most companies. Many businesses still struggle with a basic understanding of who their customers are, what they want, and what they contribute to or cost the company. This is due to the myriad of systems typically found in organizations that contain some form of customer data—CRM and database marketing, legacy and ERP (enterprise resource planning), customer service, order management, financial, call center, and sales force automation systems. In addition, integration complexity grows as organizations add external sources such as customer survey, demographic, credit, and lifestyle data. Integrating relevant data to enable a holistic view of the customer requires overcoming many obstacles, which typically encompass duplicate data, incompatible and conflicting definitions, and ownership/political battles.

BACKGROUND

The analyst firm Gartner refers to customer data integration (CDI) as the people, processes, and technologies required to create and maintain a unique, complete, and accurate customer profile and make it available to all operational systems (Shah, 2005). An effective CDI solution makes economic sense by treating the customer as a person rather than a disparate set of loosely related data sources and systems. It recognizes and analyzes how customer interactions affect every function of an organization, from sales and marketing to operations and support. As previously noted, this seemingly "simple" concept is difficult to achieve in organizations. A recent Meta Group study on customer data integration revealed that the greatest challenge in information management is integrating the wide variety of data sources required for extracting needed information (Kontzer, 2004).

To address this challenge and strengthen customer relationships, organizations are implementing organizational data mining (ODM) technologies, which are defined as technologies that leverage data mining tools to enhance the decision-making process by transforming data into valuable and actionable knowledge to gain a competitive advantage (Nemati & Barko, 2001). The growing interest in ODM and associated predictive technologies is confirmed in a recent IDC study by Henry Morris. After surveying 43 North American and European companies, Morris discovered that the median return on investment (ROI) for projects that incorporated predictive technologies was 145%, while the median ROI for projects that did not was only 89% (Stodder, 2005). This finding illustrates that predictive, customer-oriented ODM technologies such as CRM and e-CRM analytics can offer greater ROI and business value to organizations that adopt them.

CRM can be defined as the adoption, through the use of enabling technology, of customer-focused sales, marketing, and service processes (Forsyth, 2001). CRM is about deploying technology, services, and processes that connect an organization with its customers in the most reliable, efficient, and cost-effective manner while striving to create long-term, profitable relationships. CRM software provides functionality that enables a firm to make the customer the focal point of all organizational decisions. CRM technologies incorporate some of the best-in-class processes for features such as customer service, product configuration, field service, and customer analysis.

CRM has become a key process in the strengthening of customer loyalty and in helping businesses obtain greater profit from low-value customers. The manner in which companies interact with their customers has changed tremendously over the past few years. Customers no longer guarantee their loyal patronage, and this has resulted in organizations attempting to better understand them, predict their future needs, and decrease response times in fulfilling their demands. Customer retention is now widely viewed by organizations as a significant marketing strategy in creating a competitive advantage, and rightly so. Research suggests that as little as a 5% increase in retention can mean as much as a 95% boost in profit, and repeat customers generate over twice as much gross income as new customers (Winer, 2001). In addition, many business executives today have replaced their cost reduction strategies with a customer retention strategy—it costs approximately five to ten times more to acquire new customers than to retain established customers (Pan & Lee, 2003).

Similar to CRM, e-CRM can be defined as the process of acquiring a thorough understanding of an organization's online visitors and customers to create and maintain online loyalty. This loyalty must be built using the most efficient and cost-effective means, since consumers' online attention spans are short, and competing choices are great. E-CRM analytics is the process of analyzing and reporting online customer/visitor behavior patterns with the objective of acquiring and retaining customers through stronger customer relationships.

Prior research has shown that to understand online customers, a company must integrate its data from both online and off-line sources (Mena, 2001). In similar fashion, our study also demonstrates that a company cannot thoroughly understand its customers if it neglects integrating its customers' behavioral data from both the online and off-line channels. In order to have this complete customer viewpoint, it is imperative that organizations integrate data from each customer touch-point. To explore these issues further, we conducted a literature review to provide a foundation for our research. From our literature review, we developed an e-CRM framework and five propositions that demonstrate the importance of data integration in facilitating successful and valuable e-CRM analytics. The research details, findings, and their organizational implications are described below.

RESEARCH FOUNDATIONS AND FRAMEWORK

Past studies (Brancheau, Janz, & Wetherbe, 1996) have shown that data has been ranked as one of the top priorities for IT executives. With the emergence of Web technologies, the collection and storage of data, both internal and external to an organization, has increased dramatically. Internal data refers to data generated from systems within an organization, such as legacy and online transactional processing (OLTP) systems. External data refers to data that is not generated by systems within an organization, such as government census data, industry benchmark data, consumer psychographic data, and economic data. If this data is collected, integrated, and formatted properly, it can prove to be immensely beneficial to a firm in better understanding its customers (Rendlemen, 2001).

Technically, data integration can be defined as the standardization of data definitions and structures through the use of a common conceptual schema across a collection of data sources (Litwin, Mark, & Roussopoulos, 1990). This implies that data is accessible across functional areas, making data in different corporate databases available and consistent. For example, if a traditional 'bricks and mortar' company deploys a Web site and decides to integrate the Web data with its legacy systems, it has to consider various technological and design issues such as data requirements, data quality, data inconsistencies, synchronization, security, and so forth.

Even though data integration is such a complex task, organizations successfully tackling this issue have derived immense benefits from it. For example, Staples Inc. integrated all customer and sales data from their store, catalog, and online efforts into a common database (SAS Institute, 2001). Integrating all this information allows Staples' marketers to monitor and predict how customers migrate from one channel to another or how they utilize the channels to get what they need. Staples can identify what products are purchased at a store vs. their Staples Direct catalog or through their online store. This valuable information gives Staples an edge over its competition and allows marketers to (1) target specific products to customers through preferred channels, and (2) give them the ability to perform cross- and up-selling to customers across multiple channels. This leads us to our first two propositions.

Proposition 1: The more data sources a company integrates, the better the customer insight, thus creating more value for the company.

Proposition 2: Integrating online data with data from the firms' off-line operations will lead to better customer insight, thus creating more value for the company.

Timeliness of data is an important component of user satisfaction (Ballou, Wang, Pazer, & Tayi, 1998). Users need to have up-to-date information about customers' needs and preferences (Swift, 2002) to thoroughly understand and satisfy those needs. Traditional measures of customer-centric metrics such as recency, frequency, and monetary statistics need to be incorporated into the analysis. Without integrated data (from online and off-line sources), these statistics will not be accurate. Traditionally, it was acceptable for organizations to update their customer database on a monthly or quarterly basis. But in today's fast-paced electronic economy where critical decisions are made daily, companies strive for more current information, requiring systems to update their databases much more frequently (daily, hourly, or in real time). This leads us to our next proposition.

Proposition 3: Data that is more frequently refreshed will lead to better customer insight, thus creating more value for the company.

Past experiences or product quality are not the only reasons why customers make purchases. There are factors external to an organization such as new marketplace competitors, economic factors, and competitor promotions that alter our buying preferences. In his book *Web Farming,* Richard Hackathorn (1998) advocates that an organization must integrate external data into its data warehouse to gain a complete picture of its business.

Researchers have also concluded that without data about why a product was purchased, it is difficult to make accurate inferences about future customer needs. Organizations that have a myopic view of the customer risk experiencing an inference gap—they lack a multi-brand, external view of the customer that captures historical data about customer behavior and preferences across multiple organizations in an industry. Making incorrect inferences about a customer can lead to faulty marketing decisions and lost revenues. Conversely, organizations that achieve an accurate multi-brand view of the customer by integrating external data will be more effective at inferring future needs and better able to service customers due to an enhanced customer understanding (Brohman, Watson, Piccoli, & Parasuraman, 2003). Sources of external data include government databases, customer demographic and lifestyle data, credit history data, census data, and weather data. This leads us to our next proposition.

Proposition 4: Integrating external data with internal data will lead to better customer insight, thus creating more value for the company.

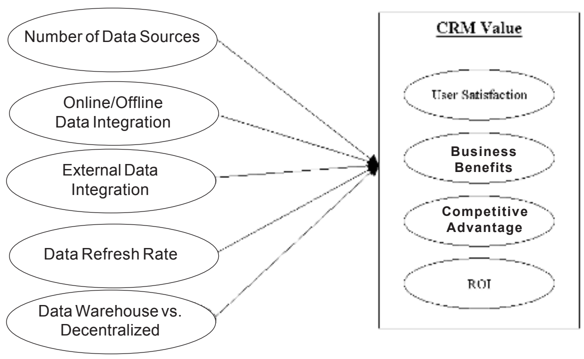
A recent Data Warehousing Institute Industry Report (Eckerson & Watson, 2001) found that organizations are challenged when integrating Web technologies into their existing legacy and IT systems. Some of the reasons behind this challenge are scalability issues, managing large clickstream databases, immaturity of technology, lack of experience, and the complexity of modeling Web data for analysis. But despite these integration challenges, the benefits realized are worth the effort.

In another survey of 800 information technology executives by the Meta Group, four out of five companies did not have a 360-degree view of their customers even though 92% of the firms surveyed ranked increasing customer knowledge as a top priority (Cooke, 2000). This study goes on to report that although business and information technology managers in these companies are interested in obtaining customer knowledge, a number of serious obstacles prevent them from doing so, such as building the right data architecture and obtaining useful analytical tools to integrate and use this data effectively. To be truly effective, an e-CRM infrastructure must provide organizations with a single view of the customer, regardless of how they are interacting with the company (Pan & Lee, 2003). Comparable research has also found that one of the fundamental requirements for a successful e-CRM solution is the consolidation of all customer-related information into a single view (Storey, Straub, Stewart, & Welke, 2000).

For successful CRM analytics, an enterprise wide, customer-centric data repository should be utilized rather than a channel-specific data repository (Beck & Summer, 2001; Swift, 2002). Vasset (2001) suggests an enterprise-wide, customer-centric data warehouse should be the foundation of any CRM initiative. This leads us to our last proposition.

Proposition 5: Deploying an enterprise-wide data warehouse as the CRM backbone will lead to better customer insight, thus creating more value for the company.

Figure 1. E-CRM value framework



Given the promise of strengthening customer relationships and enhancing profits, CRM technology is gaining greater acceptance within organizations. However, findings from recent studies suggest that organizations generally fail to support their CRM efforts with complete data (Brohman et al., 2003). As a result, considerable attention from researchers in many diverse disciplines is currently focused on implementing CRM. Although there is a growing pool of literature that addresses many aspects of the application of CRM for business solutions, there are few scholarly publications that focus on the study of CRM from an e-commerce perspective. Given the complexity of the issues involved in data integration, the enormous benefits that e-CRM can offer, and the role data integration plays in achieving e-CRM's goals, we developed an e-CRM value framework (see Figure 1) to study data integration issues and their impact on the overall value attained from e-CRM projects. Through this framework, we empirically test our five propositions to determine the impact each factor has on creating e-CRM value for an organization. The results of our analysis reveal that four of the five factors support this new framework and have a significant influence on creating value and building a competitive advantage for an organization.

Research Findings

Respondents worked in a wide variety of industries, with the majority coming from CRM/technology, transportation, healthcare, advertising, and financial industries. Job categories for respondents range from executive management to business managers to CRM professionals. These respondents were employed by an equal mix of both small and large companies. The majority of respondents were also clicks 'n bricks (Web and store) companies vs. purely Web retailers.

Our research findings strongly suggest that data integration is essential to accurately assess customer needs, thus allowing an organization to achieve greater e-CRM and business value. Four of the five propositions presented were statistically significant (proposition 3, the daily refresh rate, was not significant), suggesting our e-CRM Value Framework (excluding proposition 3) is a valid model for generating greater total benefits and a competitive advantage for organizations engaging in e-CRM projects (Nemati, Barko, & Moosa, 2003). To achieve the greatest level of benefits, we propose that organizations integrate all their customer data (online, off-line, and external) into a data warehouse or similar CRM data repository. With this architecture in place, a company is able to achieve greater profitability by obtaining a better understanding of its customers and its relationships with them.

FUTURE TRENDS

There is little debate that the volume of data captured and analyzed by organizations will continue to grow. This data explosion will likely require new data mining methods and techniques to accurately and quickly extract valuable knowledge from real-time data streams. Stanford University's continuous query language (CQL) is a variation of standard SQL (structured query language) designed for long-running, "incremental" queries over continuous data streams. The Back Side of Moore's Law (computers get 30% to 40% cheaper every year at the same performance point), along with increasing e-commerce activity, will drive the growth of both off-line and online data storage volumes, requiring more advanced and robust integration technologies. And lastly, we feel the open-source movement popular in today's database, Web server, operating system, and software development environments will eventually permeate data mining and advanced analytics, and possibly even data integration.

CONCLUSION

We have discussed the importance of customer data integration and presented a new e-CRM Value Framework to better understand how organizations can benefit. The significance of integrating data from all customer touchpoints, the number of data sources integrated, and integrating off-line, online, and external data and data architectures are discussed. Our findings suggest that despite the cost and complexity, data integration for e-CRM projects contributes to a better understanding of the customer and leads to higher ROI, a greater number of benefits, improved user satisfaction, and a greater chance of attaining a competitive advantage. Thus, when all else is equal, a company's total value increases when a company integrates data from online, off-line, and external sources. We hope that our empirical research and findings can assist practitioners and managers in identifying more efficient and effective ways of creating CRM value through customer data integration.

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KEY TERMS

CDI (Customer Data Integration): The people, processes, and technologies required to create and maintain a unique, complete, and accurate customer profile and make it available to all operational systems.

CQL (Continuous Query Language): An expressive SQL-based declarative language developed by Stanford University's STREAM project for registering continuous queries against data streams.

CRM (Customer Relationship Management): The technology, services, and processes that connect an organization with its customers in the most reliable, efficient, and cost-effective manner while striving to create long-term, profitable relationships.

E-CRM (Electronic CRM): A subset of CRM that focuses on acquiring a thorough understanding of an organization's online (via the Internet) visitors and customers to create and maintain online loyalty.

E-CRM Analytics: The process of analyzing and reporting online visitor and customer behavior patterns with the objective of acquiring and retaining customers.

Moore's Law: The prediction by Intel cofounder Gordon E. Moore that the number of transistors on a microprocessor would double approximately every 24 months. To date, Moore's law has proven remarkably accurate.

ODM (Organizational Data Mining): The process of leveraging data mining tools and technologies in an organizational setting to enhance the decision-making process by transforming data into valuable and actionable knowledge to gain a competitive advantage.

Location Management and Mobility Modeling in Wireless Systems

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INTRODUCTION

One of the most salient features of wireless communications is that users can deploy a variety of wireless devices to communicate with others, regardless of their locations. Although mobility support provides flexibility and convenience, it introduces many challenging issues to network design, planning, and performance evaluation. With the increasing demand for multimedia applications, location-aware services, and system capacity, many recognize that modeling and management of location and mobility are becoming critical to locating mobile objects in wireless information networks. *Location management* and *mobility modeling* strongly influence the choice and performance of mobility and resource management algorithms, such as routing, handoff, and call admission control in many types of wireless networks. For these reasons, it is important to understand mobility modeling and location management mechanisms and the manner in which these mechanisms depend on the characteristics of mobile environments. This article is concerned with issues in, and methods for, location management and mobility modeling in wireless data networks.

The most distinguished features of next generation *wireless systems* can be highlighted as reliable *quality of service (QoS)* for various applications and global roaming. Since the intrinsic characteristic of mobile communications is mobility support, wireless systems must be able to locate roaming *mobile terminals (MTs)* at any time to deliver services and to maintain connections, as the MTs move from one service area to another. Location management techniques enable mobile users to move around, even between different systems with dissimilar signaling formats and protocols, while simultaneously offering them incoming calls and maintaining services in progress. Therefore, the objective of mobility modeling is to estimate the current and future locations of a mobile user upon the arrival of a connection request, which involves many parameters, such as moving speed, call duration time, distance between the last known position and destination, and geographical conditions. Location management, however, deals with the problem of how to register or update new location of a mobile user with a wireless system, and how to locate a mobile terminal given the information in system databases.

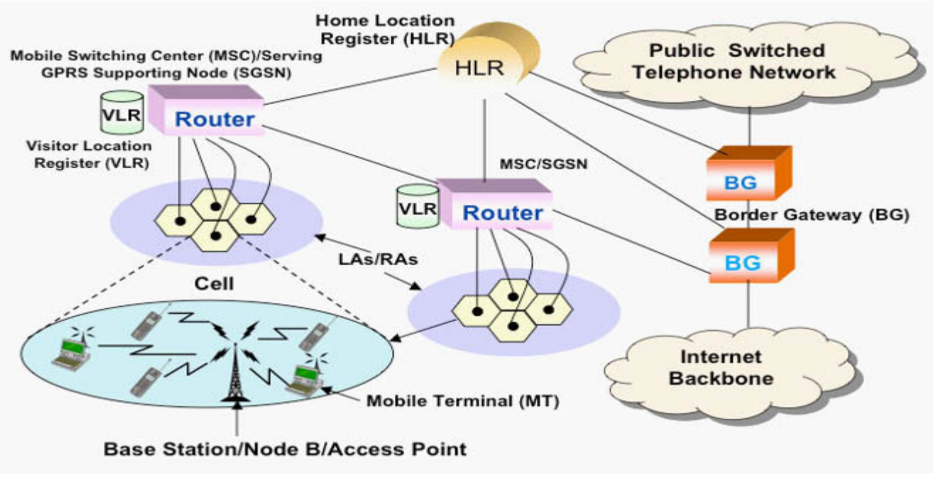
BACKGROUND

System Architecture and Problem Description

In wireless networks, each base station (BS) handles incoming and outgoing connection requests from mobile users residing within its coverage, or radio cell. A cluster of cells can be grouped together, controlled by a mobile switching center (MSC) or a serving GPRS supporting node (SGSN) in *cellular networks* such as *Universal Mobile Telecommunication System (UMTS)*. These MSCs and SGSNs are usually interconnected by wires for high-speed data transmission. The geographic coverage of a group of cells, which is also the area in the control of an MSC, is called a "location area" (LA). In wireless networks, it is very important to maintain the latest location information of each MT in the system so that a connection can be established when an incoming or an outgoing service request is received. However, mobile users change their positions over time. The identity of mobile users and their billing information are stored in a centralized database, a home location register (HLR). When an MT moves into a different region network, it must update or register with a local database, a visitor location register (VLR). In other words, the VLR in a visiting network keeps the most recent location information of a mobile user, and it will communicate with the HLR to renew location information (see Figure 1).

Location management is a technique that updates the location of MTs during the course of their movement and determines the locations of MTs for call delivery. In particular, it includes two phases: location update and *paging*. During location update or location registration, mobile terminals send location update requests to an MSC to establish or refresh their locations information in VLRs. For paging and call delivery, the system needs to search for the called MTs for message delivery. Location update and paging involve algorithms or strategies to send loca-

Figure 1. Network architecture



tion update messages and to find MTs based on known information in network databases; whereas, location registration and call delivery are related to the procedures and signaling messages.

Basic Location Update and Paging Algorithms in Cellular Networks

Location management is a two-stage process that allows wireless systems to discover the current attachment point of a mobile user for call delivery. The first stage is *location update,* or *registration*. In this stage, an MT periodically notifies a network of its new access point, allowing the network to authenticate an MT's identity and revise the user's location profile. The second stage of location management is *paging,* during which the network is queried for the user location profile so that the current position of a called MT can be found (Akyildiz et al., 1999).

The service area of a network is often divided into several LAs so that the MT informs the network when it enters a new LA by monitoring the LA identification (LAI) through public broadcast channels. Usually, MTs send location update requests when they move from one LA to another. With location update/registration, the network is able to keep track of MTs in a specific region constrained by the distance, time, or movement. An LA can be determined by retrieving an MT's record in the HLR; thus, an MT's current residing cell can be found by sending a polling message to all BSs encompassed in an LA. When an incoming call arrives, the MSC, which is associated with the LA of an MT's last registration, sends a paging message via the paging channel to the BSs with the called MT's ID. The serving BS of MT then responds to the network. As a result, the network knows in which cell an MT is residing, and an incoming call can be delivered to the MT.

In current personal communication service (PCS) systems, paging is a fundamental operation for locating an MT. As the demand for wireless services grows rapidly, the signal traffic caused by paging increases accordingly, consuming limited radio resources. In a paging process, a wireless system searches for an MT by sending poll messages to the cells close to the last reported location of the MT at the arrival of an incoming call. Delays and costs are two key factors in the paging issue (Rose & Yates, 1995; Wang Akyilidz, Stüber, & Chung, 2001). Of the two factors, *paging delay* is critical to reducing setup relay of service delivery. *Paging cost*, which is measured in terms of cells to be polled before the called MT is found, is related to the efficiency of bandwidth utilization and should be minimized under delay constraint. Many paging schemes have been proposed to resolve this conflict (Akyildiz, Xie, & Mohanty, 2004).

Mobility Modeling

A variety of mobility models exist that can find applications in different kinds of wireless networks. Because mobility models are designed to mimic the movement of mobile users in real life, many parameters need to be considered. Most of the existing mobility models describe the behaviors of mobile terminals without considering previous records. In this context, we will focus on this type of mobility model and so-called synthetic models, and we will introduce several developments that take traces or profiles into account and combinational models.

Mobility models can be categorized into different groups based on the following criteria (Bai & Helmy, 2004; Camp, Boleng, & Davies, 2002; Hong, Gerla, Pei, & Chiang, 1999; McGuire & Plataniotis, 2003):

- **Dimension:** The movement of MTs can be described in one, two, and three dimensions.
- **Scale of Mobility:** Different level of details may be used to describe a movement, including micromobility (i.e., small scale, and macromobility, such as moving from one system to another).
- **Randomness:** It depends on many unpredictable factors, such as direction, speed, and residence time in a certain area, like a cell (Nain, Towsley, Liu, & Liu, 2005).
- **Geographical Constraints:** Mobility models can be very specific for particular scenarios.
- **Destination Oriented:** Some mobility models are developed to track or describe the route or the path of a movement. For example, if it is known that a mobile user will go to a particular location, it is very likely to estimate the position and the time of his or her traveling.

It is worth mentioning that there are many mobility models, which are derived from the abovementioned models. Also, there are some hybrid models that combine two or more attributes in different models (Lin, Noubi, & Rajaraman, 2004). Several commonly used mobility models will be introduced in this article by describing their motivations, representations, and applications.

CHALLENGES AND NEW ADVANCES IN LOCATION MANAGEMENT AND MOBILITY MODELING

Dynamic Location Update and Delay-Constrained Paging

The standard LA-based location update method does not allow adaptation to the mobility characteristics of the MTs. Therefore, in recent years, there have been many efforts in designing dynamic location update and paging algorithms which take into account user mobility and optimize the total signaling cost of location update and paging. For instance, an MT can update its location or send a location registration request to a wireless network based on the distance between its current location and previous position from which the previous request is sent, which is referred to as *distance-based* location update scheme (Akyildiz, Ho, & Lin, 1996; Liang & Hass, 1999).

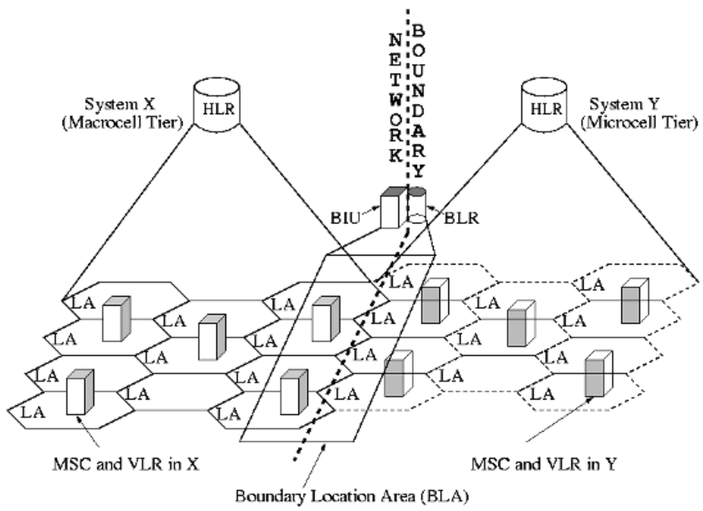
Moreover, an MT can send a registration request upon a predefined timer (i.e., an MT's location information is updated whenever a timer is expired), which was called a "time-based" scheme (Tabbane, 1997). Another location update scheme—a movement-based scheme—in which an MT performs a location update when the number of movements since the last location registration equals to a predefined threshold—a movement threshold. These schemes are aimed at designing location areas so that the total signaling overhead of location update and paging can be reduced. Considering that moving patterns differ from one use to another, some dynamic location management schemes, or mobility-based schemes, are designed based on the mobility scale. For example, location areas can also be designed based on mobility patterns in which a mobile terminal carried by a pedestrian can register its location at a small LA and can register at a large LA when that pedestrian enters a taxi, automobile, or other vehicle. The large LAs are at higher levels of the system's registration hierarchy and small LAs are at lower registration levels. Smaller LAs may consist of clusters of microcells, while larger LAs may be formed by clusters of macrocells or spot beams. The location updating rate tends to remain fixed over a wide range of terminal mobility, which is effective in avoiding excessive location updating signaling traffic (Lin & Park, 1997).

Intersystem Location Update and Paging

Diverse mobile services have stimulated an enormous number of people to deploy mobile devices, such as cellular phones and portable laptops, as their communications means for high-quality services. This demands developing effective techniques to locate and trace mobile users in order to deliver services with minimum overhead in terms of resource consumption and processing latency. Efficient location management techniques for intersystem roaming, which consists of location update/registration and paging, thus have become one of the most challenging issues for next generation wireless systems as the number of mobile users, different types of handsets, and various technologies increases (Akyildiz & Wang, 2002). As shown in Figure 2, there are two systems that may use different protocols, such as personal communication service (PCS) systems in the macrocell tier and Wi-Fi systems in the microcell tier. Each hexagon represents a location area (LA) within a stand-alone system, and each LA is composed of a cluster of microcells. The terminals are required to update their location information with the system whenever they enter a new LA; thus, the system knows the residing LA of a terminal all the time. In the macrocell tier, there may be different systems, such Global System of Mobile Communication (GSM) and Universal Mobile Telecommunication System (UMTS), in which one LA can be one macrocell.

The intersystem location update is concerned with updating the location information of an MT performing

Figure 2. Intersystem roaming: Boundary location area (BLA) and boundary location register (BLR)



intersystem roaming. The intersystem paging is concerned with searching for a called terminal roaming between different service areas. The goal of intersystem location management is to reduce signaling cost while maintaining QoS requirements. For example, reducing call loss is one of the key issues in maintaining connections of ongoing calls; decreasing paging delay is critical to reducing call set-up time. For intersystem location update, we consider a boundary region called *boundary location area* (BLA) that exists at the boundary between two systems in different tiers. As illustrated in Figure 2, systems X and Y are in the macrocell and microcell tiers, respectively. There is a home location register (HLR) for each system, and a user is permanently associated with an HLR in his or her subscribed system. The BLA is controlled by a boundary interworking unit (BIU), which is connected to MSC/SSGN in both systems. The BIU is responsible for retrieving a user's service information and transforming message formats. Also, the BIU is assumed to handle some other issues such as air interface conversion and authentication of mobile users. In addition to the concept of BLA, we designate a *boundary location register* (BLR) to be embedded in the BIU. A BLR is a database cache to maintain the roaming information of MTs moving between different systems. The roaming information of mobile terminals is captured when MTs request location registration in the BLA.

Delay-Constrained Paging Algorithms

In future wireless networks, many applications of multimedia services will have various QoS requirements, including delay, transmission rate, pricing models, and so on. As the demand for wireless services, such as e-mail, e-transactions, and Web-browse grows rapidly, the signaling traffic caused by location *tracking* increases accordingly, which consumes limited available radio resources. To improve the efficiency of bandwidth utilization, location tracking optimization cost under delay constraints is explored, which is based on a time-varying probability distribution on user location (Akyildiz et al., 2004; Fang, Chlamtac, & Lin, 2000; Hellebrandt & Mathar, 1999). The probability distribution of user location depends on factors such as mobility model, calling pattern, and so forth. In order to estimate these probabilities, many tracking schemes are designed to predict cell location probabilities and to estimate the next location of an MT accurately.

One approach to solving the optimal paging problem is to design an optimal searching sequence for polling the probable locations of a called MT, which is aimed at minimizing the signaling cost of paging under time constraint (Rose & Yates, 1995). Another method, which is independent of location probability distributions of mobile users, is proposed to satisfy delay constraint while minimizing the amount of bandwidth used for locating a mobile user (Wang et al., 2001). In this method, cells are grouped by an optimal partition algorithm and a detailed paging procedure is designed for implementations in real systems.

The mobility management issue, which is related to how to keep records of mobile users and how to utilize location information for service delivery, was discussed in this section. In the following section, mobility models that describe the movements of each mobile terminal in wireless networks are introduced.

L

Mobility Modeling

A simple but commonly used mobility model is called the "fluid-flow mobility model," which is derived from Brownian motion with a drift model (Camp et al., 2002). In this mobility model, moving direction, which can be of any direction available, is not considered. Depending on the selection or constraint of velocity, moving direction, and acceleration speed, many other mobility models are developed for different application scenarios (Mark & Zhuang, 2003). In this model, for example, mobile terminals are assumed to be uniformly distributed in the cell, and the movements of mobile users are not correlated. Moreover, the directions of these movements are uniformly distributed on $[0, 2\pi]$.

Although the fluid-flow model can describe the positions of mobile users statistically, it cannot demonstrate details of a movement. Thus, another model, the random-walk model, is developed for such an environment in which there are many entities moving in random directions with unpredictable speed. In this model, a mobile object travels from one location to a new location by randomly choosing a direction and speed. The speed is considered in a range, and the direction is chosen between $[0, 2\pi]$. In simulation, the movement is often observed in a simulation region. If a mobile terminal reaches the boundary of the simulated region, it will be "absorbed" or "bounced" off. The random walk model is basically a memoryless pattern, because it does not consider previous locations and speed values. The only factor that influences future locations and speed is the current status. There are many derivatives of random-walk models, which have been widely used in the design of wireless networks, especially for microcell or picocell systems in which moving users can freely move to neighboring cells.

The two previously described mobility models intend to represent the behaviors of mobile objects without using mobility trace files. However, because mobility trace files are mobile users' records observed in real environments, they can be used to describe moving behaviors in the real world. Toward this end, a combinational model is proposed to characterize different scales of mobility based on synthetic model and empirical results (Brown & Mohanl, 1997). This model consists of micro- and macromovements. At the micro level, it is assumed that the mobile objects move around in the vicinity of their current locations or frequently visited places, such as home and office; this micromobility is described by a random-walk model. At the macrolevel, mobile users move toward a remote destination that is based on their historical records in a wireless system.

A relatively new model, the random waypoint model, is a commonly used mobility model for simulations in wireless networks, especially for ad hoc networks (Bettstetter, Hartenstein, & Perez-Costa, 2003; Camp et al., 2002; Lin et al., 2004). A mobile node in a given simulation area randomly chooses a destination point (i.e., the "waypoint") and moves with a constant speed on a straight line to this point. After it reaches a waypoint, the mobile node will pause for a certain period of time (the "pause time") and change its speed or moving direction. It then chooses a new destination and speed and moves at constant speed to this destination, and so forth. Observing that fluid-flow models and random mobility models are memoryless models, they are not suitable to describe a movement realistically, because, in reality, a mobile user's current speed and location are correlated with their previous speed and directions. Therefore, a Gaussian-Markov model is proposed to capture the correlation of a mobile's velocity in time, in which a mobile user's current speed depends on its previous speed, with a Gaussian distribution (Liang & Hass, 1999). The Gaussian-Markov model has been used in the research of cellular networks and mobile ad hoc networks, as well.

The design a of mobility model is to accurately describe the movement pattern of a mobile object, which is random in dynamic mobile environments. The mobility models discussed can be applied in different scenarios. In

FUTURE TRENDS

Location management and mobility modeling are two major issues in supporting high-speed, real-time applica-

Table 1. Comparison of mobility models. (Their applications are marked with "x".)

	Indoor Environment	Outdoor Environment	Infrastucture (I)/ Ad hoc (A)
Fluid-flow Model		x	I
Random Walk	x	x	I & A
Random Waypoint	x	x	A
Gaussian-Markov		x	I & A

tions over wireless networks, which are of particular importance to e-mobile commerce. As more and more people are concerned with security transactions using mobile devices, location management mechanisms need to be incorporated with authentication, authorization, and accounting. In addition, to protect privacy such as user locations, it is necessary to balance the tradeoff between service satisfaction and security functions since these two requirements, in many cases, are contradictory. Meanwhile, mobility modeling will continue to be a research topic as more realistic factors are taken into account, in addition to the measurements of mobility patterns in campus or test-bed networks.

CONCLUSION

There are many challenging issues in the area of information technology, in particular, incorporating wireless systems in backbone networks for providing ubiquitous services. In this article, an overview of location management and mobility modeling in wireless networks is presented, which includes a brief introduction of the issues, current solutions, and advanced research.

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KEY TERMS

Location Management: A technique that updates the location of mobile users during the course of their movement and determines the locations of mobile users for call delivery.

Location Registration: Mobile users update their location information with a wireless system.

Mobile Users: Customers who use wireless devices.

Mobility Management: A technique that maintains wireless communications of mobile users.

Mobility Models: To describe user movement in wireless networks.

Paging: A technique to locate mobile users in wireless systems.

Quality of Service: Parameters to describe system performance.

Wireless System: A system that provides service through wireless channels.

Category: Concepts, Trends, and Challenges

Location–Based Services in the Mobile Communications Industry

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INTRODUCTION

Advances in wireless communications and information technology have made the mobile Web a reality. The mobile Web is the response to the need for anytime, anywhere access to information and services. Many wireless applications have already been deployed and are available to customers via their mobile phones and wirelessly connected PDAs (personal digital assistants). However, developing the "killer" wireless application is still a goal for the industry rather than a reality. One direction for developing such applications points to location-based services (LBSs). LBSs are services that are enhanced with and depend on information about a mobile station's position. Location information by itself is not the ultimate service, but if location information is combined with content, useful services may be developed. These services offer the capability to users and machines to locate persons, vehicles, machines, and resources, as well as the possibility for users to track their own locations (GSM Association, 2003). The focus of this article is the analysis of the most critical success factors and challenges for LBS.

BACKGROUND

In order to show the domains on which LBS may have an impact, a list with the LBS categories, as defined by the Third-Generation Partnership Project (3GPPP, 2004), is presented in Table 1. Also, based on the information-delivery method, we identify three types of LBS: pull, push, and tracking services (GSM Association, 2003). In the case of a pull service, the user issues a request in order

Table 1. Standardized LBS types and corresponding application domains

Application Domain	Standardized LBS Types
Public Safety Services	Emergency Services Emergency Alert Services
Tracking Services	Person Tracking Fleet Management. Asset Management
Traffic Monitoring	Traffic Congestion Reporting
Enhanced Call Routing	Roadside Assistance Routing to Nearest Commercial Enterprise
Location Based Information Services	Traffic and public transportation information City Sightseeing Localized Advertising Mobile Yellow Pages Weather Asset and Service Finding
Entertainment and Community Services	Gaming Find Your Friend Dating Chatting Route Finding Where-am-I
Location Sensitive Charging	
Service Provider Specific Services	

to be automatically positioned and to access the LBS he or she wants. A use-case scenario demonstrating a pull service used broadly in the LBS literature (Poslad, Laamanen, Malaka, Nick, Buckle, & Zipf, 2001; Zipf, 2002) is the following. A tourist roams in a foreign city and wants to receive information about the nearest restaurants to his or her current location. Using a mobile device, the tourist issues an appropriate request (e.g., via SMS [short messaging service] or WAP [wireless application protocol]), and the network locates his or her current position and responds with a list of restaurants located near it. On the contrary, in the case of a push service, the request is issued by the service provider and not the user. A representative example of push services is location-based advertising, which informs users about products of their interest located at nearby stores. In this service, users submit their shopping-preference profiles to the service provider and allow the provider to locate and contact them with advertisements, discounts, and/or e-coupons for products of interest at nearby stores. So, in this case, the service provider is the one who pushes information to the user. Finally, in a tracking service, the basic idea is that someone (user or service) issues a request to locate other mobile stations (users, vehicles, fleets, etc.).

From a technological point of view, LBSs are split into two major categories depending on the positioning approach they use to locate mobile stations. There is the handset-based approach and the network-based approach. The former approach requires the mobile device to actively participate in the determination of its position, while the latter relies solely on the positioning capabilities of elements belonging to the mobile network. For both of these approaches, several positioning techniques have been developed or are under development. What distinguish them from one another are the accuracy they provide and the cost of their implementation. The most popular network-based positioning techniques are cell-global-identity (CGI) methods, timing advance (TA), uplink time of arrival (TOA), and angle of arrival (AOA), while the most popular handset-based positioning techniques are observed time difference of arrival (OTDOA), enhanced observed time difference (E-OTD), and assisted Global Positioning System (A-GPS; Drane, Macnaughtan, & Scott, 1998; Swedberg, 1999). The accuracy provided by some of these techniques in different coverage areas of the mobile network is presented in Table 2.

In order to understand the emergence of LBS, one has to identify the major forces that brought to the surface the need for this kind of services. There exist four major forces, namely, market forces, competition forces, technology forces, and regulatory forces. Each of them is briefly discussed in the following paragraphs.

Market Forces

Market research around the globe has documented the willingness of mobile subscribers to pay for LBS. The LBS subscriber base is forecast to reach 680 million customers globally by 2006. Predictions are that LBS will generate over $32 billion in Europe only by 2005. Numerous firms have already emerged to tap into this growing opportunity (Rao & Minakakis, 2003).

Competition Forces

Having established large customer bases, cellular-service providers will seek new ways to ensure customer loyalty by offering new types of services. Location-based services are the most promising type of these services (called value-added services). Some of the advantages for the cellular-service provider who offers location-based services are the following.

Table 2. Positioning accuracies

	CGI	E-OTD
Rural Area	1km – 35km	100m – 300m
Suburban Area	1km – 10km	50m – 150m
Urban Area	100m – 1km	50m – 150m
Dense Urban Area	100m – 1km	50m – 150m
	CGI-TA	**A-GPS**
Rural Area	550m	50m – 100m
Suburban Area	550m	30m – 100m
Urban Area	100m – 550m	10m – 20m
Dense Urban Area	100m – 550m	10m – 20m
	E-CGI	**TOA**
Rural Area	250m – 8km	85m - 100m
Suburban Area	250m – 2.5km	30m - 75m
Urban Area	50m – 550m	25m - 70m
Indoor Urban Area	50m – 550m	25m - 70m

- Innovative service provision attracts new customers and enhances existing customers' loyalty to the provider.
- Revenues increase due to the traffic generated by the use of such services.
- There is the capability to introduce new revenue streams through deals with third-party companies (that specialize in LBS implementation and/or provision) in order to sell to these companies user location information.

Technology Forces

The first location-based services are expected to be offered or are already offered to mobile-phone users via WAP, SMS, or MMS (multimedia messaging service). Every mobile phone supports the SMS feature and most of them also support WAP and MMS. The cost for such a phone is negligible nowadays. This means that many customers can instantly make use of the location services provided. In addition, the evolution from GSM (global system for mobile commications) to general packet radio service (GPRS), which means a significant increase in the available bandwidth for data communication over mobile phones (from 9.6 Kbps to over 115 Kbps), also assists the provision of LBS, which in many cases can be bandwidth demanding (not to mention the introduction of UMTS [universal mobile telecommunications system] networks in many countries). Finally, new types of phones such as media phones and "communicators" have already entered the market, giving greater capabilities for displaying information (e.g., user interfaces enhanced with photos, buttons, etc., not only text based).

Regulatory Forces

In the USA, the Federal Communications Commission has issued a directive requiring the identification of the geographical origin of an emergency call made by a mobile-phone user. According to this directive, operators should be able to provide location information for every mobile subscriber who makes an emergency call with an accuracy of 100 m 67% of the time (GSM Association Services Expert Rapporteur Group [ASERG], 2000). A similar directive has been released for the European Union.

SUCCESS FACTORS AND RESEARCH CHALLENGES IN LBS

Despite the appealing idea of using user location information to provide highly personalized and intelligent services, there are certain challenges that should be addressed in order for LBS to succeed. We can divide these challenges into three categories, namely, technological challenges, ethical challenges, and business challenges.

The main technological challenge for LBS is the capability to create easy-to-use and satisfying services. There is much talk concerning what would be the most suitable user interface and type of service (pull or push) in terms of user satisfaction. For example, in the case of push-based services, a user is not required to manually issue queries in order to get the information he or she seeks. The system automatically informs him or her based on the current location and a list of preferences listed in the user's profile. The problem is that in this way, user intent cannot be perfectly captured and the user may be frequently disturbed by out-of-context information. So, despite the easiness of usage (no or minimal interface), user satisfaction is not assured. On the other hand, in pull-based LBS, in which clients have to poll the server for updates, the users may experience difficulties in using these services because cell phones, PDAs, and wearable computers are less suitable for browsing and query-based information retrieval due to their limited input-device capabilities (Burcea & Jacobsen, 2003). All these restrictions along with the unpredictability in mobile environments (disconnections, frequent context differentiations, etc.) have to be taken very carefully into account when designing LBSs. Some of the implied requirements, as identified in Tsalgatidou, Veijalainen, Markkula, Katasonov, and Hadjiefthymiades (2003), are the following:

- A less intensive use of the mobile network and a minimal volume of transmitted data;
- The possibility of off-line operation;
- Simple and user-friendly interfaces, and limited and well-specified amounts of presented information content.

Therefore, it becomes apparent that LBS will not succeed in attracting users without implementing sophisticated techniques based on carefully designed interfaces and/or detailed knowledge of customer profiles, needs, and preferences. So, given existing technical limitations such as device capabilities, access speeds, and so forth combined with human limitations such as reduced consideration sets and the need for speed and convenience, in order for LBSs to succeed, they will need to deliver relevant, targeted, and timely information to consumers at the time and place of their choice (Rao & Minakakis, 2004).

Also, from a database perspective, LBSs raise critical challenges such as spatial and temporal query processing because the continuous movement of users or objects leads to the need for fast and frequent or continuous updates to the databases. Some of the most important database research challenges brought to the surface by LBS, as identified by Jensen, Friis-Christensen, Pedersen, Pfoser, Saltenis, and Tryfona (2001) and Saltenis and Jensen (2002), are the following.

- **Support for Nonstandard-Dimension Hierarchies:** In LBS, the geographical area may be divided into multidimensional regions following the pattern of network coverage. Until now, geographical-area representation models used by data warehouses were in the form of completely balanced trees (strict hierarchies), which cannot capture irregularities like those that frequently occur in mobile networks (e.g., the same region covered by more than one base station).
- **Support for Imprecision and Varying Precision:** Varying precision means that the location of the same user may be pinpointed with different accuracies depending on the positioning technology used while he or she is roaming from network to network. Imprecision means that the location data for the trace of a specific user may be incomplete (e.g., a user may have gone out of the network coverage or may have switched off the device for some time). So, varying precision and imprecision should be carefully handled by employing intelligent query-processing techniques, especially for queries on complete user traces.
- **Support for Movement Constraints and Transportation Networks:** Most of the time, users move on certain routes as defined by transportation networks (e.g., railways, roads, etc.) and their movement is blocked depending on the morphology of the land (e.g., mountains). The incorporation of such constraints in query resolution may offer increased positioning accuracy to LBS despite the potentially low-accuracy positioning technology used.
- **Support for Spatial Data Mining on Vehicle Movement**
- **Support for Continuous Location Change in Query-Processing Techniques**

From an ethical point of view, a critical challenge is to protect user privacy. LBS can potentially intrude on customer privacy. The adoption of LBS is highly dependent on the successful confrontation of digital frauds, attempts of intrusion in customer databases with sensitive data and profiles, and the threat of unauthorized or uncontrolled resale of location information. As underlined in Rao and Minakakis (2003, p. 63), "LBS providers must alleviate consumer privacy fears by implementing secure network and encryption technologies to curb illegal activity and by developing clear communication strategies to interact with customers and allay their fears." It has also been shown that a privacy-intruding service (for example, an always-on tracking service), despite its usability, is not desirable by users since it does not allow them to switch it off whenever they want (Barkhuus & Dey, 2003). So when designing an LBS and in order for the service to be adopted, the provider should take into account very seriously the user's concerns on privacy.

From the point of view of the regulator of the telecommunications market, new laws have to be implemented. In order to protect user privacy, there are certain laws in the United States (Wireless Communications and Public Safety Act of 1999) and the European Union (Personal Data Processing and the Protection of Privacy in the Telecommunications Sector, 97/66/EU Directive) with direct references to the way location data should be handled. However, these laws have certain deficiencies and shortcomings, and there are ongoing efforts to achieve full legislative coverage of the LBS sector.

Finally, capitalizing on the promise of LBS requires developing sustainable and viable business models for offering such services. Unfortunately, until today there has been little effort on developing a framework with which to identify the most appropriate business models for the large variety of LBSs. The major obstacle for this arises from the fact that there is a multitude of players participating in the provision of such services forming a complex value network. The main categories under which these players are grouped are the following:

- Application developers and content providers;
- Service providers and network providers;
- Hardware manufacturers.

The roles of all these different actors or players are many times conflicting if not competitive, and fairness in revenue sharing is viewed differently buy each actor. In this context, it is difficult to determine which activities should be performed by which actor (e.g., should the network operator develop its own services or outsource them to more focused application providers) or to identify which actor should be the dominant one in the business model (i.e., the operator providing access to its customer base, the content or service provider offering the actual service, or the location-technology vendor offering the enabling positioning equipment).

FUTURE TRENDS

In the new era of 2.5G, 3G, and 4G, location-based services have been recognized as one of the fastest growing areas for novel service provision in the telecommunications sector with great revenue potential. What differentiates them from traditional services is their ability to offer highly personalized, context–sensitive, and timely information to users anytime, anywhere. However, they have not yet matured enough in order to provide the so-much-anticipated killer application mainly due to technical, business, and ethical challenges that have not yet been adequately addressed. All the participants in the LBS-provision market should first understand and fix their roles within the value chain, then provide the essential guarantees for protecting user privacy, and finally develop new, intelligent ways to manipulate and present location information in order to increase user convenience and satisfaction.

CONCLUSION

We have discussed several aspects of the role of LBS in today's wireless industry. We primarily focused on technological, ethical, and business challenges imposed by LBS and provided directions for further research. User privacy protection, easy-to-use and context-aware service interfaces, sophisticated geospatial-data management techniques, and flexible business models have been identified as the most critical issues that the LBS industry should pay particular attention to in order for LBS to become a success.

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KEY TERMS

A-GPS: The assisted Global Positioning System uses measurements from fixed GPS receivers scattered throughout the mobile network in order to assist a mobile phone in locating the available satellites and calculating its location.

AOA: The angle-of-arrival method measures the angle of a signal arriving at the antenna of a base station. The intersection of the projection of two calculated angles (from the antennas of two base stations) on the two-dimensional space reveals the location of the mobile phone.

CGI: Each base station in a cellular network has a unique ID that the mobile phone receives when entering the area of the base station. Cell global identity uses this unique ID in order to pinpoint the base station's area of coverage in which the mobile phone is located.

CGI-TA: Cell global identity with timing advance is a positioning method that uses the time needed for a signal to travel from the mobile phone to the base station to compute the distance between the phone and the mobile station. Along with the base station's ID, this method provides a rough estimation of the position of the phone in the base station's area of coverage.

E-OTD: The enhanced observed-time-difference method is similar to OTDOA without the need for base stations to be synchronized (additional elements are used that measure the real-time differences between base stations to correct the measurements).

MMS: The multimedia messaging service is a service giving the capability to a mobile-phone user to send a message containing any combination of images, video clips, text, and audio to another user.

OTDOA: Observed time difference of arrival is an alternative for the TOA method in which the mobile phone measures the time differences between signals from three or more base stations.

PDA: A personal digital assistant is a small, palm-sized mobile device with increased processing and viewing capabilities.

SMS: The short messaging service is a service giving the capability to a mobile-phone user to send a text message to another user.

TOA: The time-of-arrival positioning method is based on measuring the time needed by a signal transmitted by a mobile phone to reach three or more location-measurement units (LMUs). From these measurements, the distance between the phone and the LMU can be calculated as the radius of a circle with the LMU as its center. The intersection of three or more such circles gives the actual position of the mobile phone.

WAP: The wireless application protocol is a protocol for providing Internet-connectivity access to thin-client devices, such as mobile phones.

Category: Applications of E-Technologies

Managing Advergames

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INTRODUCTION

Advergames have been defined as online games that incorporate marketing content (Dobrow, 2004). They are *interactive* games that are centered around a brand, a product, or a character associated with a brand or a product. The game can be used to demonstrate the use of a product or to associate the product with an activity or a lifestyle.

Studies conducted in the U.S. have discovered that games are extremely popular among all categories of online users. A study conducted by Jupiter Media found that in December 2003, 84.6 million people visited online gaming sites (D5 Games, 2004a). This number is projected to reach 104 million by 2007.

The preconception that only kids or teenagers are interested in *interactive* games is contradicted by findings: in the U.S., 66% of the most frequent game players are over 18 years old, and 40% of them over 35 years old, the average age of a player being 28 year old (D5 Games, 2004a). Another study conducted during December 2003-January 2004 in the U.S. has identified women over 40 years old as a major segment interested in online gaming (Arkadium, 2004)—they spend 9.1 hours per week playing games or 41% of their online time in comparison with only 6.1 hours per week, or 26% of their online time for men.

These data demonstrate the huge potential of *advergames* (Rodgers, 2004; Sennott, 2004). However, despite the hype created by this new *advertising* method, most of the information presenting advergames is professionally-oriented (DeCollibus, 2002; D5 Games, 2004b; Hartsock, 2004). Very few academic studies have been initiated to investigate the characteristics of advergames, and their influence on *consumers' perceptions* and *behavior* (Hernandez, Chapa, Minor, Maldonaldo, & Barranzuela, 2004; Nelson, 2002).

This article attempts to identify, based on the existent professional literature, the specific characteristics of an efficient advergame, and to verify the influence of advergames on players' behaviour. Therefore, the research objectives of this study are the following:

1. To present the potential of advergames.
2. To discuss the theories explaining the effect of advergames on consumers' perceptions and behaviour.
3. To analyze the influence of advergames on consumers' behaviour, using the empirical data collected through an experimental research project.

The following section of this article presents the main characteristics of advergames. Section 3 opens a theoretical debate regarding the mechanism of action of advergames on consumers' perceptions and behaviour, based on the "state of flow" and the AIDA models. The effect of advergames is empirically investigated in Section 4, which presents the results of a survey conducted in Montpellier Business School, France. The article concludes with an overview of the study and with proposition for future research.

DESCRIPTION OF ADVERGAMES

The interest in *advergames* has substantially increased in the last five years, because of its perceived advantages (FreshGames, 2002; WebResource, 2004):

- Low-cost marketing in comparison with the traditional *advertising* channels, such as TV and radio;
- A captured audience that can transmit valuable personal information about their demographic profile, behaviour, needs, attitudes and preferences;
- Customer retention: the average time spent in an advergame is 7 to 30 minutes, which cannot be reached for a classical TV advertisement.
- Viral marketing: 81% of the players will e-mail their friends to try a good game.

The advergames industry is using the format of classical computer games: the Internet user is able to access a set of instructions that describe the game, the main commands and the tastes that activate them, and then he/she is invited to start playing. Although the advergames are free, some games require registration, the data introduced by the player providing important information about the profile of the audience. Depending on their complexity, the advergames can have one or more game levels, and can be played alone or together with other participants. The score is displayed on the screen, and, in line with the viral aspect of advergames, the players are often encouraged to send information about the game to their friend and relatives, an e-mail facility being offered for this purpose. In order to increase the motivation of players, some advergames promise gifts, prizes, or promotional incentives to the best scorer(s).

The companies specialized in creating advergames have identified and presented the characteristics of an efficient advergame (D5 Games, 2004b):

- Accessible to all users, and especially to non-gamers;
- Immersive and engrossing—it should capture and hold player's attention for 5 to 30 minutes;
- Easy to understand, but challenging;
- Competitive—encouraging repeated visits;
- Relevant for the firm/brand/product that is advertised;
- Viral—to encourage communication with friends or family.

An advergame can be designed and used for various reasons, such as:

- To increase the notoriety of a firm, a brand or a product;
- To associate positive emotions with a firm, a brand or a product;
- To initiate an action of *viral marketing*;
- To introduce and facilitate a promotional campaign;
- To induce the purchasing behaviour, and therefore to increase the volume of sales; or
- All of the above.

As any other marketing communication tools, the advergame characteristics will have to correspond to: (1) the personality of the advertised brand, (2) the profile of the targeted audience, (3) the characteristics of the medium—in this case the Internet, and (4) the strategic objectives of the communication campaign.

The difficulty to concomitantly evaluate these complex variables is probably the reason for a low rationalization of the advergame development in the professional literature. The creation of an efficient advergame is still considered predominantly as a creative work, that it is difficult to describe in a formal, precise manner.

THE INFLUENCE OF ADVERGAMES ON CONSUMER PERCEPTIONS AND BEHAVIOUR

The placement of products or brand names in movies or TV shows is a relatively old technique, but the studies regarding their influence on *consumer perceptions* and *behaviour* are inconclusive (Gould, Pola, & Grabner-Krauter, 2000; Russell, 2002). The advergames present a few distinct characteristics that can eventually enhance their marketing effect:

- The advergames are selected by the player himself/herself, and are not forced upon an unwilling viewer;
- The player interacts with advergames adopting an active stance, in comparison with the passive attitude of the TV audience;
- Advergames incite the players to share the gaming experience with their friends or family.

From a marketing point of view, the advergames attempt to capture the attention of players, and then to transmit to them, in an indirect way, suggestions that aim to modify their *perceptions* regarding an enterprise, brand, or product.

The psychological fundament of this process is the inducement of the "state of flow". This concept is used by psychologists to describe a mental state in which attention is highly concentrated on a specific process, the environmental information is screened out, and the person experiences a harmonious flow of present experience (Csikszentmihalyi, 1991). The *state of flow* is known to create a state of well being, as well as increased perception and learning capacity.

The state of flow can be induced by any activity that is very interesting for a person: watching a movie, reading a book, or playing a game. The ludic activity is considered as one of the best inducers of the flow state for children, and often also for adults.

The interaction with Internet applications can also induce the state of flow in specific circumstances (King, 2003). Mihaly Csikszentmihalyi, world specialist in the state of flow, outlines that the most successful Web sites are the ones that offer interactive experiences, and not simply content.

The state of flow can be created online if the following essential conditions are combined: user motivation, user telepresence, and interactivity of the Internet application. On the other hand, the existence and the maintenance of the state of flow is a dynamic process that depends on the relation between the capabilities of the user—or player in the case of an advergame—and the level of difficulty proposed by the game. Figure 1 presents three possible scenarios of the interaction between an Internet user and an advergame.

When the capability of the player is lower than the difficulty of the advergame, the player will experience frustration and will abandon the game with a negative feeling. If the capability of the player is higher than the level of difficulty proposed by the game, a feeling of boredom is likely to result, determining the exit of the

Figure 1. The inducement of the state of flow online

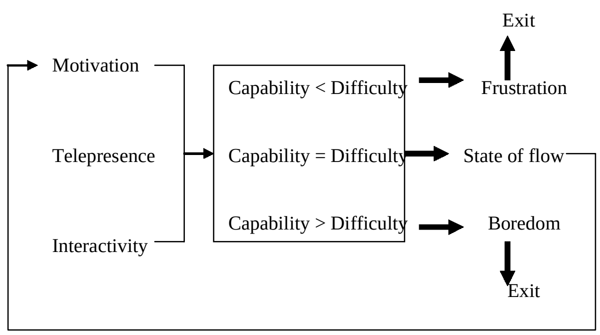
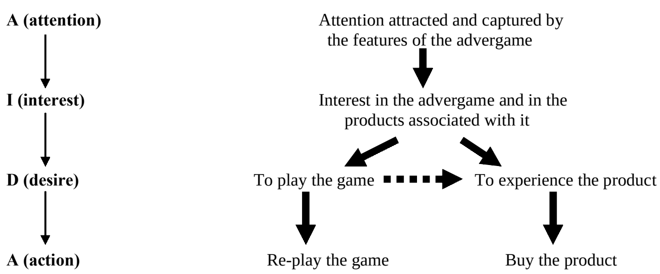


Figure 2. The possible influence of the advergame on the perceptions and behaviour of players, explained though the four phases of the AIDA model



player from the advergame environment. Finally, if the level of capability of the player and the level of difficulty of the advergame match, the state of flow results and reinforces the motivation of the Internet user to revisit the site and to play again the game.

However, the situation is more complex than that. Once induced, the maintenance of the state of flow requires a constantly evolving challenge for the player, because his/her level of capability is likely to improve after playing the game a few times. This raises the problem of including in the advergame a progressive level of difficulty that can represent a dynamic challenge for players.

In terms of consumer behaviour, one of the most popular models in explaining the effect of marketing communication messages on the prospective customer can be used to investigate the possible effects of advergames. The *AIDA model* was developed by St. Elmo Lewis in the 1898, its longevity and applicability being determined by its simplicity and clarity (Fill, 2001).

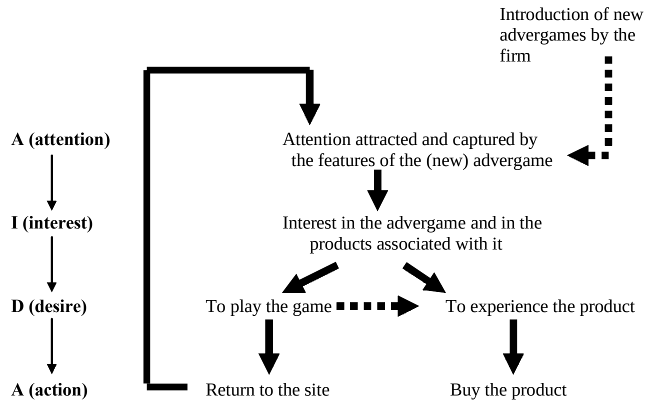
Considering the effects of advergames on the perceptions and behaviour of a player/consumer, we can define for every stage of the model a specific influence (see Figure 2).

A main problem might appear during the transition between the second (Interest) and the third stage (Desire). Some players might ignore completely the marketing dimension of the advergame and, although they continue to play, their behaviour does not evolve towards purchasing the advertised product. Ideally, the desire to play the game should influence in an indirect way the consumer's perception, creating the desire to experience the advertised product that can eventually lead to a purchasing action.

The application of the AIDA model to advergames has a number of important limitations. First of all, the presented situation corresponds to a singular interaction company-customer. Nowadays, the development of a long-term relationship between the firm and its customers has become essential for increasing and stabilizing the profitability of the company, which transforms the use of advergames in a dynamic, iterative activity (see Figure 3).

On the other hand, the viraal marketing dimension is not represented in the above model. Viral marketing describes any strategy that encourages individuals to

Figure 3. The iterative application of the AIDA model for advergames in the context of relationship marketing



pass on a marketing message to others, creating the potential for exponential growth in the message's exposure and influence (Wilson, 2000). The use of advergames corresponds well to a strategy of viral marketing, which incorporates the following principles (Wilson, 2000):

1. Give away products or services;
2. Provide for effortless transfer to others of these products/services;
3. Scale easily from a small to a very large audience;
4. Exploit common customer motivations and behaviors;
5. Utilize existing communication networks to transfer the products/services, or messages about them;
6. Take advantage of others' resources (existing users/customers).

From the perspective of the viral marketing strategy, the application of the AIDA model becomes even more complex (see Figure 4).

In order to verify the effect of advergames on players' behaviour, an experiment was designed and applied in Montpellier Business School, France. 100 first year students aged between 20 and 24 years, were asked to fill in a questionnaire about their buying habits of two competing soft drinks brands: Pepsi and Coca-Cola, as well as about their knowledge of advergames related with these two brands. In the second stage of the experiment, they were invited to access the Web sites of the two brands and to play the games available online. Finally, in the third stage of the research project, 10 days after they were asked to play the games, the students were given a second questionnaire, focused on their

Figure 4. The iterative application of the AIDA model for advergames in the context of relationship marketing, using the framework of a viral marketing strategy

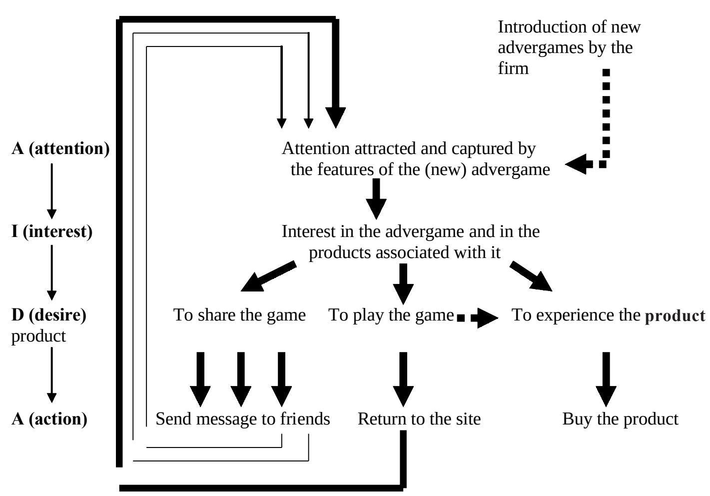


Table 1. The influence of previous knowledge about advergames on their evaluation—for Pepsi advergames

Previous knowledge / Evaluation of advergame	No N	No %	Yes N	Yes %	Total
Neutral	21	22.8	7	87.5	28
Positive	71	77.2	1	12.5	72
Total	92	100	8	100	100

Chi Square = 15.270 p < 0.0001

Table 2. The influence of previous knowledge about advergames on their evaluation—for Coca-Cola advergames

Previous knowledge / Evaluation of advergame	No N	No %	Yes N	Yes %	Total
Neutral	17	20.2	11	68.8	28
Positive	67	79.8	5	31.2	72
Total	84	100	16	100	100

Chi Square = 15.689 p < 0.0001

Table 3. The consumer behaviour before and after exposure to advergames

	Consumption of Pepsi before exposure		Consumption of Pepsi after exposure		Consumption of Coca-Cola before exposure		Consumption of Coca-Cola after exposure	
	N	%	N	%	N	%	N	%
Very frequently	17	17	19	19	18	18	22	22
Frequently	8	8	26	26	25	25	30	30
Occasionaly	16	16	19	19	27	27	28	28
Rarely	45	45	25	25	20	20	12	12
Never	14	14	11	11	10	10	8	8
Total	100	00	100	100	100	100	100	100

evaluation of advergames, the effect of viral marketing induced by these games (communication with other people about these games), as well as on the evolution of their buying behaviour as a result of their exposure to advergames. The data collected were analyzed using the SPSS software.

Table 1 and 2 demonstrate that there is a statistically significant relationship between the previous knowledge about the advergame and the evaluation of the advergame, to a level of p < 0.0001. In fact, the results show a certain "fatigue" related with an already known game—for both games proposed to respondents, the large majority of people that already known the game have evaluated it neutrally, while the new players tend to appreciate them positively. This indicates the importance of novelty for an advergame; once played, the game becomes uninteresting and looses its impact on players' behaviour and perceptions.

Table 3 shows that the advergames had an important impact on the buying behaviour of respondents. The frequence of consumption for both Pepsi and Coca-Cola have increased significantly after the exposure to advergames.

In what concerns the viral marketing effect, Tables 4 and 5 show that the players who had a positive evaluation of advergames tend to transmit the information to more people than the persons that have only a neutral opinion about the advergame. Relating this finding with the information presented in Tables 1 and 2, it means that the viral effect of the advergame is directly related with its novelty and attractiveness.

An objective evaluation of the advergame relevance for the firm/brand/product advertised is difficult at this stage, because it is necessary to define a number of quantifiable criteria that can describe and assess the personality of a brand. However, future studies should investigate this dimension in order to identify the compatibility between the image of the company/brand/product and the characteristics of advergames.

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Table 4. The influence of the evaluation of Pepsi advergames on the communication with other people

Communication / Evaluation of advergame	More than 7 people N	%	4 to 6 people N	%	1 to 3 people N	%	None N	%	Total
Neutral	0	0	8	16.3	17	48.6	3	23.1	28
Positive	3	100	41	83.7	18	51.4	10	76.9	72
Total	3	100	49	100	35	100	13	100	100

Chi Square = 11.982 p = 0.007

Table 5. The influence of the evaluation of Coca-Cola advergames on the communication with other people

Communication / Evaluation of advergame	More than 7 people N	%	4 to 6 people N	%	1 to 3 people N	%	None N	%	Total
Neutral	1	5.3	5	16.7	15	42.9	8	50	29
Positive	18	94.7	25	83.3	20	57.1	8	50	71
Total	19	100	30	100	35	100	16	100	100

Chi Square = 14.107 p = 0.003

CONCLUSION

The advergames represent an important new area of studies, related with the quick development and application of new technologies in advertising. Until now very few academic studies have been initiated on this subject, most of the secondary information about advergames use and development being provided by the professional literature.

This article attempted to present the influence of advergames on players' behaviour and perception regarding the represented products or brands. Based on a theoretical discussion of the main mechanisms that can influence consumer behaviour, an exploratory experiment was designed and implemented. The results, although limited in scope and number, show a clear relationship between the exposure to advergames and an increased consumption of the represented brands. On the other hand, the novelty and the attractiveness of advergames play an important role in the dissemination of viral information about these advergames.

The methodology applied in this project can be used in future studies, to analyze in more depth the relation between the characteristics of advergames and the image/personality of the represented brand/product, and, on the other hand, the profile of targeted players. Only on the basis of a good understanding of their mechanism of action and of their effects, the advergames can be designed and implementer more efficiently.

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Managing E-Business Change

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INTRODUCTION

Kalakota and Robinson (1999) state that "the creation and implementation of an e-business project is inextricably linked to the management of change" (p. 60). This requires systematic attention to learning processes, organisational culture, technology infrastructure, people and systems thinking. E-business change (eBC) is defined as the processes surrounding the effective management of different stages of online business development and growth. Guha, Grover, Kettinger, and Teng (1997) view this as an organisational initiative designed as a business project "to achieve significant breakthrough improvements in business performance" (p. 121). For example; cost reductions, responsiveness and flexibility, customer satisfaction, shareholder value, and other critical" e-business measures. Planning and managing such systems requires an integrated and multi-dimensional approach to the development of new e-business processes (Kumar & Crooks, 1999; Scheer & Habermann, 2000). Sharma (2004) recommend "a change management framework for e-business solutions" (pp. 54-69).

This article reports on the findings from multiple case studies of e-business projects in ERP enabled organisations. The summation of the findings from four case studies is captured into a pattern of generalisations for the components of an established research model. Various patterns are developed as indicators of success, trends and variance that have implications for both research and practice. This suggests an improved model of eBC management, refined in terms of the relationships between the elements of the model. Such a model would represent a comprehensive tool, for assisting managers in diagnosing the key facilitators and inhibitors of successful e-business projects for B2B interaction.

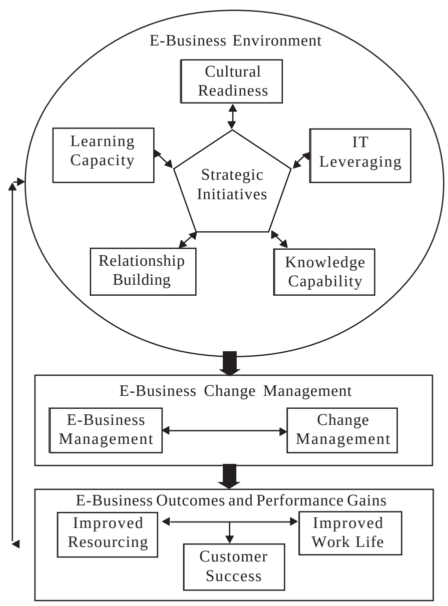
BACKGROUND

In trying to bring about e-business change: *"managers would do well to recognise the complementary nature of technology, business models, and e-business readiness throughout the value chain from their suppliers to their customers"* (Barua, Konana, Whinston, & Yin, 2001, p. 39).

Theoretical Framework

The study used an established theoretical framework (Figure 1) from business process change case-based research (Guha et al., 1997), for identifying and examining the facilitators and inhibitors of successful e-business projects. The model represented by Figure 1 was adapted from previous research on business process change by Guha et al. (1997, p. 121) to include e-business change. Also it acknowledges the existences of inter-relationships between components, as suggested by Kaplan and Norton in developing their Balanced Scorecard (2000, p. 168, 2004, p. 55).

Figure 1. Model of e-business change (Adapted from Guha et al., 1997, p. 121)



Research Approach

The research proposed three questions:

1. Which components of eBC framework facilitate and/ or inhibit success of e-business projects?
2. What are the critical success factors of e-Business projects?
3. Is the eBC framework appropriate for identifying patterns of change?

Embedded multiple case study analysis was chosen to investigate the research questions concerning the complex phenomenon of e-business change projects, in eight organisations (Yin, 1989). Embedded approaches enlist the use of multiple units of analysis: (1) the company (strategy), (2) the project team, and (3) the project. This triangulation attempts to validate primary data (Eisenhardt, 1989).

The case study selection criterion required a major e-business project, which had organisational implications. Also, as the focus was on studying antecedents to organisational performance, a set of projects having a range of B2B initiatives with variance across cases, but with the same outcome measures was required: cost reductions, responsiveness and customer satisfaction, shareholder value, and other e-business metrics (Venkatraman & Henderson, 1998, p. 34).

Case information for this study was gathered from three data sources:

1. **Primary Data:** From interviews using an established semi-structured questionnaire with questions that map the eBC items in Table 1, conducted between June and July 2000.
2. **Secondary Data:** From company documents collected or sent via e-mails in 2001.
3. **Tertiary Data:** From case articles written by authors and other researchers in 2002.

Data-collection methods included a semi-structured case protocol as; (1) a qualitative interview questionnaire, (2) multiple documents and archival records, and (3) telephone interviews. Such triangulation reduces bias and is recommended in case research (Kean & Parent, 1998, p. 308).

Case Selection

Eight cases were used for an initial assessment of the components of the eBC framework. A "Summary of Comments" table was constructed for each case by identifying key comments captured from case interviews. In each case, the components were assessed for their contribution or influence to the project success, using a 3-point scale.

Four cases out the eight that participated were selected to provide the detailed content for analysis against the eBC model. Halliburton is the representative of the four cases that exhibited little or no inter-organisational focus; that is with 'nil' B2B interaction:

- Case 1, Halliburton: [nil] business-to-employee (B2E) "Employee Tracking"
- Case 2, British Biotech: [low] business-to-supplier (B2S) "B2B Procurement"
- Case 3, Fujitsu-Siemens: [mod] business-to-customer (B2C) "Online Sales"
- Case 4, Dell & LSI: [high] B2S + B2C "B2B E-Commerce Integration"

CASE SUMMARIES

Case 1

For Halliburton, the primary beneficiaries were the off-shore project managers who needed access to the HR employee tables for personnel management and gained this through the innovative use of web-based technology. The result was one of considerable cost savings and improvement of staff resourcing through improved decision making by the project managers when working off shore. The intrinsic motivation and self-management of autonomous knowledge within the development team played an important role in the successful implementation. The emphasis was much more on collective performance rather than individual, but at the same time, development and maintenance of personal and professional reputations was a significant driver. Interestingly, while the project was rated highly successful there was strong opposition from their partner operations to implement the same system. This came from the counterpart HR staff who had not been exposed to the participative development process. The organisational management was lukewarm in their support initially, viewing the proposed system as a threat to a strongly centralised control culture. Once the benefits broke down their initial reluctance, management assumed responsibility for the success and leadership for global implementation.

We are very proud of our Web-based Personnel reporting system. (SAP project manager)

Case 2

British Biotech is a research and development stage pharmaceutical company based in the UK. Its mission is to create partnerships with pharmaceutical companies to complete the development and marketing of its compounds. The B2B Procurement project was able to ease the workload of the company's procurement department by automating the old, paper-bound purchasing process. The next step of the project was to negotiate more favourable conditions with the slimmed-down vendor base and build up closer business relationships with each one. Apart from more efficient purchasing procedures, the company's buyers have a more interesting job. Biotech's scientists should be relieved of routine paperwork, enabling them to concentrate more on research. B2B Procurement is expected to broaden day-to-day task base (Shaw, 2003).

They'll have more time to spend on nurturing relationships and working on optimisation of projects and other duties. (manager of SAP B2B project)

Case 3

Fujitsu-Siemens Computers (FSC) showed how a computer technology division within a large global organisation succeeded in making the sell-side e-business processes available over the Internet. An order and request (extranet) system was developed as an appropriate online sales system by leveraging the power of graphics and Internet technology, thus extending the reach for cross-divisional users. The efficiency gains came from speed, accuracy and security of order transactions. The primary beneficiaries were the other business partners (divisions) and independent partners. The result was one of considerable cost saving and greatly improved online sales, through any time, anywhere access (Siemens, 1999).

Interestingly, while the project was rated moderately successful the opposition came from the partner reluctance to implement the same system due to the conflict of the established offline sales channels. Further, the lack of a coordinated corporate wide strategy by the parent company was viewed as the main obstacle for uptake of the system by the business partners.

The lessons learned were two fold; (1) the use of a common platform needs the agreement of all functions, (2) The internal and external marketing of the facility is essential to the acceptance of divisional business network and to foster end-user acceptance of the technological change in business practice. Once the initial benefits broke down user reluctance, management "assumed" responsibility and leadership for a new global strategy. It highlights the need to evolve a coordinated corporate strategy and encourages the balancing of conflicting organisational knowledge when contemplating the adoption of e-business solutions.

We are beginning to recognise the potential benefits of leveraging our e-business processes and functionality through the new Web-based environment. (SBS manager)

Case 4

In 2000, Dell pioneered its first B2B "e-business integration" with an established customer company, LSI. This case demonstrates a comprehensive approach to inter-enterprise computing. This is an example of an integration architecture made possible through a variety of backend systems and procurement systems. LSI, was able to leverage its existing backend system and SAP business connector supported by Web technology to communicate directly with Dell's e-business system. The integration between LSI's SAP system and B2B e-procurement application to Dell catalogues automated the procurement of Dell products via the Internet (Dell, 2000).

We are beginning to recognise the potential benefits of leveraging our partners SAP R/3 business processes and functionality through B2B e-Commerce integration. (Dell's B2B project manager)

FINDINGS AND IMPLICATIONS

The overall findings show the Dell Corporation achieved most success, Fujitsu-Siemens Computers achieved moderate success, while Halliburton was least successful. Assuming these ratings reflect the presence of facilitators and inhibitors, then the initial findings indicate that a successful project should have facilitators in all components, including the business environment and project management, (e.g., Dell). Further there is the implication that the least successful e-business projects will have inhibitors in the areas of cultural readiness and change management practice, (e.g., Halliburton).

Evaluation of E-Business Project Success

Table 1 summarises the data captured on each construct. Consistent with the research objectives, specific probes were made concerning the constructs of each component of eBC. In addition, any construct that had a positive or negative influence on conducting eBC, or overall eBC effectiveness, was documented with either a plus (+) or a minus (–) sign. These positive or negative influences were identified and cross-validated either through direct statements by the respondents during the interview or from other data sources. In some cases, both positive and negative (+ & –) contributions were found from one component variable. For Halliburton leadership was found to exhibit (+ & –) contributions.

Table 1 is especially useful in separating those constructs that have variance across the range B2B Interactions and those that have none. For *stimuli* all four case were the same, *proactive* but reacted very differently to stimuli. To be successful, eBC management must support a *proactive* way the organisation *reacts* to the stimuli. While most successful organisations had positive characteristics, not all characteristics were seen to be equally important or indeed to directly influence success. Some constructs such as *cross-functional cooperation* were seen as "satisficing" factors, that is, they needed to be present but not necessary to be excellent. These involve components other than strategy and cultural readiness.

Lessons Learned

In Table 1, Dell is rated as the most successful project consistently showing positive facilitators in all components of the eBC model. In contrast, FSC acknowledged many inhibitors, and is rated moderately successful. Inhibitors to eBC were clustered in the areas of cultural readiness and change management.

These results confirm that the more successful projects were found to have facilitators in all components of the eBC framework, including the change environment and project management. Further, there is the implication that the least successful e-business projects will have inhibitors in both dimensions, especially in the area of cultural readiness and change management (Farhoomand, Markus, Gable, & Khan, 2004).

The cases highlight the need to evolve a coordinated corporate strategy and encourage the balancing of conflicting organisational knowledge when contemplating the adoption of e-business solutions. While this research found an important role for IT in support of eBC, the message from these case studies is that IT should not drive e-business projects.

Although all four cases reported a "proactive" response to the strategic *stimuli* construct, each reacted very differently to stimuli. In managing eBC, the organisation needs be proactive in reacting to stimuli. While the most successful organisation had positive characteristics in all components, not all characteristics were seen to be equally important or indeed to directly influence success (Markus, Axline, Petrie, & Tanis, 2000). This is viewed as a satisfying condition for success.

A MODEL FOR MANAGING E-BUSINESS CHANGE

While the study used a flat model of eBC, where all constructs in Table 1 were considered antecedents to success, the results from the case analyses suggest a more sophisticated configuration of interrelated components. A dynamic model for managing eBC is proposed for future studies where the focus is on inter-relationships between the components of eBC within three core levels of business activity: strategy, development and management.

Figure 2 represents a new conceptual framework for managing eBC distilled from the case findings. It illustrates how strategy drives developmental and management activity, management supports developments in e-business, which in turn provides feedback to strategic planning (Kaplan & Norton, 2004; Kaplan & Sawhney, 2000).

Table 1. Detailed findings for each construct with + & – identified

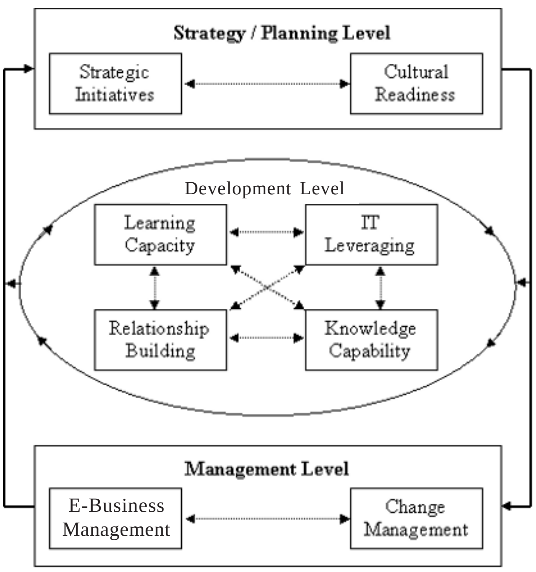
eBC Components *constructs*	**Case #1 Halliburton**	**Case #2 Biotech**	**Case #3 FSC**	**Case #4. [a]Dell & LSI[b]**
Strategic Initiatives				
stimuli	+ pro-active?	+ pro-active	+ pro-active	+ [a]pro-active[b] +
formulation scope	incremental	incremental	revolutionary	[a]incremental, revolutionary[b]
decision making	autocratic (centralised)	+ champion emergence	- autocratic	+ [a]champion emergence[b]
strategy led	eventually	onset	-onset	+ [a]onset[b] +
Cultural Readiness				
change agents	+ & -	+ leadership	- leadership	[a]+ leadership
risk aversion	welcomed	welcomed	cautious -?	+ [a]welcomed[b] +
extent of open communictn.	+	+	?	+
Learning Capacity				
improve efficiency	learn by doing	learn by doing	learn by doing	+ [a]learn by doing[b]
adaptation	+ learning from others	response to IT change	response to IT change	+ [a]learning from others response to IT[b]
learning type	double-loop	+ double-loop	single-loop	+ [a]double-loop single-loop[b] +
external information use	boundary spanners	technology gate keeper	boundary spanners, customers +	+[a]boundary spanners, technol. keeper[b]
declarative knowledge	knowledge base	R&D resources IT	R&D resources IT, knowledge-base	+ [a]focus on core competencies[b]

Table 1. Detailed findings for each construct with + & – identified, cont.

eBC Components *constructs*	**Case #1 Halliburton**	**Case #2 Biotech**	**Case #3 FSC**	**Case #4. [a]Dell & LSI[b]**
IT Leveragability				
role of IT	+enabling & socio-technical	dominant factor	dominant factor	+ [a]enabling[b] +
use Internet technology	+ superior	+ adequate	+ adequate	+ [a]superior[b] +
Network relationships				
inter-organisational linkages	+ cooperative	+ cooperative	cooperative	+ [a]cooperative[b]+
cross-functional cooperation	adequate	+ superior	adequate	+ [a]adequate[b] +
Change Mgt Practice				
mgt's. readiness to change	participative	committed	- participative	+ [a]committed, participative[b]
pattern of change	+	+	-	+ [a]
scope of change	improvement	radical change	improvement	[a]improvement, radical change[b]
managed change	alleviation of dissatisfaction	+ a well managed change process	a vision for change, a well managed change	+ [a]evolutionary, revolutionary change tactics[b] +
e-Bus. Mgt Practice				
e-business measures	improvement feedback loop	improvement feedback loop	e-business info. capture	+ [a]use e-bus metrics, audit[b]
use of e-business tools and techniques	+ adequate	adequate	+ superior	+ [a]superior, adequate[b]
use of team structure	+	+	+	+[a]

Key: + = facilitator, - = inhibitor, + & - = facilitator and inhibitor, ? = unknown

Figure 2. A model for managing e-business change



Strategy/Planning Level

Strategic Initiatives

There tends to be strategic "stimuli" ranging from competitive pressures, continued market leadership, customer expectations, employee dissatisfaction and organisation inefficiencies that trigger managers to undertake eBC:

- According to these findings, management of eBC does not have to be proactive to be successful, but rather by the way the organisation reacts to the stimuli. This is viewed as a satisficing condition for managing eBC.
- Incremental eBC can work but appears to be appropriate when risk aversion is welcomed. Also incremental projects were perceived as revolutionary in nature.
- Successful eBC projects establish an objective and unbiased team or individual champion that continues to push the organisation and groups to find new innovative processes. These champions must be empowered to implement the changes within a culture of e-business readiness (Segev & Gebauer, 2001).

Cultural Readiness

To address complexities of change, each component must be aligned, along with the enabling technology, to the strategic initiatives (Hesterbrink, 1999):

- An organisation attempting to change performance radically seems to require some "sense of urgency" in their business situation, which translates in turn into a compelling vision that is espoused throughout the organisation (Farhoomand et al., 2004).
- To overcome pockets of reluctance to change, an organisation's vision for change must provide an atmosphere of communication where individual

concerns are not seen negatively but rather welcomed (Craig & Jutla, 2000)

- An important ingredient in the right cultural mix for successful eBC is leadership from the top and initiatives from employees, together with an atmosphere of open communication, participation, committed cross-functional access to experts, and committed inter-organisational focus (Farhoomand et al., 2004).

Development Level

1. **Learning Capacity:** Successful eBC projects are enabled in organisations that:
   - have a propensity to learn from best practice and customer needs,
   - exhibit learning whereby employees individually and collectively reflect on their past experiences, modify their course when necessary, and discover new opportunities, a new culture of the learning organisation.
2. **Relationship Building:** Successful eBC projects require commitment between partner organisations to use common IT platforms and sharing of corporate information (Oliver et al., 2003).
3. **Knowledge Capability:** Successful eBC projects are enabled in organisations that leverage external information and experts, and focus on core competencies.
4. **IT Leveragability:** Successful eBC involves the coalescence of 'IT' and e-business best practice, whereby IT plays a supportive, but not always commanding role that is linked to the business case for eBC. Balanced consideration of the social, technical, and business value elements should be maintained during implementation (Hesterbrink, 1999).

Management Level

A well-defined transparent management approach should include a documented methodology of change, use objective and quantified metrics showing the value of change, continuously communicate process metrics to senior management, and possess a well-documented rollout of the new e-business design (Dell, 2000, Farhoomand et al., 2004).

To achieve this requires continuous articulation and recognition of the value of reporting results, as well as monitoring each individual's contribution and accountability to the overall company's change effort. At this individual level, concern should be placed on how the eBC will improve employee satisfaction and the quality of work life (Guha et al., 1997).

The nature of change was reported to be participative change resulting in an evolutionary change tactic. This was viewed as a "waterfall" progression of change, starting with an alleviation of dissatisfaction by employees and eventually working towards a well-managed e-business implementation from: (1) the alleviation of dissatisfaction, (2) with a vision for change, (3) by evolutionary change tactics, and (4) a well-managed process for change (Guha et al., 1997; Farhoomand et al., 2004).

FUTURE TRENDS

While the study used a flat eBC model (Figure 1) where all constructs were considered antecedents to success, a new model (Figure 2) was developed from case the findings. This dynamic model for managing eBC is recommended for use in future studies. It suggests an investigation of inter-relationships between the three levels of strategic planning, organisational development and management, as well between the components embedded within the levels.

The cases presented used an established research framework for gathering evidence to identify the factors for success of an e-business project. This research framework demonstrated its ability to examine complex phenomena. It is seen as evolutionary in nature, and was content driven. It is essentially a diagnostic tool for identifying factors contributing to success of new e-business models. It specifically useful for exploring the phenomena related to the success of learning organisations where the key issues remain as people oriented organisational issues.

CONCLUSION

The results confirm that a successful project was found to have facilitators in all components of the eBC framework, including the change environment and management practice. Further, there is the implication that the least successful e-business projects will have inhibitors in both components, especially in the area of e-business readiness and change management.

While broad generalisations from the four case studies are viewed as premature, various patterns of constructs were developed as indicators that have implications for both research and practice. These patterns represent indicators for: success, failure, a tendency to mediocrity, and variances across B2B interaction, where the latter is regarded as the most significant indicator.

The eBC framework (Figure 1) and associated semi-structured interview protocol was found to be a useful research tool for exploring the complex phenomena of eBC. A new model for managing eBC (Figure 2) is recommended to other researchers in exploring the topic further.

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KEY TERMS

Change Management: The coordination and action by management required to lead the change of organisational systems and structures in order to support a new business activity or effort.

Cultural Readiness: The preparedness of an organisation's culture of its people and processes (past and present) to facilitate or inhibit change.

E-Business Change: The processes surrounding the effective management of different stages of online business development and growth.

E-Business Outcomes: E-business forces change to occur in three corporate domains; technology, process, and people–at strategic and operational levels.

E-Business Performance Gains: The improvement in; corporate resourcing, employee work life and customer satisfaction.

E-Readiness or E-Business Readiness: The preparedness of an organisation's technology, processes, and people to facilitate or inhibit e-business development.

Category: Concepts, Trends, and Challenges

M-Commerce Opportunities

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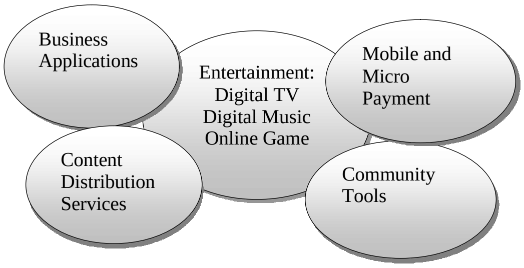
INTRODUCTION

The mobile phone industry has experienced an explosive growth in recent years. Mobile phone subscriber numbers have passed the 1.6 billion mark at the end of 2004. The emerging markets such as China, India, and Brazil contribute this growth. In China, the number of mobile subscribers has already surpassed the number of fixed landline phone subscribers. In Korea, the number of mobile phone Internet subscribers is 34.53 million people or 72% of the population in June 2004 (APEC, 2005). Mobile e-commerce (m-commerce) makes business mobility a reality. Mobile users can access the Internet at anytime and anywhere with ubiquitous, inexpensive computing infrastructure. Mobile wireless services are ranging from mobile phone networks to wireless local area networks. The service provided by mobile phone systems has achieved huge success. Mobile phone users originate from all walks of life and include almost all age groups—from teenagers to retired people. It creates a new method of personal communication without location constraints. As telecommunication technologies are converging at fast speed. We will study mobile phone and personal digital assistant (PDA) related to mobile and wireless telecommunication. Hence, m-commerce is defined as electronic commerce carried out in handheld devices such as mobile phone and PDA through mobile and wireless telecommunication networks.

BACKGROUND

E-commerce is characterized by e-marketplaces, online auction systems that act as the intermediary between buyers and sellers. On the other hand, m-commerce is more personalized and ideal for access to location based services. Many new business models have been established around the use of mobile devices. Mobile devices have the characteristics of portability, low cost, more personalization, GPS (global positioning system), voice, and so forth. The new business models include micropayment and mobile payment, content distribution services, entertainment, community communication and business services. Figure 1 illustrates m-commerce applications. Because of their existing customer base, technical expertise and familiarity with billing, mobile telephone operators are the natural candidates for the provision of mobile and micro payment services. Micropayment involves small purchases such as vending and other items. In other words, the mobile phone is used as an ATM card or debit card. Consumers can pay for purchases at convenience stores or buy train tickets using their mobile phones.

Figure 1. M-commerce applications



Content distribution services are concerned with real time information, notification (e.g., bank overdraft), using positioning systems for intelligent distribution of personalized information by location (e.g., selective advertising of locally available services and entertainment). Real-time information such as news, traffic reports, stock prices, and weather forecasts can be distributed to mobile phones via the Internet. The information is personalized to the user's interests. By using a positioning system, users can retrieve local information such as restaurants, traffic reports and shopping information. Content distribution services with a greater degree of personalization and localization can be effectively provided through a mobile portal. Localization means to supply information relevant to the current location of the user. Users' profile such as past behavior, situation and location should be taken into account for personalization and localized service provision. Notification can be sent to mobile devices too. Mobile network operators (MNOs) have a number of advantages over the other portal players (Tsalgatidou & Veijalainen, 2000). First, they have an existing customer relationship and can identify the location of the subscriber. Second, they have a billing relationship with the customers while the traditional portal does not. MNOs can act as a trusted third party and play a dominant role in m-commerce applications.

In addition, mobile phone has become a new personal entertainment medium. A wide range of entertainment services are available, which consist of online game playing, ring tones download, watching football video clips, live TV broadcasting, music download and so on. According to *Screen Digest* estimates, Korea and Japan accounted for 80% of worldwide games download revenues of Euro 380 million (*Screen Digest,* 2005). Unsurprisingly, adult mobile services and mobile gambling services are among the fast growing services. According to Juniper research, the total revenue from adult mobile services and mobile gambling services could be worth US$1billion and US$15 billion respectively by 2008 (Kowk, 2004). Law regulators have to stay ahead of the fast growing development. Community tools also generate a lot of revenue. It consists of SMS (Short Message Service) and chat. SMS broadcasting is an ideal communication tool in community. And chat allows a mobile user to keep contact with the others while he or she is on the move.

M-commerce also has a great impact on business applications, especially for companies with remote staff. Extending the existing enterprise resource planning (ERP) systems with mobile functionality will provide remote staff, such as sales personnel, with real-time corporate and management data. Time and location constraints are reduced and the capability of mobile employees is enhanced. Also it makes paperless office a reality so that off-site engineers or salesmen don't need to carry with loads of paper such as delivery note to their clients. The logistic related business also benefits from the use of mobile inventory management applications. One interesting application is "rolling inventory" (Varshney & Vetter, 2002). In this case, multiple trucks carry a large amount of inventory while on the move. Whenever a store needs certain items/goods, a nearby truck can be located and just-in-time delivery of goods can be performed. M-commerce offers tremendous potential for businesses to respond quickly in supply chains.

CHALLENGES IN M-COMMERCE

M-commerce has a number of inherent complexities as it embraces many emerging technologies: mobile wireless systems, mobile handheld devices, software, wireless protocols, and security (Ojanperä & Prasad, 2001). These technologies have rapid product cycles and quick obsolescence. M-commerce, which is more complex than e-commerce, faces a number of challenges:

1. **Economic Aspect:** The delay in 3G Mobile network operators (MNO) in implementing their systems infrastructure. The success of M-Commerce in Japan changes the concept of "free" Internet to "paid" Internet. Users are willing to pay for the service. MNOs anticipate a huge profit in taking control of the backbone of m-commerce—the wireless infrastructure. In addition, MNOs also play a dominant position in providing m-commerce applications. This has created an unreasonably high expectation from the services. Big companies in Europe, such as Deutsche Telecom, France Télécom, Spain's TelefÌnica and the United Kingdom's Vodafone spent an estimated USD125 billion to USD150 billion on 3G licenses (Garber, 2002). Many of them are burdened with high debts. In Europe, 3G was slowly rolled out in 2004 and the number of users was less than 1 million after a huge price-cut campaign.
2. **Social Aspect:** With the exception of Korea and Japan, there is a lack of interest in 3G mobile phone systems. The western European market has reached saturation point, where mobile possession rate is close to 100% in some countries. In addition, mobile users have "upgrade fatigue" (i.e., they are reluctant to upgrade their mobile phones). In 2002, the mobile phone business pushed very hard on picture messaging, which requires new expensive handsets. The response has been poor. The mobile revenue mainly comes from the voice calls and SMS messaging. Recently, Apple iPod is a big success. It transforms the music industry and shows that consumers are willing to pay for download music. In 3 GSM World Congress 2005, mobile phones operators are unveiled to team up music companies and mobile phone manufacturers to offer digital music download and play in mobile phone. MNO hopes that they can attract the customers to use their networks to download music.
3. **Standards Aspect:** The market for handheld devices is quite different from the personal computer (PC) market. For instance, Nokia, the handset manufacturer, not only produces handset hardware but also develops the Symbian software (the OS of mobile phone) together with other handset manufacturers such as Motorola. And the handset manufacturers have closed relationship with MNOs. The OS standards are under the control of handset manufactures and MNOs. Since 2002, Microsoft has provided the OS for mobile phone and PDA respectively. Though pocket PC become dominant in PDA, the smartphone system for mobile phone is disappointed. The key is to make sure that the product is attractive to MNOs (Fried, 2005).
4. **Technologies Aspects:** Security is a major issue. Mobile communications offer users many benefits

such as portability, flexibility, and increased productivity. The most significant difference between wired networks and mobile communication is that the airwave is openly exposed to intruders. The intruder eavesdrops on signalling and data connections associated with other users by using a modified mobile phone. In addition, their small size, relatively low cost, and mobility means that they are likely to be lost or stolen. Sensitive information such as the "private-key" is thus vulnerable (Karygiannis & Owens, 2002). A 3G mobile device, when connected to an IP network, is in the "always-on" mode. Both this "always-on" mode and bluetooth's "on" mode make the device susceptible to attack. Moreover, it also provides the opportunity to track a user's activity, which may be a violation of privacy.

Furthermore, handheld devices have many inherent limitations. Technological developments will increase the computing power and storage in handheld devices. However, insufficient battery life and power consumption will impede the potential growth of M-Commerce even when 3G is widely available. At present, the battery life is very short (e.g., 2-4 hours for surfing). Fuel cells may be the answer to treble the power of a mobile phone. However the liquid is inflammable, commercial viability is in doubt. Furthermore, the small screen is another limitation. PDA's have a larger screen (13cm* 8 cm), whereas the screen of a mobile phone is 7cm*5cm, which poses difficulty when surfing the Web. A low power, inexpensive, high-resolution colour display would seriously increase the growth of m-commerce.

FUTURE TRENDS

Technology has historically advanced in waves of disruption. It is the same in the telecommunications. The disruptive technologies are Wi-Fi, WiMax, mesh networks, and powerline broadband. WiFi (Wireless Fidelity) allow users to surf the Internet on moving, are proliferating at astonishing speed on a global scale. Worldwide retail chains like Starbucks and McDonald offer wireless Internet access to their customers. It offers a fast and stable connection; the data rate is several times faster than 3G. The WiFi is an important, new and disruptive technology to mobile telephone technology and it may be a watershed for all other m-commerce investment by telecom and content providers in the world of the mobile Internet (Lamont, 2001). In making use of this technology, mobile phone manufacturer (Nokia) and wireless network manufacturer (Cisco) have been working together closely to produce the Wi-Fi phone. In future, the tariff of accessing the mobile Internet will be reduced to a budget price.

WiMax (Worldwide Interoperability for Microwave Access), a low cost wireless broadband connection in wide area network (WAN) will be rolled out (Cherry, 2004). It will offer an opportunity for new mobile phone operators to enter the mobile industry. As the mobile and wireless technologies are converging, the competition will be keen in the industries. Wireless mesh networks are peer-to-peer wireless communication systems that allow two user devices to communicate directly, instead of being routed through a central switch. End user devices in a mesh network not only send their data but also act as routers or repeaters, relaying signals for other devices. Mesh wireless broadband is much cheaper and nearly half the price to Wi-Fi offering. It will substantially lowered entry barriers for green-field operators, which are new phone companies started from scratch. In addition, powerline broadband has the potential to make an impact too. It is a technology delivering high-speed Internet access into electrical outlets via common electrical grid (Buvat, 2005). The transmission rates are currently better than DSL (Digital Subscriber Line)/cable. It is important for MNO to embrace those technologies in order to maintain its competitive edge.

CONCLUSION

As the mobile and wireless technologies are evolving rapidly and sophisticated mobile phones becomes affordable, mobile commerce will become part of our daily life. Mobile Internet is ideal for particular applications and has useful characteristics that offer a range of services and content. The widespread adoption of mobile commerce is fast approaching. In business, the mobile computing is changing the logic of business; businesses have to implement effective strategies to capture and retain increasingly demanding and sophisticated customers. Business needs to think critically about how to integrate the mobile Web to the wired Web.

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KEY TERMS

3.5G: It is based on a technology called, HSDPA (high-speed downlink packet access). It will be upwardly compatible with 3G W-CDMA systems, but will enable more than 10X the peak data rate and more than 6X the capacity of initial 3G systems.

Global System for Mobile Communications (GSM): It is a world standard for digital cellular communications using narrowband TDMA (Time Division Multiple Access). It is the standard most commonly used in Europe and Asia, but not in the United States.

I-Mode: It is the packet-based service for mobile phones offered by Japan's leader in wireless technology, NTT DoCoMo. The i-mode protocol uses compact HTML (cHTML) as its markup language instead of WAP's wireless markup language (WML) to provide mobile phone voice service, Internet and e-mail.

Short Message Service (SMS): It has grown very rapidly and is very popular in Europe. SMS messages are two-way alphanumeric paging messages up to 160 characters that can be sent to and from mobile phones.

The Third Generation (3G): It will bring wireless transmission speeds up to 2Mbps, which permits high-quality wireless audio and video. It comprises three primary standards: W-CDMA (wide-band code division multiple access), CDMA2000, and TD-CDMA (time division CDMA).

Wi-Fi (Wireless Fidelity): It is a popular term for 802.11b, a wireless local area network (WLAN) specified by the Institute of Electrical and Electronic Engineers (IEEE) and is based on the Ethernet protocol and CSMA/CA (carrier sense multiple access with collision avoidance) for path sharing. Wi-Fi supports a range of about 150 feet and data rates up to 11mbps.

WiMax (Worldwide Interoperability for Microwave Access): It is called 802.16 in industry standard, a wireless broadband connection in wide area network (WAN). It offers fast wireless data communications over distance up to about 30 miles.

Wireless Application Protocol (WAP): It is an open, global specification that empowers mobile users with wireless devices to easily access and interact with information and services instantly. The WAP is a standard for providing cellular phones, pagers, and other handheld devices with secure access to e-mail and text-based Web pages.

Category: Applications of E-Technologies

Mobile Agent Assisted E-Learning System

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BACKGROUND OF ORGANIZATION

In the past decades, the Internet has evolved so rapidly that it makes the information-technology industry grow extremely fast. Internet-based applications such as e-commerce, e-payment, e-billing, e-learning, and so forth have tremendous influence on society: There is a trend that our society will be reshaped by the Internet. Among these applications, e-learning is one of the killer applications.

Currently, the traditional education system faces some challenges that arose from the development of the knowledge-based economy. School enrollment increases with the population growth, education levels also increase for the new economy, and the cost of higher education escalates. On the other hand, in the workforce-training market, as the information economy develops, the demand for skilled workers increases. As the technology keeps changing, the workforce needs continuous training to maintain its productivity level. Hence, both formal school-based education and continuous workforce training have become big business now, and they will be even bigger in the future (Kerrey & Isakson, 2000). A more sophisticated education model is required to take this challenge, and so e-learning came into being.

Compared to traditional classroom teaching, e-learning provides one major advantage: It makes the access of information much easier and more convenient. Hence, it makes learning of all kinds, at all levels, anytime, anyplace, at any pace a practical reality (Kolar, 2001). E-learning also gives tremendous cost savings for both instructors and learners; the learning model is shifted from instructor centered to learner centered, which focuses primarily on the needs of learners. The updating of online material is also much easier. Many e-learning systems can develop personalized and interactive applications that allow users to customize their e-learning models to their own pace, and they can truly engage the user in that they involve the simulation of real-world events and sophisticated collaboration with other learners and instructors (Quah & Chen, 2002). In our e-learning system, we incorporated mobile-agent technology to enhance the response time of information retrieval. The purpose of this incorporation is to overcome the bottleneck problem faced by many pure client-server-based systems. Since mobile agents are able to traverse from one information server to another autonomously to search for relevant documents for users, only relevant articles are sent back. This saves bandwidth and enhances the efficiency of the e-learning system. As a result, the turnaround time for user queries or information searches reduces, and the feedback from the user community is positive as the response time is shorter and users find it easier to maintain their trains of thought in their study.

DESCRIPTION OF MOBILE AGENT ASSISTED E-LEARNING SYSTEM

Mobile Agent

The server-client paradigm is popularly used in current e-learning applications. Mobile agents are an emerging technology; they make the design, implementation, and maintenance of distributed systems much easier, so they attract a great deal of interest from both industry and academia. In particular, the mobile-agent paradigm has been used to design applications ranging from distributed information retrieval to network management.

A mobile agent is an autonomous, intelligent program that can migrate from machine to machine in heterogeneous networks, searching for and interacting with services on the user's behalf. Typically, agents possess such characteristics as being autonomous, adaptive, goal oriented, collaborative, flexible, active, proactive, and so forth (Smith & Paranjape, 2000). The mobile-agent paradigm is used in distributed computing as it improves performance upon the conventional client-server paradigm.

Under the mobile-agent paradigm, any host in the network is allowed a high degree of flexibility to possess any mixture of service codes, resources, and CPU (i.e., processor) time. Its processing capabilities can be combined with local resources; the service code is not tied to a single host but rather is available throughout the network (Gray & Kotz, 2001).

Information Push and Pull Based on Mobile Agents

With the above features, the mobile-agent paradigm is suitable for distributed information retrieval and e-commerce applications.

The rapid evolution of Internet-based services causes information overloading on the Web. It has been estimated that the amount of information stored on the Internet doubles every 18 months, and the number of home pages doubles every 6 months or sooner (Yang, Yen, & Chen, 1998). Therefore, it becomes difficult for the user to find the required information or services on the Internet in the huge amount of information.

Information push and pull technologies make the delivery of information from service providers to users easier. Push technology is the process of service provision by the provider in anticipation of its use, and pull technology is the process of searching for information in the network (Quah & Lim, 2003).

Ahmad and Mori (2000) from the Tokyo Institute of Technology proposed the faded information field (FIF) architecture based on mobile-agent technology to cope with fast-changing information sources and reduce the information access time of the user. In FIF, each component such as the user, provider, and node is considered an autonomous entity. The information is distributed on these nodes, and the amount of information decreases away from the service provider as shown in Figure 1. The nodes near the service center are allocated a larger volume of information, and those farther from the central nodes are allocated a smaller volume of information.

In FIF, service providers generate push mobile agents to push information in the neighbouring nodes in faded patterns. These agents negotiate with neighbouring nodes and allocate information according to the situation and the importance level of the information. The important information is stored at more nodes, and less important information is stored in less nodes. The user looks for information with pull agents, and the pull agents navigate through the distributed nodes in FIF autonomously to find the appropriate information.

The algorithm for designing autonomous information fading takes consideration of the popularity, size, and lifetime of the information. A parameter access effort $E_g(i)$ is defined to assign the fading level to each piece of information as

$$E_g(i) = \frac{N_i \ln(d_i + 1)}{\ln(S_i + 1)}, \qquad \text{(Equation 1)}$$

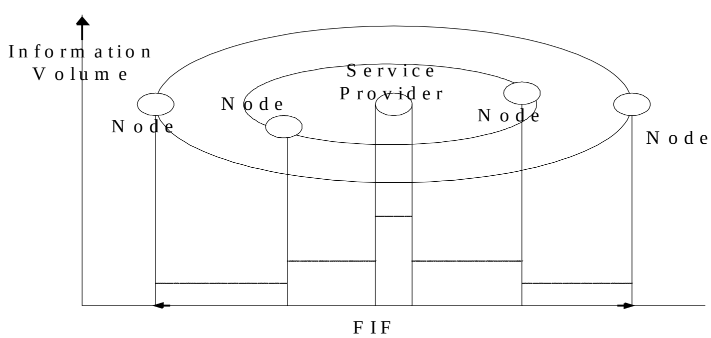
where N_i, d_i, and S_i denote the number of accesses, the lifetime, and the size of the information unit, respectively. The information having high access effort is assigned high priority and is stored on all nodes.

Through the cooperation of push agents and pull agents in FIF, the access time for the user to get the needed information is reduced since the user need not reach the service provider and can get the required information from the closer nodes. The service provider can avoid the congestion of the access, and the levels of reliability are improved.

IMPACT OF THE MOBILE AGENT ASSISTED E-LEARNING SYSTEM ON THE ORGANIZATION

We use a system architecture based on mobile agents to improve the performance of current systems. In our system, the university centers preinstalled a certain mobile-

Figure 1. Faded information field



agent base software and were connected through the agent transfer protocol (ATP) on the Internet to form a virtually huge and powerful e-learning system. The client is a networked PC (personal computer) connected to the Internet, enabling it to connect to the agent server center (ASC) to make a query to the universities on behalf of the user. The ASC will then create a mobile agent that will roam the university servers to hunt for required data. Each university center may offer some courses to users. Users may access the e-learning system through any Web browser via the Internet.

All of the university centers can be considered as different nodes in the network, and the courses are information distributed into theses different nodes. We construct an FIF to implement the information-push and -pull technology as mentioned to improve users' access time to information with a higher reliability.

The FIF system consists of logically connected nodes; information providers and users correspond to these nodes, and information allocated to these nodes decreases in amount away from the information center. That means the nodes adjacent to information center contain more information, while farther nodes contain less. As the users' demand for the subcourse materials changes dynamically over time, FIF provides an autonomous navigation mechanism by university centers through mobile agents to satisfy users' heterogeneous requirements. The university centers generate push mobile agents, and these agents carry out information fading by negotiating with the other neighbouring nodes in the network. When the push agents perform the information fading, they need to take into account the popularity, size, and lifetime of the information. They assign a priority level to each information unit: The information with higher priority is stored on more nodes, and low-priority information is stored in fewer nodes. All the nodes around the university centers are ranked by distance. The nodes with lower traffic costs are ranked as near to a university center, and those with higher traffic costs are ranked as far from a university center. The information push agents perform their tasks at a certain network off-peak time to avoid network congestion.

Through the mobile-agents-based architecture and the faded information field, the network structure is decentralized and can be extended to a larger scale easily by adding more university centers. The course materials are usually stored on more than one server so that the users can get the course materials from the nearest node, which saves information access time. When some nodes in the networks are down, users can still get course materials from other nodes, which means reliability is increased. The system is robust and fault tolerant.

Mobile Agent Based Searching

Keyword searching and text mining are popularly used among current search engines. They involve the server collecting the index of all the stored information. When a user wants to retrieve information from a server, he or she is required to enter a keyword to query the server database. The server then searches all the indexes that match the keyword entered by the user and retrieves the information accordingly (Martin & Eklund, 2000).

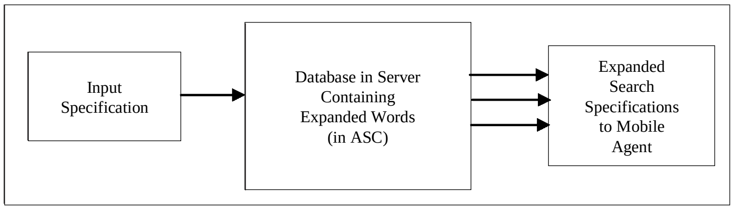
In this information-retrieval mechanism, two problems may occur. First, this mechanism is based on the assumption that the user has a good understanding about the server-stored information and can express what he or she wants to retrieve in terms of keywords correctly and accurately. If the query keyword is poorly structured or some typing error exists, the searching will not work as the user expected and may even return nothing. In order to overcome this problem, a thesaurus function is used to expand the search keys. Second, if the query causes plenty of information to be returned to the user at the client site, most likely not all the information is what the user wants, and the user needs to browse through the retrieved information and discard those pieces that are not important; this causes a waste of network bandwidth and user time also. To assist the user, the system provides a weighted keyword function to gauge the importance of each piece of retrieved information.

Adding artificial intelligence (AI) to the keyword search will improve the search quality. One approach is to do a parsing on the user-entered keywords (Katz & Yuret, 1999). This will generate several synonyms equivalent to the original keywords. When the query done with the original keywords is not satisfactory, the query based on its synonyms will be performed to return more information. Figure 2 illustrates the process of user-query expansion.

One of the AI approaches for e-learning-course search is to build Web agents (Karjoth, Lange, & Oshima, 1997); they will search for information on behalf of the user according to user preferences. The user preferences are stored in the user profile database (So, Baek, & Park, 1999). It has a learning function and can learn the user's preferences and dislikes when the user searches the Web with keyword searching.

Initially, the user enters the keywords and searches the Web. The monitor agent will save the keywords entered by user, then the search agent will start to roam on the Web searching for information (Cabri, Leonardi, & Zambonelli, 2000). When the search agent finds information at remote sites that matches the user's requirements, it will carry the information back to the user.

Figure 2. Thesaurus module



At the user site, the extraction agents will extract the keywords from the retrieved Web documents. The keyword extraction includes two methods: One is based on the frequency of a word or phrase that occurs in a Web document, and the other is based on the frequency of a word or phrase that occurs in different Web documents. The occurring frequency is computed and weighted. If it exceeds a threshold value, the word can be treated as a keyword and be saved into the user profile database together with user-entered keywords. When the user reads through the retrieved Web documents, some documents may not be what the user wants and are simply discarded. The monitor agent will monitor this and add a negative preference with a weighting to the extracted keywords. For the correctly retrieved Web documents, a positive preference weighting is added.

The next time the user does a keyword search and enters similar keywords as the previous session, the user preference database will first find all the keywords stored with positive and negative weightings and list them for the user to select as the keyword. The search priority is based on the weighting: Positive weighting indicates higher priority, and negative weighting indicates low priority. As the negative weighting exceeds a certain threshold value, the Web documents that contain such keywords will not be retrieved in future sessions.

The monitor agent, search agent, and user preference database operate in a closed feedback loop. With learning ability, the user preference database will grow larger in size as the user does keyword searches of the Web more frequently, and the search process will become more intelligent. Figure 3 shows the architecture of the search tool (Quah & Chen, 2002).

Overall Technical Architecture

In our system, the IBM Aglet workbench is used as the agent platform. Figure 4 shows the technical architecture.

The whole system consists of three layers: the front-end user machine, the back-end server, and the e-learning servers on the Web. The front end can be any PC connected to the back-end server. The back-end server has an SQL (i.e., Structured Query Language) server database storing the user account information. It is used for user verification when logging into the system, and each new user needs to register his or her account with the back-end server. The handling of these data is through CGI (i.e., Common Gateway Interface) scripts.

The addresses of all the e-learning servers on the Web that are to be visited by the searching mobile agent are also captured in the database, which forms a search directory for the searching aglet. Each e-learning-course center on the Web must preinstall the Aglet Tahiti server and has a database server to store the course materials. These e-learning centers register their addresses with the

Figure 3. AI search-engine architecture

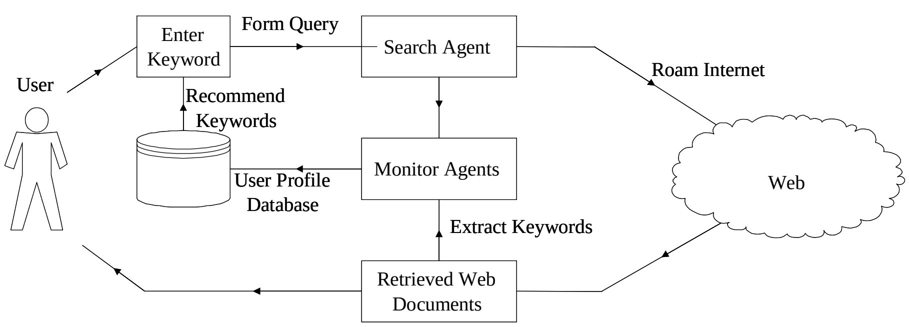
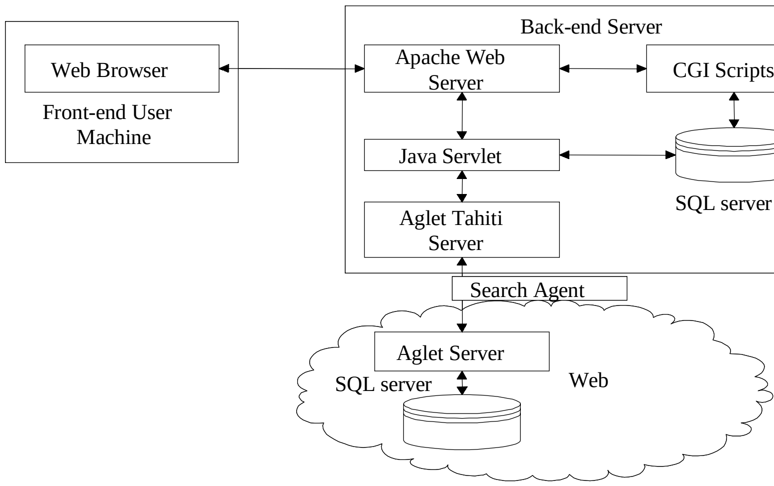


Figure 4. Overall architecture



back-end server and provide context for the searching aglet to operate.

Each time the user does a search, a Java servlet will run at the back-end server, which will generate an aglet carrying the searching criteria and send it into the Web. The mobile agent will roam the Web searching for the required information on the user's behalf. When information is found, the mobile agent will send it back and continue on to visit the next aglet host in the predefined trajectory.

The retrieved information will be filtered by the thesaurus module and then presented to the user. The filtering process is a reverse process of the query-expansion process. Text-mining techniques are used to narrow down the search criteria, taking into consideration the context in which the keywords are used.

Interactive User Tracking

It was shown that the more interactive and cooperative instructors and learners are, the more effective learning will be. The user-tracking function provides an interactive environment for lecturers and students to conduct teaching and learning. This can be realized through the cooperation of static agents at student machines and static agents that sit on the e-learning central server. These two groups of agents monitor the course status for a particular student and communicate this information by message passing.

There are two types of tracking. At the lecturers' side, agents receive feedback from the student regarding the course material's effectiveness. For example, if the user-tracking report shows a high access rate of a certain course material, it may mean the difficulty level of this course material is appropriate or the course is taken by many students. On the contrary, if the access rates of certain courses are low, that may mean the courses are not very popular: Either the difficulty levels are too high or the course formats are not user friendly. With the feedback from students, the course materials can be customized to match the students' learning pace and interests.

To test the effectiveness of student learning, after the course is taken, the system also provides some randomised questions for students in the form of quizzes. The quizzes will be graded by the e-learning server, and the server will give feedback information on the grades to each student. This is realized through communications of the two groups of static agents.

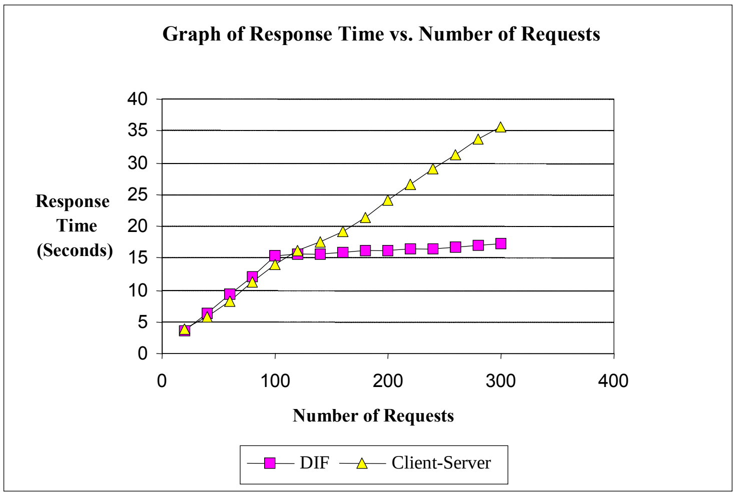
System Performance

We performed a response-time comparison (for document retrieval) between the e-learning system with mobile agents and a basic client-server system with the equivalent hardware and software components.

From the data collected, the results were plotted onto a graph to show the response time for the two systems vs. the number of requests from the user community (Figure 5). The system with mobile-agent technology (denoted as "DIF", meaning "Distributed Information Field") yields an average of 10 seconds of improvement in response time. This can be attributed to the following reasons.

- Mobile agents are not part of a stand-alone process. They are in a thread and need to work together with other programs in the agent host to complete tasks. Hence, the system is flexible and small in size. In our system, the search agent is only around 10 K, with

Figure 5. Response-time comparison



small variations depending on the user-query size, therefore the amount of time taken to transport mobile agents is small.

- Mobile agents move the query computation to the data server, so the repetitive request and response handshaking in the client-server system is eliminated. Data selection is performed at the remote server, and only the selected documents are sent to the user. However, in a client-server system, intermediate results and information need to be passed through the network between the server and client. Hence, mobile agents reduce network traffic and improve performance in terms of response time.

CONCLUSION

The experience gained from this project is largely positive. The acceptance of the Web-based e-learning system by users (students and professors) at large testifies to the strengths of the system in three aspects. First, the system exhibits intelligence in gathering and picking documents requested by users. The highly interactive Web-based design added to user friendliness. Second, the system is able to maintain good response times due to the load-balancing feature of the information-push and information-pull agents. Finally, from the technical-support group's perspective, the system is robust and fault tolerant (as multiple hosts serve as each other's backup). It is also able to withstand higher volumes of transactions and storage requirements. This will eventually convert to cost savings as the need for equipment upgrades becomes less frequent.

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KEY TERMS

E-Learning: Technology-enhanced instruction whereby learners are able to progress at their own paces and choose their own learning paths.

Faded Information Field: A group of server machines connected in a topology that allows information documents to be distributed in a fashion that can improve retrieval efficiency, typically through some algorithmic computation to determine server locations.

Information Pull: The process of user access to information stored in servers linked via the Internet or an intranet.

Information Push: The process of a directory server relocating information files to active server machines within a faded information field based on the frequency of users' accesses.

Information-Retrieval Mobile Agent: A small, portable program code that can migrate from server to server and execute its master's instructions for information retrieval.

Thesaurus Module: A keyword-expansion mechanism to increase the coverage and success rate of information search using a user-entered keyword (or keywords).

User Tracking: An automated logging mechanism that stores and retrieves information on a user's progress as he or she advances through the courses on an e-learning system.

Mobile Agent–Based Auction Services

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INTRODUCTION

Electronic Commerce, a Booming Industry

There is now a gradual shift of many of the traditional business models from the real world to the Internet platform; of these models, auction service is most successful. The existence and development of numerous auction Web sites, such as eBay and OnSale Inc., have demonstrated the survivability of electronic auctions in online transactions.

However, current Web-based systems suffer from shortcomings in the following aspects:

- **Fairness and Friendliness:** Due to the different conditions of Internet connections, users across different regions may suffer from the inadequacy of limited bandwidth, especially when participating bidders are distributed across the world. This global nature also makes online auctions difficult to adapt to the potential users across the world.
- **Security and Privacy:** Security concern is one of the important issues users consider when using electronic transactions. Many users also wish to be guaranteed of privacy when doing business.
- **Intelligence and Flexibility:** The vast majority of electronic auction customers are not Internet experts but ordinary people that do not know much about the technical details. Current Web-based auction systems require too much user intervention. It would be commercially profitable if intelligent assistance is provided.

Software Agents, a Paradigm for Mobile Computing

Mobile agents refer to self-contained and identifiable computer programs that can move within the network and act on behalf of the user (Pham & Karmouch, 1998). The mobile agent paradigm as reported in the literature has two general goals: reduction of network traffic and asynchronous interaction. The mobile agent paradigm proposes to treat the network as multiple agent-friendly environments and the agents as programmatic entities that move from location to location, performing tasks for users.

Research on agent-based e-commerce is still underway (Franklin & Reiter, 1996; Guan, Ngoo, & Zhu, 2002; Guan & Yang, 2004; Guan & Zhu, 2002; Maes, Guttman, & Moukas, 1999; Poh & Guan, 2000; Subramanian, 1998; Yi, Wang, Lam, Okamoto, & Hsu, 1998). Mobile agents have demonstrated tremendous potential in conducting transactional tasks in e-commerce. The architecture proposed here is based on mobile agents. The advantages of mobility, intelligence, and autonomy of the agents are taken, which are actually representatives of their respective owners to perform the auction process. By using this framework, we wish to get rid of the previously listed disadvantages in the current online auctions. Specifically, the features of the system will be as follows:

- **Fairness:** The deficiency of bandwidth and network traffic will be overcome by taking the advantages of the mobility of software agents.
- **Autonomy:** Based on the preferences of an owner, agents can be fully automated to participate in the auction with little or no intervention from the owner.
- **Security and Privacy:** Third-party involvement is introduced to enhance the security and privacy throughout the auction. Agents are protected from malicious attacks during transportation and bidding. Furthermore, with the assistance of the coordinator and the encryption mechanism, the real identity of each participating bidder is protected.
- **Flexibility:** The architecture proposed will serve as a unified framework for various auction types as long as the bidding strategies and competing rules are well defined.

Related Work

There has been much research in agent-based auction systems. The Michigan Internet AuctionBot (http://ecommerce.media.mt.edu) sees itself as an information service that collects the bids, determines the resulting price, and notifies the participating parties about the outcome. The Fishmarket Project (http://www.iiia.csic.es/Projects/fishmarket/)evaluates a very narrow field of electronic commerce. Its main focus lies in rebuilding a commerce structure that is found in real life on downward-bidding fish markets of Spain, and it supports Dutch auction style. CASBA (Guttman, Moukas, & Maes, 1998) offers flexibility and support for all common auctions types including auctioning of multiple units. It does not have sophisticated negotiation strategies and learning mechanism to improve agent performance on the market. It is not designed with mobile agent capability. The **KASBAH** project of the AmEC Initiative (http://ecommerce.media.mit.edu/) introduced agents that negotiate following three time-constrained rules. The system itself was designed to be one huge double auction system. It is not designed with mobile agents in mind.

DESCRIPTION OF MOBILE AGENT–BASED AUCTION SYSTEMS

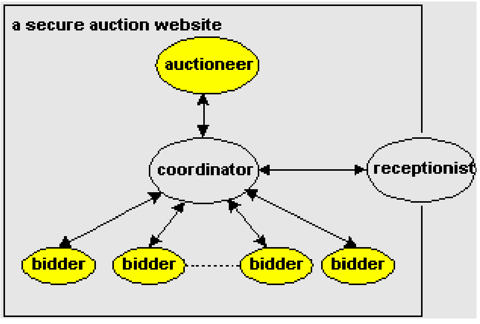
A complete auction service involves the following aspects: information shopping, auction process, payment, and shipping. In our architecture (Figure 1) however, we are only interested in the auction process and assume that auction-related information has been collected by the participants ahead of time.

Overview

In an English auction, the buyers gather together to bid for a certain product, according to the published rules and preferred strategies. In the proposed architecture, the following are typical:

- **Participants:** The auctioneer agent represents the seller of the products; the bidder agents represent potential buyers who wish to compete for the auction item; the coordinator agent is the coordinator of the auction, the receptionist agent collaborates with the coordinator and serves as the receptionist during the auction. The functions and particulars of each agent are listed in Table 1.

Figure 1. A typical auction scenario



- **Place:** The auction Web host is a secure auction environment provided by a certified third party, widely trusted by the participants.

Admission

Admission is the preparation, namely the reception of agents and the build up of the auction relationship. The admission process will be further divided into two periods: SAFER transport and auction registration. SAFER (Guan & Yang, 1999; Yang & Guan, 2000; Zhu, Guan, Yang, & Ko, 2000), has been proposed as a framework for intelligent mobile agent mediated e-commerce. Our system adopts one of the three proposed transport protocols, the supervised agent transport protocol for the secure roaming of agents to prevent agents from malicious attacks during their transportation. The agent is built up with the bidding strategies customized by the owner and carries the owner's certificate for identification purpose and his or her public/private key for encryption and signing purpose. Figure 2 illustrates the supervised agent transport protocol.

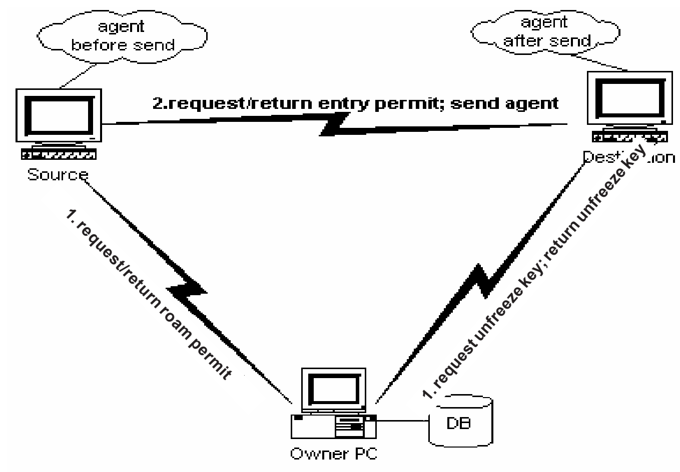
After the agents have successfully roamed to the destination, all agents are welcome by the auction receptionist. The agents then communicate with the reception-

Table 1. Functions of the participating agents

Participating Agent	Owner	Function
Auctioneer	Seller	Decide the winner
Bidders	Customers	Bid
Coordinator	Third party	Coordinate auctions
Receptionist	Third party	Receive agents

M

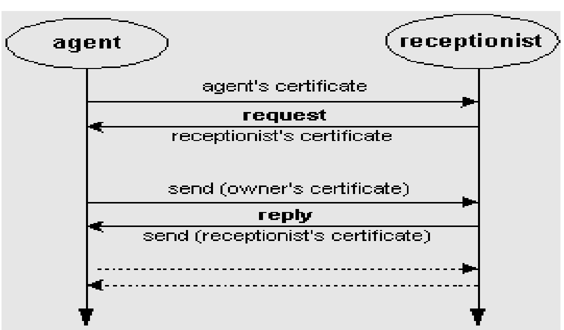
Figure 2. Supervised agent transport protocol in SAFE



ist to complete other registration formalities. Figure 3 gives a sample of the communication between agents and receptionist during registration.

The receptionist and each participating agent will check the qualifications of the others. The receptionist then requests the public key and other necessary information from a bidder for later use and will return necessary information including a unique alias to the bidder. This assigned alias will be used throughout the auction process. The bidder's real identity is kept in the receptionist's database and will not be disclosed to other participating agents including the auctioneer. When the deadline for the published admission period is due, the receptionist forwards the registration information to the coordinator, which will be used as the basis for building up an architecture regarding the competitive relationships among various agents.

Figure 3. Communication between agents and the receptionist



Bidding

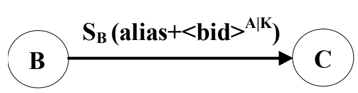
Each bidding agent is equipped with the owner-customized bidding strategies as instructions for submitting bids. The bidding period is divided into several rounds. There will be a set of predefined secure communication protocols for bidding. Let us give the following definitions before we move on to discuss the details:

- ***A, B, C, W*** denotes the auctioneer, bidder, coordinator and the final winner, respectively.
- **$<m>^{A|K}$** denotes the encryption of a message *m*, with *A*'s public key *K*;
- **$S_A(m)$** denote the digital signature of a message m by a process *A*, (i.e., with *A*'s private key)

Submitting a Bid

When a bidder decides to submit a bid in a round, the following procedures are used:

Step 1.



B prepares a message m containing its own alias and the bid, which is encrypted with the auctioneer's public key. *B* signs the message with its own private key and sends it to coordinator C.

Step 2.

$$C \xrightarrow{S_C(\langle number+\langle bid\rangle\rangle^{A|K})} A$$

Upon receiving the message from *B*, C first checks the validity of the message, generates a number (to represent the message thread in the database), and removes the alias from the message and further signs it with its own private key and sends the message to *A*.

Step 3.

A receives the message from *C* and first checks its validity with *C*'s public key. A then decrypts the original message with its own private key and gets the bid.

Broadcasting a Bid

The following procedure is used to broadcast the bid winner.

Step 1.

$$A \xrightarrow{S_A(\langle m\rangle^{A|K})} C$$

A prepares the message containing the information for the winner of a particular round, which is signed with *A*'s private key, and sends the message to *C*.

Step 2.

$$C \xrightarrow{S_C(m)} B$$

Upon receiving the message from *A, C* first checks its validity, decrypts the message and searches the information of the message in his database according to the number provided to find out the matching one to reconstruct the message, which is further signed with *C*'s own private key.

Step 3.

Bidders first check the validity of the message and then use *C*'s public key to get the information as the result of the previous round.

The coordinator together with the encryption mechanism used is instrumental in achieving the following goals:

First, the auctioneer is kept blind from the bidding process, in that the auctioneer can verify the validity of each bid, but is not able to know who has actually submitted bids. This also helps to prevent the auctioneer from linking the winner with a specific bid. This procedure ensures that the customers can bid anonymously and will not suffer from the release of their bidding information. Secondly, all the bidders are notified of the highest successful winning bid in each round, together with the alias of the originator.

Let us further consider two exceptional cases that might occur during this stage: early withdrawal and late arrival. Before an early withdrawal agent leaves, he needs to consult with the receptionist with his withdrawal and obtains permission from him so that the receptionist may forward the most updated bidding status to the coordinator. In the case of late arrivals, despite the requirement that agent must follow the standard procedure before entering the auction, it may also need to consult with the receptionist about the latest bidding situations.

Conclusion

The final stage of the auction is conclusion, in which the auctioneer announces the result of the auction and the final winner and the auctioneer identify each other to ensure nonrepudiation with the assistance of the coordinator. Based on the published rules for the auction, the auctioneer is to decide upon the closing time of the auction and select the final winner from a pool of candidates. The following procedure is used for the successful identification of the winner and the auctioneer.

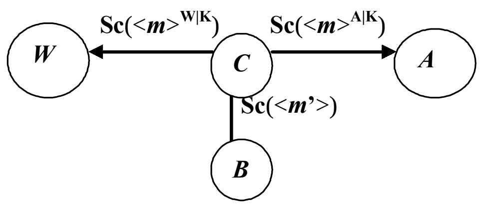
Step 1.

The auctioneer first sends a message to the coordinator to announce the close of the auction. Upon receiving the acknowledgement from the coordinator, he or she sends the result, which contains the number of the final winning message and the winning bid to the coordinator for verification:

$$A \xrightarrow{S_A(number+\langle m\rangle^{C|K})} C$$

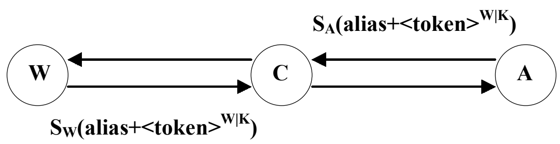
Upon receiving the message, *C* first checks the validity of the message, then retrieves the information from his database according to the number provided to find the alias of the person who submits the winning bid. The coordinator then formally announces the result of the auction.

Step 3.



The coordinator sends the signed message which contains the information and real identity of the auctioneer and the winner to each party encrypted with their own public keys respectively. The coordinator also needs to send the final result to the other participating agents. However, the message *m'* he or she sends to the losing bidders contains only an alias of the winner. Upon receiving the message, the winner and the auctioneer will first verify its authenticity and then save the information regarding identities.

Step 4.



The winner and the auctioneer exchange the identification token, which possibly includes for each party's real identity and other information, such as the agreement on the delivery of goods.

Implementation

A simple prototype has been developed and implemented to prove the feasibility of agent-based auction systems. It is deployed to ensure that security, privacy, user anonymity, and fairness are attainable in agent-based e-auctions.

The overview of the architecture is shown in Figure 4.

Descriptions of the Prototype

The three main components realized in this prototype are as follows:

1. The user interface consisting of the agent factory panel and the auction host panel;
2. The agent factory, where a bidding agent is fabricated according to the user's needs; and
3. The auction host system, whereby the auction is conducted.

Figure 5 depicts the scenario of the components implemented.

In this prototype, a user customizes an agent by setting parameters such as user identification number, maximum and minimum bids, user IP address, port number, and the desired product he or she wants to buy. When the user clicks the submit button, a Java agent is automatically generated according to these parameters. The agent is sent to the user's machine.

Running on the auction host is a multithreaded server "coordinator" that talks to the bidding agents and the auctioneer agent in a synchronized manner, as is shown in Figure 6. Once the bidding agent is invoked, it begins to establish a socket connection to its home host. The auction host will spawn child processes or threads to handle communication between bidders and auctioneer in a synchronized mode.

Implementation Issues

There are two possible ways of customizing agents:

- **Local Agents & Local Customization (LALC):** Agents are software programs downloaded and possessed by owners. Agents can be customized by the owner with his preference in bidding strategies and other specifications. The owner sends out the agent to the remote host for an auction and the

Figure 4. Auction system architecture

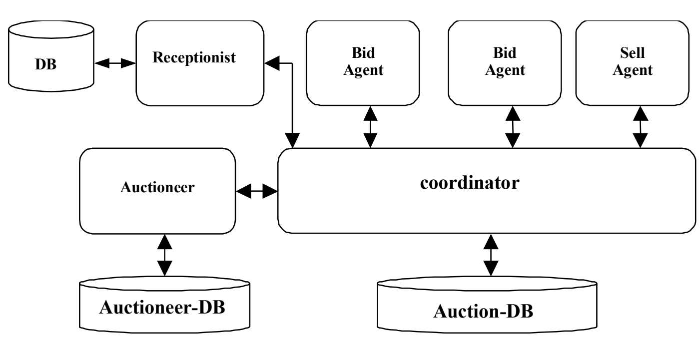


Figure 5. Implemented auction system overview

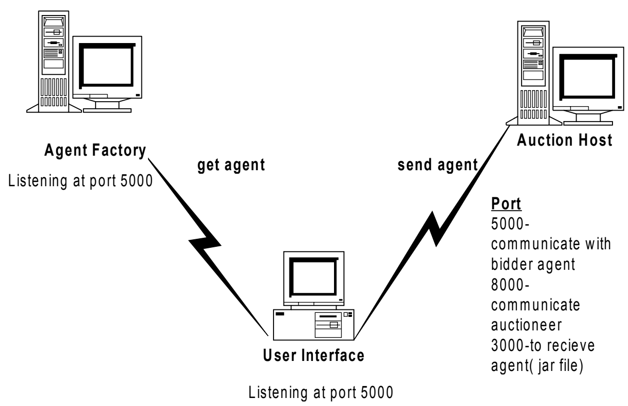
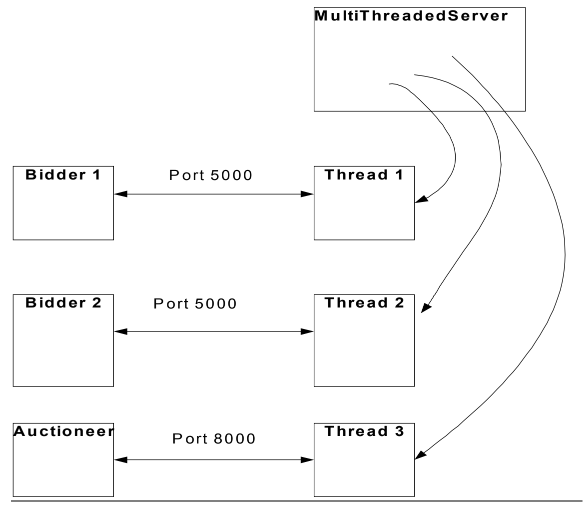


Figure 6. Multithreaded auction server



agent returns to the owner when the task is completed. The owner can still maintain communication with his bidding agent.

- **Remote Agents & Local Customization (RALC):** Agents are standalone programs which reside in the auction hosts. Users may use the browser to select the proper agent and customize it with his or her bidding strategies and other preferences by way of standard CGI forms. The user-customized agents will then be sent and automatically invoked to start the auction at the remote host. We have adopted the latter scheme in our implementation.

IMPACT OF MOBILE AGENT–BASED AUCTION SYSTEMS

The intelligence and autonomy of mobile software agents will enhance the performance of agents in auctions and reduce the workload for users. Our proposed agent-based system provides a flexible and unified structure for various types of auctions, in which both security and user anonymity are guaranteed. The proposed system is suitable when users want to be relieved from auction details or when the auction value is small. It will be useful when it is used with wireless devices, such as handphones, where users generally stay off-line and are interested in the results only.

CONCLUSION

In the previous sections, we have discussed in details the architecture for an agent-based electronic auction system. Compared to existing Web-based auctions, our proposed scheme exhibits some unique features and advantages when addressing the issues of security, privacy, fairness, and flexibility.

One of the attractive features of using software agents in an auction is its autonomy and intelligence. Given such a system, a good bidding strategy becomes the critical factor to win. A good strategy should be adaptive enough so as to respond rapidly and intelligently to the behaviors of the other partners. Agents equipped with such strategies will be “smart” while at the same time remain vigilant and faithful to their owners.

The proposed agent-based auction system may also provide an interface for future implementation with communication to devices such as wireless application protocol (WAP) phones. The proposed agent-based scheme also brings in new commercial opportunities for the Internet service providers, such as providing the programs for software agents, the design and implementation of intelligent bidding strategies, and so forth. The system will also inspire novel types of auction services that have no counterpart in the real world, enriching business content in the Internet world.

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KEY TERMS

Adaptability: The ease with which software satisfies differing system constraints and user needs.

Agents: A piece of software, which acts to accomplish tasks on behalf of its user.

Anonymity: The degree to which a software system or component allows for or supports anonymous transactions.

Cryptography: The art of protecting information by transforming it (*encrypting* it) into an unreadable format, called "cipher text." Only those who possess a secret *key* can decipher (or *decrypt*) the message into plain text.

Flexibility: The ease with which a system or component can be modified for use in applications or environments, other than those for which it was specifically designed.

Category: Concepts, Trends, and Challenges

Mobile Banking Systems and Technologies

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INTRODUCTION

The last decade has witnessed the rapid growth of mobile communication devices and wireless technologies across the globe. The convergence of mobile devices and wireless technologies has not only changed the way many activities are conducted, but has also provided a foundation for a new type of technology-aided commerce called mobile commerce (m-commerce). As e-commerce's next evolutionary stage, m-commerce opens up new business opportunities in business-to-consumer (B2C) markets in addition to extending current operations in e-commerce and traditional brick-and-mortar businesses (Varshney & Vetter, 2002). The significant power of m-commerce is primarily a result of the anytime-anywhere connectivity of wireless devices, which provides unique experiences and services (Figge, 2004; Zwass, 2003).

One of the most promising and value-added m-commerce services is mobile banking (Lee, McGoldrick, Keeling, & Doherty, 2003; Mallat, Rossi, & Tuunainen, 2004). Mobile banking is the newest electronic delivery channel to be offered by banks in which technology has become an increasingly vital element, and it provides convenience and enhanced value to both banks and customers. With its clear benefits, mobile banking is now gaining rapid popularity in European and Asian countries with the significant market penetration of mobile handsets and the optimally designed marketing tactics of service providers (Suoranta & Mattila, 2004). However, mobile banking is still marginally adopted across the globe, and especially in the U.S., the growth appears much slower than anticipated (Mallat et al., 2004). In the United States, there are only a small number of banks that have actually introduced mobile banking services, and most other mobile banking efforts are in small-scale trials (Charny, 2001). Therefore, the technology which will be employed in the United States market has been of interest not only to financial institutions, but also to mobile technology developers and future users.

BACKGROUND

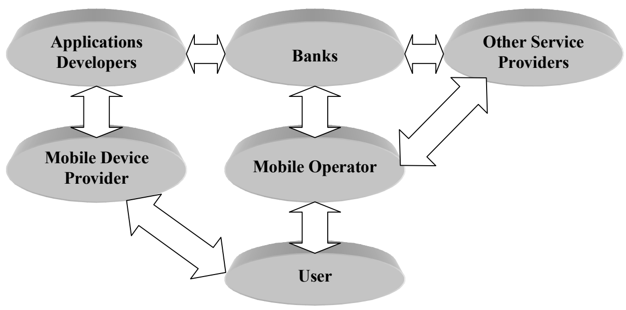
M-commerce is defined as any transaction with a monetary value—either direct or indirect—that is conducted over a wireless telecommunication network (Barnes, 2002). However, there is no clear definition for mobile banking services, so often the traditional banking services using mobile handsets (i.e., making transaction by calling a call center using a mobile phone) are considered as mobile banking services. Thus, it is very important to define a clear boundary of mobile banking service to avoid confusion. In this article, mobile banking refers to a client-server system that is specifically designed for mobile devices, allowing banking customers to use handheld devices to access their accounts, pay bills, authorize fund transfers, or perform other activities. Table 1 shows various mobile banking services currently provided.

Mobile banking has two big advantages over the narrow sense of e-banking: security and convenience (Herzberg, 2003). E-banking is based on account-holder authentication by the payment system which can fail in multiple ways but do not distinguish the source of fraud. However, mobile devices, usually with a built-in display and keyboard, are well positioned to provide a technical solution for reducing fraud and allowing the fair allocation

Table 1. Mobile banking services

• Check the balances of checking and savings accounts, investment accounts, business banking accounts, lines of credit, credit card accounts, and loan and mortgage accounts
• Electronic funds transfer (EFT)
• Pay bills and taxes
• Request a checkbook
• Inquire about check status
• Customize the statements according to the user's specific needs and requirements

Figure 1. Mobile banking life cycle (Adapted from Varshney & Vetter, 2002)



of responsibility for damages from fraud. In addition, unlike e-banking, the transactions through mobile banking can be made anywhere whether on foot or in cars, planes, or trains.

Mobile banking services began in 1999 in European and Asian countries, and have gained rapid popularity with the significant market penetration of mobile phones, the optimally designed marketing tactics of service providers, and the increased exposure to mobile technology (Suoranta & Mattila, 2004). Like many other mobile commerce services, mobile banking services are provided by several different entities, with which the customers of mobile banking services must interact to complete a successful mobile banking transaction, especially the mobile device provider, mobile operator, and content provider (Varshney & Vetter, 2002; see Figure 1). Thus, each entity in the mobile banking cycle must assist the others to attract more customers to mobile banking. The fastest way to promote the growth of mobile banking services is mutual cooperation among the entities (Datta, Pasa, & Schnitker, 2001).

Mobile Devices

The significant potential of mobile banking derives mainly from the fact that the mobile device is a familiar device which is always with the user (Mattila, 2003). Thus, satisfaction with the mobile device is a very significant factor of the mobile banking adoption decision. Mobile device in this article refers to those devices that are used to connect to mobile services (Tarasewich, Nickerson, & Warkentin, 2002). Various mobile devices are available, including mobile phones, personal digital assistants (PDAs), wireless-enabled handheld computers, laptop computers, vehicle-mounted technologies, and personal message pager devices. Among them, wireless-enabled laptops, PDAs, and handsets are currently highly preferred mobile devices for mobile banking (M-Commerce Insider, 2001). Since the use of mobile banking depends on the capabilities of mobile devices, users' satisfaction with various factors of mobile devices significantly influences their adoption of mobile banking. Some of the features of mobile devices which prevent the adoption of mobile banking are small multifunction keypads, less computation power, and limited memory and disk capacity (Siau, Lim, & Shen, 2001).

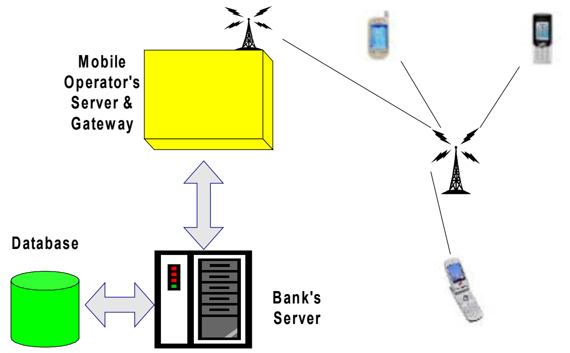
Mobile Operator

Like many other m-commerce services, mobile banking services are so new that no single company has all the expertise required to develop and deliver compelling services on its own, but many studies point out that mobile operators play a significant role since customers access their networks to perform all transactions (Donegan, 2000; Varshney, 2003). Due to the significant power of mobile operators in mobile banking services, banks often see mobile operators trying to control the financial transaction, and the relationship between banks and the mobile operator is often described as one of mutual distrust (DeZoysa, 2001). The significant power of mobile operators in the m-commerce cycle also imposes important duties to perform in support of m-commerce, such as content provider relationship management, content billing, settlement, and customer care (Buellingen & Woerter, 2004). Thus, the m-commerce users utilize the service of the mobile operator more frequently than that of any other entity, and the service attributes of mobile operators, such as call quality and tariff level, not only influence the satisfaction with the mobile operator, but also influence the adoption of mobile banking services. For instance, current pricing strategies, mainly based on time-usage, of many mobile operators are considered to prevent the mobile users from adopting mobile banking (Yeo & Huang, 2003).

Banks as Content Provider

In mobile banking services, banks are the entity providing content, which is considered one of the most important factors regardless of whether a site is Web based or wireless. Poor quality of content is considered to be significant barrier to m-commerce (Venkatesh, Ramesh, & Massey, 2003). Therefore, users increasingly choose their mobile operators on the basis of the content available, and a majority of mobile network service subscribers are willing to switch mobile operators to get better mobile content (Barnett, Hodges, & Wilshire, 2000). However, the important feature of m-commerce content is that a successful Web interface does not simply translate into a successful mobile interface (Lee & Benbasat, 2004;

Figure 2. How mobile banking services work



Venkatesh et al., 2003). Therefore, in addition to accurate and stable content, proper fonts and colors that fit into mobile device screens are also considered significant factors to attract customers to mobile banking services.

MOBILE BANKING TECHNOLOGIES

Mobile banking services are conducted by communication between the user's handset and the bank's server (see Figure 2). When the user requests a service, it is transmitted to mobile operator and forwarded to its gateway server. The server later interprets the request and forwards it to the bank's server. Then, the bank's server validates the customer for the mobile number and other information based on its database, and processes a valid request. The result is then passed on to the mobile operator's server which converts the format and transmits it to the user's mobile handset for display.

Like other entities in the mobile banking service cycle, the technologies employed for mobile banking services also play a significant role in mobile banking adoption. Various technologies have been tested and implemented in mobile banking systems, including short message service (SMS), Java, wireless application protocol (WAP), iMode, XHTML, and integrated-circuit (IC) chip. Among them, SMS and WAP have been the most popular technologies for mobile banking systems in Europe and some Asian countries (Marenzi, 2004).

Short Message Service (SMS)

An SMS mobile banking system uses the popular text-messaging service. When the customer requests information by sending an SMS containing a service command to a pre-specified number, the bank responds with a reply SMS containing the specific information. The most important feature of SMS mobile banking systems which attracts many customers is that it can be used conveniently with low cost. In addition, mobile banking with SMS enables every owner of a mobile phone to use mobile banking services. Therefore, in spite of its significant disadvantages, such as low data throughput, relatively long transaction time, limited service, and difficulty of use, SMS mobile banking services have been a dominant mobile banking technology (Kwon, 2004).

Wireless Application Protocol (WAP)

WAP has been implemented as a mobile banking technology to deliver fast and accurate banking services to customers (Lomax, 2002). WAP supports simple pages with 'menu' structures which are needed for most financial transactions (Economist, 2000). Therefore, it was popularly implemented as a major technology for mobile banking systems. However, even though WAP applications offer a greater graphical look and feel on current mobile phones, only a small percentage of the mobile users have WAP-enabled mobile devices, and only a small proportion of them actually have the knowledge of how to use them (Telephonyworld, 2004). In addition, WAP runs over circuit-switched networks in which the user is charged based on the time they spend online or how long they occupy the circuit (Yan, 2003). Since the initial connection takes a long time and there is a data call charge for browsing the service, WAP-based mobile banking service costs are usually high. Not surprisingly, WAP mobile banking service has proved too complex to use and has been replaced with less advanced technology, SMS, in many places (Zeddies, 2003).

iMode

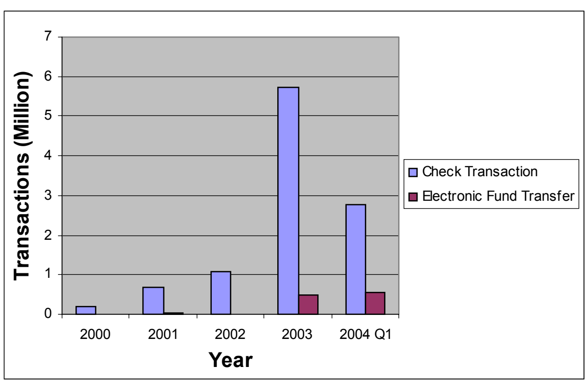
Recently some Western European banks started providing new mobile banking services using the Japanese iMode technology in the hope of revolutionizing mobile banking (Marenzi, 2004). iMode created a successful business model and gained popularity in Japan. The packet-switching iMode uses the Packet Data Cellular Protocol to speed transmission, so users pay for each packet of data rather than their time (Yan, 2003). Therefore, the cost of using iMode banking is much cheaper than WAP-based mobile banking. However, this popular interactive service neither appeals to European customers nor changes the dominant trend of SMS in Europe and Asian mobile banking markets (Marenzi, 2004).

Integrated-Circuit (IC) Chip

Like in most other countries in Asia and Europe, SMS was also the first technology employed as a mobile banking technology in South Korea, where more than 70% of its 48 million citizens carry one or more mobile handsets and one-third of all mobile phone subscribers use their handsets for m-commerce activities (Kim, 2004). However, unlike most other countries, SMS mobile banking services in South Korea, where well-advanced e-banking services are available, did not attract customers at all and was considered as a failure since not much interest was shown (Kwon, 2004). Since then, various technologies including WAP and virtual machine (VM) have been tested and used to attract customers (Korea, 2004), but customers did not display much interest. However, a new integrated-circuit (IC) chip technology provided by the nation's smallest mobile operator changed the history of mobile banking in South Korea (Kim, 2004). The new chip-based offerings were a big hit, as a total 280,000 people signed up for the new services during the first four months after its introduction in September 2003. Since then, the number of mobile banking users has dramatically increased and reached 1.1 million as of September 2004 (Korea, 2004; see Figure 3).

The most important feature of IC chip-based mobile banking is that bank account data is encrypted on a smart-card chip, so it enables customers to connect to their account quickly and securely by pressing a single button on their mobile phone. In addition, to prevent someone else from using a mobile phone or IC chip, a special password or code given by banks is required for the user to make each transaction. Another important feature of IC chip-based mobile banking systems in South Korea is that they were introduced in cooperation between banks and mobile operators (Herald, 2004). Therefore, better services, such as relatively low-cost fixed data service (around

Figure 3. The number of mobile banking transactions in South Korea (Source: www.bok.or.kr/contents_admin/info_admin/main/home/financial/payment/material/info/mobile.pdf



$7 per month), are offered to users (Kim, 2004). Korea's mobile banking service history clearly shows the significant role of technology implemented in mobile banking services.

FUTURE TRENDS

In the United States, differing technical standards and the 'called-party-pays' system somewhat inhibit the use of mobile phones and mobile commerce (Economist, 2000). However, the market has been dramatically expanded over the last two-and-a-half years. The mobile data services market in the United States has grown from nothing to a market worth an estimated $1.5 billion, and various services have been added in the m-commerce marketplace (Media, 2004). However, the majority of mobile data usage in the United States to date revolves around text messaging and low-value downloads such as ringtones (Media, 2004).

In 2004, the first for individual subscribers in the country, AT&T Wireless Services Inc., an affiliate of Japan's NTT DoCoMo Inc., started offering a mobile phone-based fast data service in the United States, enabling users to browse the Web, e-mail, and share video clips (Wireless, 2005). Sprint, another mobile operator, introduced a new mobile banking service to small and independent business owners with spring mobile loan officer (Sprint, 2004). Thus, though mobile banking services have suffered from customer disinterest, many experts insist that mobile banking will eventually become a significant channel for personal banking. One Atlanta-based bank already reported recent success in mobile banking (RCR, 2004), and a major U.S. bank found that 93% of its customers are very interested in mobile banking services (O'Connell, 2004). All the evidence suggests that if mobile banking services are provided in the proper way, they will soon be a major transaction channel for personal banking.

CONCLUSION

There are three important factors which will decide the success of mobile banking services. First is the technology, *per se*, which when implemented for mobile banking systems will significantly influence the use of mobile banking. The success of South Korea's IC chip-based mobile banking service clearly shows that a good technology ultimately appeals to customers. Secondly, it is important that the technology should be approved before it is implemented by future users. The success of SMS and the failure of WAP demonstrates that the ability to offer simple services done well has proved far more attractive than sophisticated services done poorly (Lomax, 2002). Finally, the service of all entities in a mobile commerce cycle, especially mobile operators and mobile device providers, will significantly influence the mobile banking adoption. Therefore, all the entities in a mobile banking cycle should cooperate and assist each other in order to promote the rapid growth of mobile banking.

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KEY TERMS

Circuit Switching: A type of communications in which a dedicated channel (or circuit) is established for the duration of a transmission.

Integrated Circuit (IC): A small electronic device made out of a semiconductor material. Integrated circuits are used for a variety of devices, including microprocessors, audio and video equipment, and automobiles.

Mobile Banking: A client-server system that enables banking customers to use handheld devices to access their accounts, pay bills, authorize funds transfers, or perform other activities.

Mobile Commerce: Any transaction with a monetary value—either direct or indirect—that is conducted over a wireless telecommunication network.

Mobile Services: Services provided by a mobile operator that enable individual customers to access information and applications anytime-anywhere.

Packet Switching: A type of communication in which packets are individually routed between nodes, without a previously established communication path.

Wireless Application Protocol (WAP): A secure specification that allows users to access information instantly via handheld wireless devices such as mobile phones, pagers, two-way radios, smartphones, and communicators.

Category: Concepts, Trends, and Challenges

Mobile Caching for Location-Based Services

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INTRODUCTION

Location-based services (LBS) are services that answer queries based on the locations with which the queries are associate; normally the locations where the queries are issued. With a variety of promising applications, such as local information access (e.g., traffic reports, news, and navigation maps) and nearest neighbor queries (e.g., finding the nearest restaurants) (Barbara, 1999; Ren & Dunham, 2000; D. L. Lee, Lee, Xu, & Zheng, 2002; W. C. Lee, Xu, & Zheng, 2004), LBS is emerging as an integral part of daily life.

The greatest potential of LBS is met in a mobile computing environment, where users enjoy unrestricted mobility and ubiquitous information access. For example, a traveler could issue a query like "Find the nearest hotel with a room rate below $100" from a wireless portable device in the middle of a journey. To answer such a query, however, three major challenges have to be overcome:

- **Constrained Mobile Environments:** Users in a mobile environment suffer from various constraints, such as scarce bandwidth, low-quality communication, frequent network disconnections, and limited local resources. These constraints pose a great challenge for the provision of LBS to mobile users.
- **Spatial Data:** In LBS, the answers to a query associated with different locations may be different. That is, query results are dependent on spatial properties of queries. For a query bound with a certain query location, the query result should be relevant to the query as well as valid for the bound location. This requirement adds additional complexity to traditional data management techniques such as data placement, indexing, and query processing (D. L. Lee, 2002).
- **User Movement:** The fact that a mobile user may change its location makes some tasks in LBS, such as query scheduling and cache management, particularly tough. For example, suppose that a mobile user issues a query "Find the nearest restaurant" at location *A*. If the query is not scheduled timely enough on the server, the user has moved to location *B* when he or she gets the answer *R*. However, *R* is no longer the nearest restaurant at location *B*.

Caching has been a commonly used technique for improving data access performance in a mobile computing environment (Acharya, Alonso, Franklin, & Zdonik, 1995). There are several advantages for caching data on mobile clients:

- It improves data access latency since a portion of queries, if not all, can be satisfied locally.
- It helps save energy since wireless communication is required only for cache-miss queries.
- It reduces contention on the narrow-bandwidth wireless channel and off-loads workload from the server; as such, the system throughput is improved.
- It improves data availability in circumstances where clients are disconnected or weakly connected because cached data can be used to answer queries.

However, as discussed above, the *constrains* of mobile computing environments, the *spatial* property of location-dependent data, and the *mobility* of mobile users have opened up many new research problems in client caching for LBS. This chapter discusses the research issues arising from caching of location-dependent data in a mobile environment and briefly describes several state-of-the-art solutions.

BACKGROUND

Location Model

Location plays a central role in LBS. A location needs to be specified explicitly or implicitly for any information access. The available mechanisms for identifying locations of mobile users are based on two models:

- **Geometric Model:** A location is specified as an *n*-dimensional coordinate (typically, $n = 2$ or 3); for example , the latitude/longitude pair returned by the global positioning system (GPS). The main advantage of the geometric model is its compatibility across heterogeneous systems. However, providing such fine-grained location information may involve considerable cost and complexity.

- **Symbolic Model:** The location space is divided into disjointed zones, each of which is identified by a unique name. Examples are the Cricket system (Priyantha, Chakraborty, & Balakrishnan, 2000) and the cellular infrastructure. The symbolic model is in general cheaper to deploy than the geometric model because of the lower cost of employing a coarser location granularity. Also, being discrete and well-structured, location information based on the symbolic model is easier to manage.

For ease of illustration, two notions are defined: *valid scope* and *valid scope distribution*. A dataset is a collection of data instances. The *valid scope* of a data instance is defined as the area within which this instance is the only answer with respect to a location-dependent query. With the symbolic location model, a valid scope is represented by a set of logical zone ids. With the geometric location model, a valid scope often takes the shape of a polygon in a two-dimensional space. Since a query may return different instances at different locations, it is associated with a set of valid scopes, which collectively is called the *scope distribution* of the query. To illustrate, consider a four-cell system with a wireless-cell-based location model. Suppose that the nearby restaurant for cell 1 and cell 2 is instance X, and the nearby restaurant for cell 3 and cell 4 is instance Y. Then, the valid scope of X is $\{1, 2\}$, the valid scope of Y is $\{3, 4\}$, and the scope distribution of the nearby restaurant query is $\{\{1, 2\}, \{3, 4\}\}$.

Client Caching Model

There is a cache management module in the client. Whenever an application issues a query, the local cache manager first checks whether the desired data item is in the cache. If it is a cache hit, the cache manager still needs to validate the consistency of the cached item with the master copy at the server. This process is called *cache validation*. In general, data inconsistency is incurred by data updates at the server (called *temporal-dependent invalidation*). For location-dependent information in a mobile environment, cache inconsistency can also be caused by location change of a client (called *location-dependent invalidation*). If it is a cache hit but the cached content is obsolete or invalid, or it is a cache miss, the cache manager requests the data from the server via on-demand access. When the requested data item arrives, the cache manager returns it to the user and retains a copy in the cache. The issue of *cache replacement* arises when the free cache space is not enough to accommodate a data item to be cached. It determines the victim data item(s) to be dropped from the cache in order to allocate sufficient cache space for the incoming data item.

Survey of Related Work

This section reviews the existing studies on cache invalidation and replacement strategies for mobile clients. Most of them were designed for general data services and only a few addressed the caching issues for location-dependent data. Temporal-dependent invalidation has been studied for many years (Barbara & Imielinski, 1994; Cao, 2000; Wu, Yu, & Chen, 1996). To carry out temporal-dependent invalidation, the server keeps track of the update history (for a reasonable length of time) and sends it, in the form of an invalidation report (IR), to the clients, either by periodic/aperiodic broadcasting or upon individual requests from the clients. In the basic IR approach, the server broadcasts a list of IDs for the items that have been changed within a history window. The mobile client, if active, listens to the IRs and updates its cache accordingly. Most existing temporal-dependent invalidation schemes are variations of the basic IR approach. They differ from one another mainly in the organization of IR contents and the mechanism of uplink checking. A good survey can be found in Tan et al. (2001).

Semantic data caching has been suggested for managing location-dependent query results (Dar, Franklin, Jonsson, Srivatava, & Tan, 1996; Lee, Leong, & Si, 1999), where a cached result is described with the location associated with the query. Unfortunately, the possibility was not explored that a cached data value may be valid for queries issued from locations different from that associated with the original query. As demonstrated in Zheng, Xu, and Lee (2002), the exploration of this possibility can significantly enhance the performance of location-dependent data caching. As a matter of fact, the invalidation information in the proposed methods (to be discussed later in this chapter) can be considered a kind of semantic description, which could improve cache hit rates.

Cache replacement policies for wireless environments were first studied in the *broadcast disk* project (Acharya et al., 1995; Acharya, Franklin, & Zdonik, 1996). In Acharya et al. (1995), the PIX policy takes into consideration both data access probability and broadcast frequency during replacement. In Khanna and Liberatore (2000), the Gray scheme makes replacement decisions based on both data access history and retrieval delay. Motivated by a realistic broadcast environment, an optimal cache replacement policy, called Min-SAUD, was investigated in Xu, Hu, Lee, and Lee (2004). The Min-SAUD policy incorporates various factors that affect cache performance, that is, access probability, retrieval delay, item size, update frequency, and cache validation delay.

In the studies on location-dependent data caching, data-distance based cache replacement policies, Manhattan distance (Dar et al., 1996) and FAR (Ren & Dunham, 2000), have been proposed. Under these two policies, the data that is farthest away from the client's current location is removed during replacement. However, data distance was considered alone and not integrated with other factors such as access probability. Moreover, they did not consider the factor of valid scope area.

CACHING FOR LOCATION-BASED SERVICES

Location-Dependent Cache Invalidation

When the client moves around, location-dependent data cached at a mobile client may become invalid with respect to the new location. The procedure of verifying the validity of location-dependent data with respect to the current location is referred to as *location-dependent cache invalidation*. To perform location-dependent invalidation efficiently, the idea is to make use of validity information of data instances. Specifically, the server delivers the valid scope along with a data instance to a mobile client and the client caches the data as well as its valid scope for later validity checking. The strategy involves two issues, namely validity checking time and validity information organization. Since a query result depends on the location specified with the query only, it is suggested to perform validity checking for a cached data instance until it is queried. For validity information organization, a number of schemes have been proposed (Zheng et al., 2002; Xu, Tang, & Lee, 2003). The proposed schemes can be classified into two categories according to the underlying location model employed. This section introduces two methods, that is, implicit scope information (ISI) and caching-efficiency-based method (CEB), for a symbolic and geometric location model respectively.

Implicit Scope Information (ISI)

Assume a wireless-cell-ID-based symbolic location model. Under the ISI scheme, the server enumerates the scope distributions of all items and numbers them sequentially. The valid scopes within a scope distribution are also numbered sequentially. For any instance of data item i, its valid scope is specified by a 2-tuple (SDN_i, SN_i), where SDN_i is the scope distribution number and SN_i denotes the scope number within this distribution. The 2-tuple is attached to a data instance as its valid scope. For example, suppose there are three different scope distributions (see Table 1) and data item 4 follows distribution 3. If item 4 is cached from cell 6 (i.e., CID = 6), then $SDN_4 = 3$ and $SN_4 = 3$. This implies that item 4's instance is valid in cells 6 and 7 only.

It can be observed that the size of the validity information for a data instance is small and independent of the actual number of cells in which the instance is valid. Another observation is that a set of data items may share the same scope distribution. As such, the number of scope distributions could be much smaller than the number of items in the database.

At the server-side, a *location-dependent IR* is periodically broadcast in each cell. It consists of the ordered valid scope numbers (SN) for each scope distribution in the cell. For example, in cell 8, the server broadcasts {8, 3, 4} to mobile clients, where the three numbers are the SN values in cell 8 for scope distributions 1, 2, and 3, respectively (see Table 1).

The validity checking algorithm for item i works as follows. After retrieving a location-dependent IR, the client compares the cached SN_i with the SDN_i-th SN in the location-dependent IR received. If they are the same, the cached data instance is valid. Otherwise, the data instance is invalid. For example, in cell 8, the client checks for the cached instance of data item 4 whose $SDN_4 = 3$ and $SN_4 = 3$. In the broadcast report, the SDN_4-th (i.e., third) SN equals to 4. Therefore, the client knows that the cached instance is invalid. The performance analysis conducted in Xu et al. (2003) shows that the ISI method performs close to an optimal strategy which assumes perfect location information is available on mobile clients.

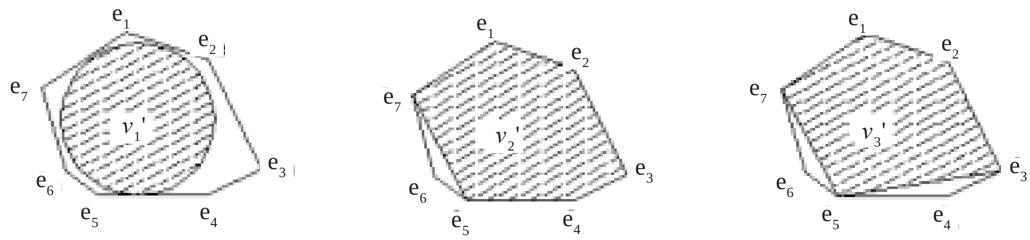
Caching-Efficiency-Based Method (CEB)

This section discusses location-dependent cache invalidation strategies for a geometric location model. Under this model, there are two basic schemes for representing valid scopes, that is, *polygonal endpoints* and *approximate circle* (Zheng et al., 2002). However, these two schemes perform poorly due to either high overhead or imprecision of the invalidation information. To enhance performance, a generic *caching-efficiency-based* (CEB)

Table 1. An example of data items with different distributions

<table>
<tr><td>Cell ID</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>Scope Distribution (SDN) #1</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>Scope Distribution (SDN) #2</td><td colspan="3">1</td><td colspan="3">2</td><td colspan="3">3</td><td colspan="3">4</td></tr>
<tr><td>Scope Distribution (SDN) #3</td><td colspan="2">1</td><td colspan="3">2</td><td colspan="2">3</td><td colspan="3">4</td><td colspan="2">5</td></tr>
</table>

Figure 1. An example of possible candidate valid scopes ($v = p(e_1,e_2,...,e_7)$)



(a)v_1'=inscribed circle of v (b)$v_2'=p(e_1, e_2, e_3, e_4, e_5, e_7)$ (c)$v_3'=p(e_1, e_2, e_3, e_5, e_7)$

method for balancing the overhead and the knowledge of valid scopes was proposed in Zheng et al. (2002).

In the CEB method, a new metric *caching efficiency* was introduced. Suppose that the valid scope of a data instance is v, and v_i' is a subregion contained in v (see Figure 1). Let s be the data size, $A(v_i')$ the area of any scope of v_i', and $O(v_i')$ the storage overhead needed to record the scope v_i'. The caching efficiency of the data instance with respect to a scope v_i' is defined as follows:

$$E(v_i') = \frac{A(v_i')/A(v)}{(s+O(v_i'))/s} = \frac{A(v_i')s}{A(v)(s+O(v_i'))}. \quad (6)$$

Let v_i' be the approximated scope information stored in the client cache. Assuming that the cache size is infinite and the probabilities of a client issuing queries at different locations are uniform, $A(v_i') / A(v)$ is the data instance's cache hit ratio when the client issues the query within the valid scope v. In contrast, $(s + O(v_i')) / s$ is the normalized overhead for achieving such a hit ratio. The rationale behind this definition is as follows. When none of the invalidation information is cached, $E(v_i')$ is 0 because the cached data is completely useless; $E(v_i')$ increases with more invalidation information attached. However, if too much overhead is therefore introduced, $E(v_i')$ would decrease again. Thus, a generic method for balancing the overhead and the precision of invalidation information works as follows:

- For a data instance with a valid scope of v, given a candidate valid scope set $V' = \{v_1', v_2',..., v_k'\}$, $v_i' \subseteq v$, $1 \le i \le k$, the CEB method chooses the scope v_i' that maximizes caching efficiency $E(v_i')$ as the valid scope to be attached to the instance.

Figure 1 illustrates an example where the valid scope of the data instance is $v = p(e_1,e_2,...,e_7)$, and v_1', v_2', v_3' are three different subregions of v, $A(v_1') / A(v) = 0.788$, $A(v_2') / A(v) = 0.970$, and $A(v_3') / A(v) = 0.910$. Assume that the data size s is 128 bytes, 8 bytes are needed to represent an endpoint, and 4 bytes for the radius of an inscribed circle; hence $O(v) = 56$, $O(v_1') = 12$, $O(v_2') = 48$, and $O(v_3') = 40$. Thus, $E(v) = 0.696$, $E(v_1') = 0.721$, $E(v_2') = 0.706$, and $E(v_3') = 0.694$. As a result, v_1' is chosen as the valid scope to be attached to the data instance. The simulation based evaluation demonstrates that the CEB method is very effective and outperforms other invalidation methods (Zheng et al., 2002).

Cache Replacement Policies

Because a mobile client has only limited cache space, cache replacement is another important issue to be tackled in client cache management. In traditional cache replacement policies, access probability is considered the most important factor that affects cache performance. A probability-based policy is to replace the data with the least access probability. However, in LBS, besides access probability, there are two other factors, namely *data distance* and *valid scope area*, which have to be considered in cache replacement strategies.

Generally, a promising cache replacement policy should choose as its victim the data item with a low access probability, a small valid scope area, and a long distance if data distance is also an influential factor. This section presents two cost-based cache replacement policies, PA and PAID, which integrate the three factors that are supposed to affect cache performance. The discussions are based on a geometric location model.

- **Probability Area (PA):** As the name suggests, the cost of a data instance under this policy is defined as the product of the access probability of the data item and the area of the attached valid scope. That is, the cost function for data instance j of item i is as follows:

$$c_{i,j} = p_i \cdot A(v'_{i,j}) \ , \quad (7)$$

where p_i is the access probability of item i and $A(v'_{i,j})$ is the area of the attached valid scope $v'_{i,j}$ for data instance j. The PA policy chooses the data with the least cost as its victim for cache replacement.

- **Probability Area Inverse Distance (PAID):** Compared with PA, this scheme further integrates the data distance factor. For the PAID policy, the cost function for data instance j of item i is defined as follows:

$$c_{i,j} = \frac{p_i \cdot A(v'_{i,j})}{D(v'_{i,j})}, \tag{8}$$

where p_i and $A(v'_{i,j})$ are defined the same as above, and $D(v'_{i,j})$ is the distance between the current location and the valid scope $v'_{i,j}$. Similar to PA, PAID ejects the data with the least cost during each replacement.

Zheng et al. (2002) have evaluated the performance of PA and PAID and demonstrated that PA and PAID substantially outperform the existing policies including LRU and FAR. In particular, consideration of the valid scope area improves performance in all settings, and consideration of the moving direction in calculating data distance is effective only for short query intervals and short moving intervals.

FUTURE TRENDS

Caching of location-dependent data opens up a new dimension of research in mobile computing. As for future work, per user based adaptive techniques can be developed since mobile clients may have different movement patterns. Besides cache invalidation and replacement schemes, it is interesting to investigate *cache prefetching* which preloads data onto the mobile client cache by taking advantage of user mobility. Furthermore, how to incorporate location-dependent data invalidation schemes and semantic caching would be an interesting topic. In addition, battery power is a scarce resource in a mobile computing environment; it is believed that power-aware cache management deserves further in-depth study.

CONCLUSION

LBS has been emerging as the result of technological advances in high-speed wireless networks, personal portable devices, and location positioning techniques. This chapter discussed client cache management issues for LBS. Two location-dependent cache invalidation methods, that is, ISI and CEB, are introduced. The cache replacement issue for location-dependent data was also investigated. Two cache replacement policies, that is, PA and PAID that consider the factors of valid scope area (for both methods) and data distance (for PAID only) and combine these factors with access probability, were presented. With an increasing popularity of LBS, caching of location-dependent data remains a fertile research area that aims to overcome inherent constraints (including power, bandwidth, storage, etc.) in a mobile environment.

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KEY TERMS

Cache Invalidation: The procedure of validating whether the cached data is consistent with the master copy at the server.

Cache Replacement: The procedure of finding the victim data item(s) to be dropped from the cache in order to allocate sufficient cache space for an incoming data item.

Location-Based Services (LBS): The services that answer queries based on the locations with which the queries are associate.

Location-Dependent Cache Invalidation: The procedure of verifying the validity of cached location-dependent data with respect to the current location.

Mobile Client: A portable device that is augmented with a wireless communication interface.

Valid Scope: The area within which the data instance is the only answer with respect to a location-dependent query.

Valid Scope Distribution: The collective set of valid scopes for a data item.

Wireless Cell: The radio coverage area in which a mobile client can communicate with the wireless infrastructure.

Mobile Commerce Applications and Adoption

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INTRODUCTION

The potential advantages of mobile commerce applications have been discussed extensively in the recent literature, with many industries offering mobile services. Examples from the financial sector include instant funds transfer (mobile banking) and share trading (mobile brokerage). Commuter services such as sending schedule change alerts or using a mobile phone to pay for parking have become widespread. Applications based on the location of the user (e.g., offering mobile coupons to customers in the vicinity of a shop or a restaurant) are also being trialled (Barnes, 2002; Siau, Lim, & Shen, 2001; Varshney, Vetter, & Kalakota, 2000).

Despite the potential benefits (for example, improved customer service) mobile commerce applications have not been widely adopted across business sectors. Mobile banking illustrates the point: initially, seen as the "killer application" of mobile commerce (Kannan, Chang, & Whinston, 2001), it has now been termed a "dead end" (Semrau & Kraiss, 2001). It has also been classified as an application which has not yet matured (Mallat, Rooi, & Tuunainen, 2004). However, innovative applications continue to emerge, for example, breaking news alerts (CNN, n.d.), and a mobile tutoring service (Butte, 2004). It has become important therefore to identify the determinants of mobile commerce adoption and the emerging adoption patterns.

A significant number of results in this area have been reported in the literature. Recent examples include studies of mobile services adoption in areas characterized by relatively high penetration of mobile devices—such as Denmark (Constantiou, Damsgaard, & Knutsen, 2004), Singapore (Samtani, Leow, Lim, & Goh, 2004), and Finland (Carlsson, Hyvonen, Repo, & Walden, 2005). The identified drivers and inhibitors of mobile commerce adoption can be broadly classified as factors related to mobile infrastructure access, and factors relating to perceived consumer value. This article proposes a mobile commerce reference model which incorporates both infrastructure access and customer value and can be used to formulate research questions related to mobile commerce adoption.

The remainder of the article is organized as follows: first, mobile commerce is defined and compared to electronic commerce. The next section introduces a mobile commerce reference model and discusses mobile commerce adoption. The article continues with a review of future trends and a brief conclusion.

BACKGROUND

The definitions of mobile commerce (m-commerce) found in the literature such as the one suggested in Varshney et al. (2000), emphasize the use of mobile telephony and a handheld device to execute transactions with monetary value (i.e., exchange of funds for goods and services). M-commerce services are offered to subscribers only.

Turban, Lee, and Viehland (2004, p. 399) classify m-commerce as a subset of electronic commerce (e-commerce). However several features of m-commerce are either not found, or are not strongly manifested in e-commerce. These include "ubiquity"—which allows the user to interact with a mobile application anywhere, even when travelling or moving (Schneiderman, 2000, p. 1); "localization"—the ability of an application to offer a service specific to the location of the customer (Köhne, Totz, & Wehmeyer, 2005) and "personalization"—the ability to tailor an m-commerce activity according to a customer profile, and use the subscriber's account for payment (Siau et al., 2001).

The m-commerce characteristics described above (ubiquity, localization, and personalization) and the profile of the potential m-commerce user as a paid mobile network subscriber provide the grounds on which to differentiate between e-commerce and m-commerce. In this article, m-commerce is defined as a value-added service that enables mobile users to conduct reliable and secure transactions through specifically-designed mobile applications. The definition implies that a company or an organization offering a mobile service needs to develop and implement an appropriate business model which will incorporate the value proposition of the service, the revenue model, and the interactions of the company with business partners, suppliers and customers (Veijalainen, Terziyan, & Tirri, 2003).

MODELLING M-COMMERCE ADOPTION

Even the most innovative and creative mobile application or service will only be commercially successful if brought to customers through a business model that clearly focuses on the added value generated and offered by the application or service. Furthermore, the adoption of the application will depend on additional factors such as whether it is accessible from all locations, or whether it depends on the specific features of the handheld device—(e.g., WAP functionality or a small screen). General factors such as security awareness, privacy, and trust concerns might also play a role (Giaglis, 2005; Lin, 2004). To be viable, an m-commerce business model needs to:

1. Take full advantage of user mobility.
2. Offer services which would be either unavailable or prohibitively expensive if offered by means of e-commerce or brick-and-mortar commerce.
3. Offer services overcoming drawbacks caused by security and privacy related issues.

The degree to which the requirements above are met will influence the adoption of a particular m-commerce application and will act as a viability determinant of the associated business model. The investigation of the process of value creation and subsequent adoption needs to consider both technological and social factors (Carlsson et al., 2005; Pedersen, Methlie, & Thorbjornsen, 2002) and needs to include the different players involved: network providers and operators, content contributors and aggregators, portal hosts and application developers. One of the approaches is to consider the interactions among the players and their roles in the value chain model of m-commerce (Barnes, 2002, 2003).

A REFERENCE MODEL FOR M-COMMERCE

The value chain approach breaks down m-commerce into a structured chain of entities with associated "actors" and allows the researcher to identify easily and conveniently the companies and organizations involved in creating mobility-related value (Barnes, 2002; Buellingen & Woerter, 2004; Olsson & Nilsson, 2002; Siau et al., 2001).

The reference model (Figure 1) places together the players involved in the value chain, and captures the features of technologies, applications and services related to m-commerce. It incorporates three basic layers: an infrastructure layer (devices and networks), an interface layer (mobile middleware and platforms), and a business layer (services, content, application-based business models). Direct interactions with subscribers/customers occur mostly at the infrastructure and business layers where the value chain players act as enablers and direct providers, respectively. At the interface layer, the actors perform the role of intermediaries. The layered structure complies with the m-commerce definition in the previous section and enables the systematic investigation of the processes of value-creation across the m-commerce value chain. The model can be used to develop evaluation criteria and study m-commerce applications and their adoption within an industry segment, at national or at a regional level.

Other proposed approaches towards conceptual modelling of m-commerce include the bundled value proposition (Anckar & D'Incau, 2002), the open-plane framework (Varshney & Vetter, 2002), the reference model for m-commerce applications (Stanoevska-Slabeva, 2003), and extended three-dimensional models (Chen, Lee, & Cheung, 2001; Tarasewich, Nickerson, & Varkentin, 2002). The reference model introduced above is somewhat similar to Stanoevska-Slabeva's and Varshney and Vetter's models but is more comprehensive.

Figure 1. A reference model for m-commerce

Business layers	Companies and organizations interact indirectly with customers (consumers of mobile services and end-users of mobile applications)	
7	Business Model	Companies/organizations offering an mCommerce application to customers (direct providers)
6	Mobile Content	Companies/organizations providing or developing content for the application (intermediaries)
5	Mobile Service	Companies/organizations offering the application to the customer, or providing a related service (intermediaries)
Interface layers	Companies and organizations mostly interact indirectly with users (consumers of mobile services and applications)	
4	Application Platform	Developers of portals, integrators, and/or network providers (enablers)
3	Mobile Middleware	Developers of general purpose middleware or specialized consortia (include network providers and device manufacturers).
Infrastructure layers	Companies and organizations interact directly or indirectly with subscribers	
2	Mobile Device	Manufacturers and vendors
1	Mobile Network	Providers and vendors (enablers)
	Layers	Players in the value chain (enablers, direct providers, intermediaries)

M-COMMERCE ADOPTION STUDIES

Research in the area has been mostly based on prior work in the areas of adoption and diffusion and the technology acceptance model (Pedersen & Ling, 2003; Pedersen, Methlie, & Thorbjornsen, 2002). Though based on different background concepts, the research directions in adoption studies have much in common as they focus on end users and customers in different contexts.

The m-commerce reference model (Figure 1) includes two customer contexts where customers interact directly with the model constructs: "infrastructure" (the customer as a subscriber) and "business" (the customer as user of mobile application). The two interaction types correspond to the "technology user" and "consumer" perspectives defined by Pedersen et al. (2002). Factors influencing adoption related to the two perspectives have been identified as: (1) interoperability of devices and protocols, bandwidth availability, device features and functions, connectivity (technology); and (2) content personalization and localization, service ubiquity, timeliness, convenience, cost, privacy issues (consumer) (Chen, Lee, & Cheung, 2001, Petrova, 2004a, Turban et al., 2004, p. 423).

To improve the understanding of the adoption process and "move from description of the process into explaining it" (Pedersen & Ling, 2003), and to include the value chain perspective, the broader research questions can be formulated as:

1. Which of the factors contributing to the creation of mobility-related value are critical success factors for the viability of an m-commerce business model?
2. What other specific factors contribute to (or inhibit) business model viability, for example environmental factors (e.g., legislation) and demographic factors (e.g., age, gender)?
3. How might m-commerce actors such as "intermediaries" and "enablers" encourage or inhibit adoption processes?
4. What is the role of m-commerce payment mechanisms in the adoption processes?

Obtaining the answers to those questions might help develop appropriate applications and business models, taking into account not only customer perceptions but the roles played by all actors in the value chain (Heikkilä, Heikkilä, & Lehmonen, 2004). An example of such an innovative application is "interactive mobile TV" (Kihlström, 2005) which is driven by a partnership between the vendor (Ericsson) and content providers (media companies). Interactive mobile TV uses the handset screen to show images or information, to download multimedia content, to enable voting for TV shows, and to display advertising messages. Another developing area is mobile education (Kurbel & Hilker, 2003). Examples of mobile learning scenarios include the use of text messaging for interactive revision (Petrova, 2004b), and mobile Internet access to online seminars (Hino, Terashima, & Bunno, 2002).

FUTURE TRENDS

Using the reference model in Figure 1 as a framework, some of the current trends in m-commerce can be summarized as follows:

- **Layers 1 and 2 (Infrastructure):** To take advantage of new technology developments such as 3G networks and smart phones, developers focus on improving browsing capabilities (Lai et al., 2004) and improving the functionality of handheld devices (personal digital assistants—PDAs, smart phones).
- **Layers 3 and 4 (Interface):** Both general purpose mobile middleware and specific platforms are developed. Raatikainen, Baerbak and Nakajima (2002) state that future systems research will focus on software systems able to provide a seamless service in environments which are both dynamic and heterogeneous, specifically aiming to support large scale applications such as home entertainment. Tarumi, Matsubara and Yano (2004) envisage developing platforms such as the "virtual city", which will serve as a common infrastructure for location based services, including entertainment and advertising. The Japanese mobile portal and services provider NTT DoCoMo continues to expand its i-mode services, including multimedia and payment (NTTDoCoMo, n.d.).
- **Layers 5, 6, and 7 (Business):** Developments in the m-commerce landscape occur in different industry sectors, two of which provide interesting and innovative examples: entertainment, and tourism and travel.

Entertainment applications include streamed music, downloadable or interactive games, streamed movie shows, and chat rooms. Data indicate that the market for mobile entertainment services might be significantly fragmented based on professional background, age and culture, therefore customer preferences and requirements need to be better understood (Leavitt, 2003; Moore & Rutter, 2004; Vlachos & Vrechopoulos, 2004).

In tourism and travel, applications include providing maps or textual guides for tourists and visitors, including vehicle drivers. Such services are location based. The geographical location of the customer determines the content of the application (e.g., directions to the nearest hardware store, or instructions for reaching a particular destination). A possible impediment to the spread of these applications is the relative lack of compatibility across devices and provider networks (Brown & Chalmers, 2003; Köhne et al., 2005; Pavón, Corchado, Gómez-Sanz, & Ossa, 2004; Tarumi et al., 2004).

Other industries with potential to develop successful applications include mobile learning (Leung & Chan, 2003) and event management (Olsson & Nilsson, 2002).

Current research focuses on theory building and analysis and classification of the m-commerce landscape (Camponovo, Debetaz, & Pigneur, 2004), on general adoption models and patterns (Vrechopoulos, Constantiou, Mylonopoulos, Sideris, & Doukidis, 2002), and on services adoption in a specific industry-country context (for example, banking in Finland—Suoranta, Mattila, & Munnukka, 2005).

CONCLUSION

This article defines m-commerce and compares it to e-commerce. It identifies the important characteristics of m-commerce applications and the main research perspectives in application adoption studies. While it is recognized that technology is the primary driver behind m-commerce development, it has also become clear that the adoption processes are aligned with socioeconomic factors. The proposed layered reference model for m-commerce accommodates all actors in the m-commerce value chain and includes the m-commerce adopter as a mobile technology user and as a mobile services consumer. It can be used to derive research questions related to the adoption of emerging applications. The future trends in infrastructure development–such as improved device functionality and greater network capacity—will be able to support innovative and consumer-attractive applications across industry sectors including entertainment, travel, education and financial services.

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KEY TERMS

3G: Stands for "third generation" mobile telephony—a wireless communication technology which supports multimedia, video streaming, and video-conferencing.

i-mode: A packet-switching wireless technology, used by NTT DoCoMo (Japan). A range of commercial and financial services are offered, including browsing the Web from a mobile phone.

LBS: Stands for "Location Based Services"—applications which can obtain information about the customer location and use it to customize the service offered.

Microbrowser: Client software (Web browser), designed to operate within the constraints of a handheld mobile device: low memory, small screen, relatively low bandwidth.

MMS: Stands for multimedia message service; similar to text messaging (SMS) but allows the transmission of graphics, sound files, video clips and text. It is based on WAP and can be used to send e-mail.

Mobile Applications: A broad range of applications and services accessible through a mobile handheld device. Examples include banking, news, betting, games, travel directions.

Mobile Commerce: Broadly refers to any value-added service providing access to a mobile application.

Smart Phone: An enhanced handheld device which combines the functions of a mobile phone and a handheld computer.

SMS: Stands for short message service (also known as text messaging, or "texting").

WAP: Stands for wireless application protocol. A set of standards which enable data display for handheld devices and support Web and e-mail access.

Category: Concepts, Trends, and Challenges

Mobile Commerce in South Africa

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INTRODUCTION

The last decade has seen a rush among businesses to get onto the Internet. Since its introduction, e-commerce has grown in leaps and bounds. The frenzy to get online and be a part of the "new economy" was spurred on by media hype describing the Internet as the greatest technology this century. Organisations embarked on initiatives to change their business models, looking for e-strategies as a means of revolutionising their business. By mid 2000, many of the dot.coms were "dot.gones." The primary reason for this sudden death was that businesses forgot the basic rule of business: creating economic value. Economic value as defined by Porter (1985) is the gap between price and cost—the larger the gap, the greater the economic value. According to Porter (2001), gaining a competitive advantage does not require a radical approach to business; it requires building on the principles of effective strategy. Businesses that went online should not have looked for e-strategies, but should have improved on their existing strategy to include an e-strategy.

GPRS, wireless Web, handhelds, m-commerce, 2nd coming of the Internet, m-management, killer apps, 2G or 3G, always-on, have been the buzzwords in the media. Is this new hype really worth the fuss? M-commerce has failed in the United States and has made a brief appearance in South Africa. Therefore, this article asks the question "Is there potential to revive m-commerce in South Africa?" In attempting to answer this question, this article will examine issues such as uses of m-commerce, the benefits and challenges of m-commerce, trends in the wireless industry, and the technology underlying m-commerce. This article will also attempt to provide suggestions for harnessing the power of the wireless Web. Most of the discussions are based on universal experience supported with what the current situation is in South Africa; therefore, this article will not be separated into a universal section with a smaller subset focussing on South Africa.

BACKGROUND

What is Mobile Commerce?

Organisations have just begun to get comfortable with e-commerce in terms of what it can do for them and what are its limitations. Some are still coming to grips with e-commerce and have now been hit with the new wave of m-commerce. According to Rainer (2000), m-commerce refers to the use of wireless communications technology to access network-based information and applications using mobile devices. Laudon and Laudon (2004) described m-commerce as the use of wireless technologies for conducting business-to-business and business-to-consumer transactions over the Internet, hence, m-commerce can be described as the mobile Internet (Herron, 2000). Cleenwerck (2002) describes m-commerce as the wireless Web. It is evident from these definitions that the main characteristics of m-commerce are mobility, wireless, mobile devices, and the Internet.

It is evident that m-commerce is merely an extension of the Internet to wireless handheld devices, thus bringing e-commerce into the palms of users beyond the physical boundaries of bricks and mortar. If m-commerce is e-commerce on the move, why all the hype?

Uses of Mobile Commerce

The proposed uses of wireless technology seem like something out of a James Bond movie. However, users should clear the image of driving a BMW with a Nokia cell phone from their minds. Improved communication is probably the most important use of the wireless Web. People have access to text-based data such as short message services (SMS), e-mails, news broadcasts, and file transfers. Advanced functions include booking of tickets for movies and shows and making restaurant reservations. Very advanced features would involve transactions such as purchasing airtime, ordering products online, and secure banking. Some of the other uses include the following:

- **Navigation Systems:** Global Positioning Satellite (GPS) services integrates the wireless Web with satellite and Geographic Information Systems (GIS) to locate people in space. These systems will be able to assist people who are lost to find their way. GPS will also be able to calculate the shortest route between two points, saving time and money.
- **Electronic Wallets:** According to Posthumus (2001), wallets built into cell-phone technology is highly appealing and could herald a new era in business

and financial systems whereby users could make payments to vending machines for the purchase of items and effect funds transfers at in-store point-of-sales (POS) systems.

- **Multipurpose Remote Controls:** Handheld devices will soon be linked to all the electronic devices in a home, allowing one to control gates, burglar alarms, televisions, sound systems, and just about anything that is electronic. Currently, some models of the Ipaq® have a multidevice interface. The use of these devices as remote controls is limited by appliance manufacturers' developing devices compatible with PDAs. Other uses of m-commerce include stock trading, weather forecasts, vehicle tracking, and instant messaging, among others.

The uses of m-commerce are limited only to the extent of one's imagination. However, Reedy, Schullo, and Zimmerman (2000) warned that certain products such as perishables and small items were not suited for sale on the Internet. Similarly, La Fontaine (cited in Brewin, 2000) noted that not all business opportunities can be translated onto the wireless Web. The uses of m-commerce are many, but do they bring with them any benefits?

M-COMMERCE IN SOUTH AFRICA

Benefits of Mobile Commerce

According to Navision (2002), the benefits of m-commerce are threefold (i.e., it provides immediate access to information where it is needed, it helps employees respond immediately to business needs, and it allows organisations to provide better field service). Wireless makes communication possible in areas of uneven terrain, such as mountains, where it is difficult to install cable. According to Haag, Cummings, and Dawkins (2000), serving customers goes beyond the provision of products and services. Businesses need to provide perfect service at the customer's moment of value; one of the dimensions of which is *place*. M-commerce makes it possible to deliver service where the customer wants it, such as at his or her work place, at home, and even at the beach. Armed with a cell phone or a PDA, a sales consultant can provide near-perfect information to assist the customer in his or her buying decision, immaterial of the customer's location.

M-management, an offshoot of mobile commerce, makes it possible to keep managers apprised of all events at the workplace, wherever in the world the manager may be. M-productivity, also an offshoot of mobile commerce, makes it possible to improve worker productivity. Employees can access their contact information, review their calendars, and respond to e-mail, which ordinarily would have to be done at a desk. Other benefits of m-commerce include the following:

- **Immediate Access:** Due to the nature of the technology, cell phones and PDAs are instantly on, which reduces overhead time, which is the time taken to get started. PCs take an extremely long time to get started, initialise all the peripherals, and then to establish a dial-up connection with the service provider.
- **Use of Niche Time:** Time that is unavailable or wasted whilst waiting for services or sitting idle in public transport can be leveraged for work (Rainer, 2000). GNER, a United Kingdom train operator, has installed WiFi on its trains. In first class, access is free, and as a result, standard-class commuters are upgrading to first class (WiFi Growth on UK Trains, 2004). WiFi hotspots are making it possible to access the Internet in airports, restaurants, and other public places in South Africa.
- **Generate New Income:** In order to generate new income, firms need to advertise extensively in traditional media such as television, radios, and billboards to stimulate impulse buying. The advertising must contain the message that these products can be ordered from ones handheld device.
- **Reduce Costs:** Cell phones, pagers, and PDAs are much cheaper than computers and laptops; this reduces organisational cost and makes m-commerce accessible to larger markets.
- **New Marketing Medium:** Short-range broadcast systems can be used within small areas or buildings such as malls, where advertisements and special offers could be sent to their mobile devices (Gaede, as cited in Mobile Services: Less Talk, More Profit, 2005).

It is evident that the benefits of m-commerce are immense. But how does one get around those tiny keypads?

Challenges Facing Mobile Commerce

Mobile phones have extremely small screens that are capable of delivering, at maximum, approximately eight lines of text (Herron, 2000). Furthermore, the absence of a QWERTY keyboard makes typing a painful experience. According to Ewalt (2000b), even when one gets the technology working, purchasing online using a cell phone or PDA is extremely difficult due to the low resolution of the screens, unreliable network support (dropped calls), and poor security.

In order for m-commerce to work properly, it will have to run seamlessly among different carriers, networks and handheld devices. In short, there must be interoperability (Mc Guire, cited in Ewalt, 2000b). Just like HTML offered a one-size-fits-all platform for the Internet, similarly, a common platform has to be developed for the wireless Web.

According to King (cited in Ewalt, 2000a), consumers are reluctant to use their phones for anything other than SMS and voice transmissions. However, user reluctance is not all. The number of users with data-enabled phones is low in the United States, which has only 1 million data-enabled phones (Brewin, 2000). Similarly in South Africa, only 3% of Vodacom subscribers had GPRS phones, and less than 0.5% of users had multimedia phones (Vodacom SA Launches GPRS, 2002).

The biggest challenge for m-commerce is developing and providing the technology infrastructure that underlies m-commerce.

Technology Required to Enable Mobile Commerce

Network Infrastructure

Current cell phone/wireless technology was not intended for m-commerce, which requires the transmission of data. Current networks were intended for transmission of voice and simple text messages. The evolution of cellular technology makes it easier to understand the technology underlying m-commerce. South Africa, a known follower in terms of technology development and technology implementation, has a more advanced cellular platform as a result of technology leapfrogging. Instead of investing in outdated technology and then upgrading systems, cellular providers in South Africa adopted the latest technology.

Debate still rages whether or not to implement 3G networks. However, the return on investment does not justify the cost of the infrastructure, especially because there are very few applications and services available that require the infrastructure.

South Africa has recently seen the emergence of GPRS with both Vodacom and MTN, making the service available on their networks. The business benefits of GPRS are immense. There is no need for dial-up modems, and users are always on. For private users, however, GPRS costs more than land-line downloads. MTN SA charges U.S.$ 8.33 for downloading one megabyte of data. The same amount of data downloaded on landlines take approximately 15 minutes, which at U.S. 1 cent per minute costs a mere U.S. 15 cents. Private users who opt for GPRS will have to pay the premium price for the convenience offered by the service. According to Socikwa (2004), broadband would enable a connection to each customer allowing for simultaneous combined voice and data services, this would reduce online time, which in turn will reduce cost. In a bid to increase broadband usage, South African mobile networks have discounted the price to a mere U.S. 33 cents (Masango, 2005). It is evident that that the enabling technology has to be in place to conduct m-commerce. However, focussing on technology and price will not drive the market; it is applications and services that will (Treguertha, 2005).

Applications

Users are beginning to realise that their phones are minicomputers and they are not satisfied with the limited choices of content available on their cell phones (King, 2005). Wireless Application Portal (WAP) was supposed to be the forerunner of bringing the Web into the hands of the user. However, according to Nadler-Nir (cited in Herron, 2000) and Gani (2002), WAP in South Africa has been a dismal failure. The failure of WAP has been attributed first to the boring services offered, and second to the wrong assumption that users want to browse the Web on their phones (Herron, 2000). Two of South Africa's leading banks, ABSA and Standard, have developed phone banking that allows users to check balances, pay accounts, and transfer funds. First National Bank has developed an alert system that alerts customers of the amount of money withdrawn when they use their debit or credit cards. If the card is used fraudulently, the customer can put an immediate stop on further purchases.

Handheld Devices

In order to get the full benefit of m-commerce, one requires a PDA, or a cell phone that has data-handling capabilities. GPRS phones were introduced in South Africa in mid 2002. These phones were only available on business contracts that cost more than an average contract, however, making the technology inaccessible to nonbusiness and prepaid users. The high cost of PDAs has made this technology equally inaccessible to non-business users. Furthermore, using PDAs is cumbersome due to the absence of a mouse and keyboard. It is evident that the network technology and hardware for m-commerce are readily available, but is this any indicator of the future of m-commerce?

Trends in M-Commerce

In the United States, several large companies are shutting down their wireless services mainly due to the fact that people use their cell phones for voice calls rather than SMS and transacting unlike elsewhere in the World, Americans use personal computers to shop online (Wolverton 2002). The hype surrounding m-commerce promised the consumer the wireless Web. However, what was delivered did not meet these expectations (Rainer 2000). For business, the promise of increased sales and exposure to new customers never materialised. According to Stahl (2002), m-commerce is still more myth than reality. M-commerce has suffered failure every bit as dramatic as the dot.gones (Ewalt, 2002b). In a survey conducted by *Information Week,* 75% of small companies and 58% of large companies were sceptical of the revenue generation potential of m-commerce (Ewalt 2002b). Is mobile commerce truly dead?

Growth Potential of Mobile Commerce

In South Africa, there are 18.7 million active cell-phone users, which increases by more than 9,000 users per day and has the potential to reach 21 million users in 2006 (Statistics of Cellular in South Africa, 2004). Between MTN and Vodacom, 71% of the geographic area is covered by cellular masts, which means that people almost anywhere in South Africa can engage in m-commerce. According to Tregurtha (2005), South Africa has the highest teledensity of mobile to fixed phones in the world. Based on the sheer numbers of cell phone users, it suggests that there is growth potential for m-commerce. However, it must be noted that South Africa has an illiteracy level of 33% (Aitchison 1998). M-Commerce which is text based, would require that users are literate in order to use the service effectively. There are no statistics to prove what numbers of users are illiterate or semi-literate. However, it will impact on the m-commerce market size. Furthermore, as mentioned previously, GPRS phones are inaccessible to a large number of cell phone users, which further diminishes the potential m-commerce market. It is evident as one dissects the statistics that the potential m-commerce market is not as large as one would expect. Does this then sound the death knell of business-to-consumer (B2C) mobile commerce?

Evidently not. Cointel, a trailblazer in m-commerce in South Africa, has reported revenues of up to R50 million per month. Rather than being distracted by new technologies such as GPRS, Cointel uses existing GSM standards to connect cell-phone users with their banks to purchase airtime. Users no longer have to go to a shop to purchase a recharge voucher—recharging can be done anywhere, 24 hours day, 7 days a week. Cointel is developing the technology to include the purchase of flowers, tickets, and limited shopping (*Comparex News,* 2001). Although m-commerce does not look very healthy, it is not entirely dead. M-Commerce needs to be given an injection in order to revive it.

What Needs to be Done to Revive Mobile Commerce?

All the stakeholders need to make an effort to revive m-commerce. Handset manufacturers, network service providers, businesses, and consumers need to work together to arrive at a solution that will harness the latent power underlying mobile commerce. Some of the issues that need to be addressed include the following:

- **Role of Network Service Providers:** Increase bandwidth to handle voice and data traffic at faster speeds. Increase capacity to hold extra traffic. Improve Security standards. Keep pricing low.
- **Role of Handset Manufacturers:** Handset manufacturers, in conjunction with networks, need to develop a transmission standard that is safe, cheap, fast, and convenient to use. Manufacture cheaper, user friendly handsets with built-in firewalls.
- **Businesses:** Businesses need to use traditional media such as newspapers, radio, television, and billboards to encourage consumers to transact through their phones. Businesses need to train their customers in the use of their m-commerce sites. Furthermore, businesses should not wait for B2C to take off; instead, they should use mobile commerce extensively to benefit from business to business transactions. Ferguson and Pike (2001) suggested that organisations choose one application and use it extensively to determine how it is adopted and how its works rather than trying to make a profit from it from the time it is implemented.
- **Content Providers:** The role of content providers is growing in stature in the revival of m-commerce. Customers are still looking for the “killer app” that will justify the move to transacting by phone. According to Cowper (cited in Mobile Services: Less Talk, More Profit, 2005), the killer app is always going to be personalisation. He stated further that Telecoms need to target the right content and services to the right customers.

It is evident that m-commerce requires a joint effort to become the new wave of electronic commerce. Stakeholders including competitors should collaborate initially to develop a set of standards. Thereafter, they can work independently at perfecting what they do best.

FUTURE TRENDS

Mobile commerce in South Africa saw a resurgence in 2004. The three networks—Vodacom, MTN, and Cell-C—

are focusing on their core business that is to provide efficient connectivity. As a result, they are not engaging in the development of mobile applications. Instead, they have invited independent content providers to develop applications for the mobile Web. WAP and SMS (short message service) have come to the fore. Companies such as Xactmobile have emerged. Users can purchase ringtones, backgrounds, games, and screensavers by simply sending an SMS request to Xactmobile. The cost of the item being purchased is debited to the users cellphone bill, which the networks then pay to the vendor. Like its predecessor e-commerce, mobile commerce has been increasingly used to download sex and pornography. For a fee, users can purchase sex stories and pornographic pictures, which are sent by WAP onto their cell phones.

After the December 2004 Tsunami disaster in Indonesia, local television stations advertised SMS numbers that users could contact to make financial contributions to the disaster relief fund. If they sent the SMS to number *x*, their cell phone account would be debited for US$ 2.50, and if they sent it to number *y*, their account would be debited for US$ 5.00.

Motor-vehicle dealerships could send courtesy SMSs to customers after they have had their vehicles serviced or repaired in order to gain valuable feedback regarding customer satisfaction. The University of Cape Town developed a content delivery system at the end of 2004, wherein lecture halls are wireless enabled, allowing for students to link their PDAs to the lecturers system. They can download lecture slides, make notes on the slides, and even answer simple multiple-choice questions. This system has great potential for e-learning. However, until the prices of PDAs drop, this will just be another great innovation that goes nowhere.

According to Ankeney (2001), research indicates that a 6-second increase in transaction speed can boost a fast-food franchise's revenues by 1%; the ability to order fast foods by phone before reaching the outlet could benefit both the consumer and the supplier. Other uses could include short-range broadcast systems where restaurants, cinemas, and other stores could detect all the cell phone users within a particular radius and broadcast messages inviting them to place their orders or make a booking in advance of arrival, thereby saving time. The biggest challenge for the mobile industry in South Africa is disposable income. Eighty-four percent of South African users are prepaid users (Statistics of Cellular in South Africa, 2004), many of whom are willing to forgo other luxuries to enjoy the status attached to owning a cell phone (Posthumus, 2001). If disposable incomes are limited, affordability of connectivity and purchasing online services will be limited as well.

Privacy and even security may be threatened due to eminent legislation. According to Perlman (2004), a draft proposal is being finalised that will oblige all mobile and fixed operators to provide real-time monitoring of all voice and data communications services including SMS, WAP, MMS, and GPRS messages. As a result, encryption techniques need to be disabled, which would expose communication and transactions to cyber-criminals on a relatively unsecure platform. This has the potential to threaten M-commerce even further.

CONCLUSION

This article has provided a balanced perspective on mobile commerce by answering the question, "Is there potential to revive m-commerce in South Africa?" Based on recent historic performance, it would seem that m-commerce was dying in South Africa. However, there are a number of issues that were outlined that need to be addressed that could see the turnaround of mobile commerce. Furthermore, current practice has shown that creative vendors are developing applications and products that cell phone and other mobile device users are willing to purchase using their mobile devices. With the large number of cell phone users in South Africa m-commerce has the potential to be the future, perhaps all it needs to rebound, is an affordable killer app and time.

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KEY TERMS

Bandwidth: Determines the rate at which information can be sent through a channel.

Broadband: A transmission facility having a bandwidth sufficient to carry multiple voice, video, or data channels simultaneously.

Internet: The Internet is a global connection of individual and networked computers to other individuals and networks.

Killer App: Technical jargon for the eternal search for the next big idea.

Mobile Commerce: Refers to the use of wireless communications technology to access the Internet to conduct purchases and sales.

Network Service Provider (NSP): Also known as network carriers, NSPs provide the infrastructure that enables mobile communication. Cell phone users pay for using the infrastructure.

Teledensity: The number of telephones per 100 people in a region.

Mobile Commerce Multimedia Messaging Peer

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INTRODUCTION

In a mobile-commerce world, shops could provide product brochures, cards, sounds, songs and so forth in the form of multimedia messaging presentations, which could be used by a customer to send to friends. Shopping malls will have information kiosks equipped with wireless access capabilities, and could perform searches across the mall's network to update its multimedia message repository. Customers can download and distribute to their friends such multimedia content via mobile messaging, leading to increased revenue for the shops.

Over the years, mobile messaging has become an essential means of communication, and it is going to be even more so with the merging of the Internet and Mobile Networks. The ability to message from a phone to a computer on the Internet and vice versa is making messaging a powerful means of communication (Yeo, Hui, Soon, & Lau, 2001).

This article discusses the development of a multimedia messaging client for a personal digital assistant (PDA) and a Kiosk providing multimedia messages composition, search, share and send capabilities. Various messaging technologies, enabling wireless technologies and the peer-to-peer model, are also discussed and evaluated in this article. We substantiate the ideas discussed in this article with a description of an MMS PDA client application using JXTA with specific references to a shopping mall scenario.

BACKGROUND

Short Messaging Service

Text messaging uses the short messaging service (SMS, 100-200 characters in length), and involves sending text messages between phones. Examples include "C U L8ER" and "OK. AT FLAT OR OFFICE." It is quick and dirty, hard to use the keypad, abrupt, punctuation challenged and incredibly useful and popular. Text messaging also has a lot of advantages, such as its convenience, availability on all phones and discreteness.

Text messaging is most prevalent in the youth market (Tan, Hui, & Lau, 2001), and especially teenagers, who are able to manipulate the difficulty of entering text with the mobile phone keypad. In fact, it is suspected that this steep learning curve and the necessary insider knowledge are two of the things that appeal to the youngsters (Bennett & Weill, 1997).

Multimedia Messaging Service

The multimedia messaging service (MMS), as its name suggests, is the ability to send and receive messages comprising of a combination of text, sounds, images and video to MMS-capable handsets (MMS Architecture, 2002). The trends for the growth in MMS are taking place at all levels within GSM (Patel & Gaffney, 1997), enabling technologies such as GPRS, EDGE, 3G, Bluetooth and Wireless Access Protocol (WAP).

MMS, according to the 3GPP standards, is "a new service, which has no direct equivalent in the previous ETSI/GSM world or in the fixed network world." Here is an introduction to the features of this innovative new service:

- MMS is a service environment that allows different kinds of services to be offered, especially those that can exploit different media, multimedia and multiple media.
- MMS will enable messages to be sent and received using lots of different media, including text, images, audio and video.
- As more advanced media become available, more content-rich applications and services can be offered using the MMS service environment without any changes.
- The MMS introduces new messaging platforms to mobile networks in order to enable MMS. These platforms are the MMS Relay, MMS Server, MMS User Databases and new WAP Gateways.

Table 1. SMS vs. MMS

Feature	SMS	MMS
Store and Forward (non real time)	Yes	Yes
Confirmation of Message Delivery	Yes	Yes
Communications Type	Person to person	Person to person
Media Supported	Text plus binary	Multiple-text, voice, video
Delivery Mechanism	Signalling channel	Data traffic channel
Protocols	SMS specific, e.g. SMPP	General Internet, e.g. MIME SMTP
Platforms	SMS Center	MMS Relay plus others
Applications	Simple person to person	Still images

- MMS will require not only new network infrastructure but also new MMS-compliant terminals. MMS will not be compatible with old terminals, which means that before it can be widely used, MMS terminals must reach a certain penetration.

Implications of SMS on MMS

The current SMS has some unique advantages that other non-voice services do not have, such as store and forward and confirmation of message delivery. However, SMS also has some disadvantages, such as limited message length, inflexible message addressing structures and signalling channel slowness.

Person-to-Person (P2P) Model

Today, the most common distributed computing model is the client-server model (Chambers, Duce, & Jones, 1984). In the client-server architecture, clients request services and servers provide those services. A variety of servers exist in today's Internet: Web servers, mail servers, FTP servers and so forth. The client-server architecture is an example of a centralized architecture, where the whole network depends on central points to provide services. Regardless of the number of clients, the network can exist only if a server exists (Berson, 1992).

Like the client-server architecture, P2P is also a distributed computing model (Yemini, 1987). However, the P2P architecture is a decentralized architecture where neither client nor server status exists in a network (Madron, 1993). Every entity in the network, referred to as a peer, has equal status, meaning that an entity can either request a service (a client trait) or provide a service (a server trait). Figure 1 illustrates a P2P network.

Though peers all have equal status in the network, they do not all necessarily have equal physical capabilities. A P2P network might consist of peers with varying capabilities, from mobile devices to mainframes (Budiarto & Masahiko, 2002). A mobile peer might not be able to act as a server due to its intrinsic limitations, even though the network does not restrict it in any way.

JXTA

Jxta strives to provide a base P2P infrastructure over which other P2P applications can be built (Project Jxta, 2002). This base consists of a set of protocols that are language independent, platform independent and network agnostic. These protocols address the bare necessities for building generic P2P applications (Jxta Technology Overview, 2002). Designed to be simple with low overheads, the protocol's target is to build, to quote the Jxta vision statement, "every device with a digital heartbeat."

JXTA vs. .NET and JINI

Jxta's XML-based messaging is similar to Microsoft's .Net and SOAP technologies. But that is a very thin foundation for comparison. As more and more third-party protocols make use of XML, it will become obvious that

Figure 1. P2P model

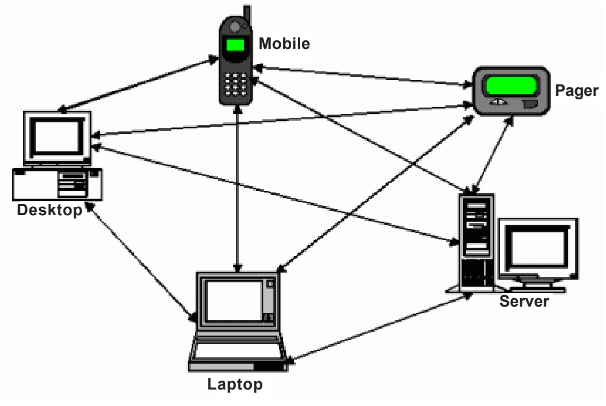
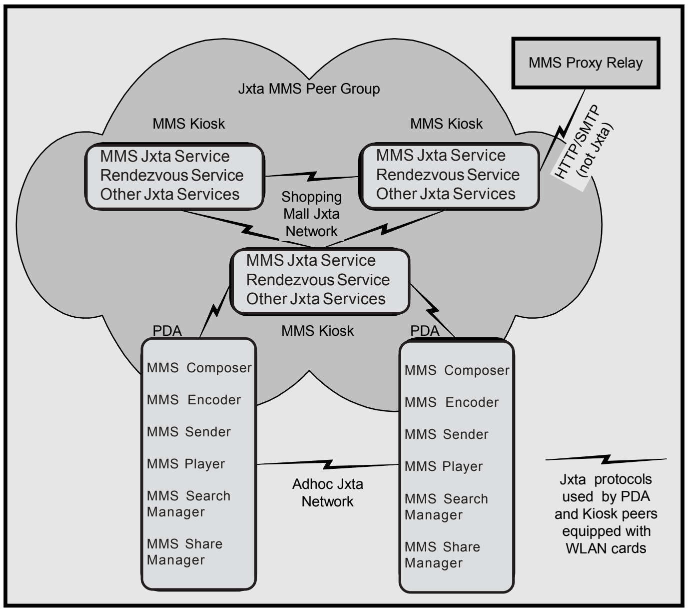


Figure 2. MMS Peers and kiosk architecture



just using XML as a message format says nothing at all about an actual networking technology. Comparing the high-level, policy-rich, Web-services-based infrastructure that is .Net to the low-level, fundamental, policy-neutral nature of Jxta is a futile exercise.

Project Jxta and the Jini project are also fundamentally different. Both of them have some similarity in higher-level interaction, enabling true distributed computing over a network. However, the similarity abruptly ends there. Strategic differences between the two are: Jxta started life as a completely interoperable technology (any platform, any programming language, any vendor). Sun is a mere contributor in the community. Jini is a Java-centered technology that Sun will integrate and deploy strategically in future product offerings. Sun will maintain a degree of control over Jini's evolution.

MULTIMEDIA MESSAGING PEER FOR MOBILE COMMERCE

Most shopping malls have information kiosks, which could be equipped with a network point and wireless service access capabilities using technologies like Bluetooth and WiFi. These kiosks could perform searches across the mall's network to update its multimedia content repository and provide a common contact point for all the shops in the mall.

The kiosks could provide product brochures, cards, postcards, pictures, comic strips, sounds, songs and so forth in the form of MMS presentations, which could be used by a customer to send to another person. The customer need not visit all the shops and need not verbally describe a product to another person before making a decision to buy something. This leads to increased revenue for the shops. These kiosks could also provide multimedia messages intended for fun and entertainment purposes and charge for them.

MMS Peer and Kiosk Architecture

An MMS Peer would not only be a multimedia messaging client like the one on a mobile phone today but also would provide the capabilities to search for content and share content with other mobile devices in the vicinity. It would also not require a WAP stack, as it would send the messages directly to the MMS Proxy using either its HTTP or SMTP interface, which are expected to be accessible through the Jxta-based MMS service provided by a peer like the kiosk or another more powerful mobile device like a laptop, which is connected to the Internet and in the vicinity.

MMS Kiosk and Jxta

In a P2P environment like Jxta, commonly accessed information gets replicated (the peers have a choice to keep a copy of content passing through them) and becomes available at peers fewer hops away. This avoids "hotspots" and is ideal for content sharing, where the content can be of any type. For an MMS Kiosk searching for multimedia messages, the situation is no different and it would thus be ideal to use a P2P framework to advertise and search for multimedia messages and media content.

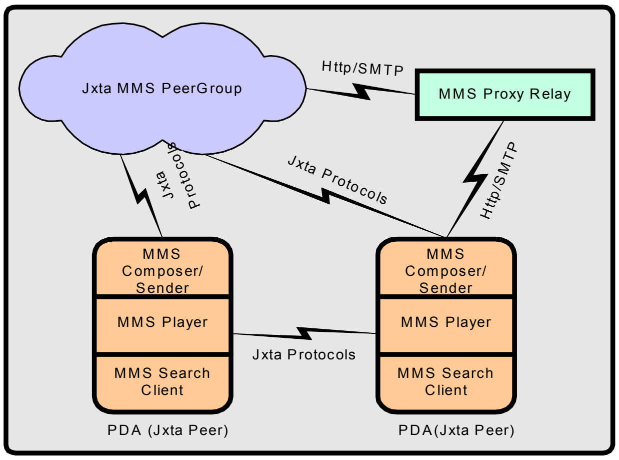
Design and Implementation of MMS Peers

Figure 3 shows the architecture due to the availability of the Jxta platform for a PDA (Jxta Platform, 2002). This architecture is almost fully P2P except the interaction between the Jxta Peer and the MMS Proxy-Relay. This offers the advantage that a customer can become part of a Peer Group due to other customers around him. This opens opportunities for customers to exchange MMS messages they have on their devices.

The PDA has been shown to have only an MMS Composer, MMS Player and MMS Sender. The MMS Composer composes a message by aggregating all the media and presentation information provided by the user. The MMS Sender performs an HTTP Post to the MMS Proxy-Relay to send the message to its destination. An MMS Player is also provided to the PDA client to view an MMS message before sending. The Kiosk/Shop is what provides the service to allow a customer to search for MMS messages and send them. The kiosk and the shops are part of a Jxta MMS Peer Group.

The protocols that the PDA can use to directly send to the MMS Proxy are either HTTP or SMTP (if the MMS Proxy-Relay provides an SMTP interface). The communication between the kiosk/shop and the PDA can be over Bluetooth, IEEE 802.11b or Infrared. Infrared is not a good choice due to its very limited range.

Figure 3. MMS kiosk environment architecture



PDA MMS Peer Design

The MMS Peer on the PDA consists of four modules:

- MMS Composer
- MMS Encoder and Sender
- MMS Player
- MMS Jxta Search and Share

MMS Composer

This module allows a user to compose an MMS on the move. It allows the user to select the media content and provide layout details and timing information for the slides of the MMS presentation. The process results in the generation of an SMIL file, which contains the presentation details of the media. Subsequently, a Jar file (JAR Documentation, 2002) is created with all the media files and the SMIL file. The MMS Sender (in the next section) takes the Jar as its input, encodes it into an MMS and sends it.

MMS Encoder and Sender

MMS can be sent either using HTTP Post or SMTP if the MMS Proxy-Relay provides both interfaces. The two modes of sending the message could be chosen based on the priority of the message. Using SMTP takes longer to send, as the message has to be ultimately encoded according to MMS standards (MMS Encapsulation Specification, 2002). Hence, SMTP could be used to send low-priority messages.

MMS Player

The MMS Player uses takes a Jar as input, extracts all the media and SMIL parts, and uses a SMIL parser to parse the SMIL and play it. The slides in the SMIL presentation are rendered using *double buffering*. The AMR audio is first converted to the WAV format and then played. Imelody (.imy files) files cannot be played by the application at this stage.

MMS Jxta Search and Share

The MMS application, once started, represents a Jxta peer. The peer becomes a member of a universal group called the NetPeerGroup. The peer then starts to discover its peers and available peer groups. The Search and Share module relies on two main modules called the Peer Group Manager and the Search Manager. The Search and Share use the Content Management Service.

Graphical User Interface (GUI) Design

The GUI was designed keeping the PDA in mind. The GUI uses as many components that can be either easily clicked or tapped with a stylus. The following things were taken into consideration for the GUI design:

- A user would always want to have the list of peers and peer groups in front of him or her because of constant interaction with these entities.
- The limited screen size of the PDA requires that every function be provided without cluttering the screen. Thus, every function is provided on a new screen.
- This sort of layout would be ideal if service clients are to be loaded dynamically upon discovery of a service.

Figure 4 shows the MMS player and sender GUI. It also shows the list of peer groups and peers currently visible. The peer groups and peers list keeps getting updated automatically. Figure 5 shows the MMS Search GUI. A user can enter the keywords and press enter to search. A button will be added also to allow easy use on the PDA.

Comparison with Other MMS Solutions

There are some other MMS clients for the PDA that exist now. The one from Anny Way (MMS—Opportunities, migration and profits, 2003) is specifically for Pocket PC. EasyMessenger (EasyMessenger, 2003) from Oksijen Technologies is the only other Personal Java-based MMS client but without the additional P2P features provided by us. Electric Pocket's Pixer (Pixer MMS, 2003) is another MMS Client that only supports Pocket PC and Palm OS and can be used to send images only. There seems to be no work done on using MMS and Jxta together or, for that matter, not even EMS or SMS and Jxta.

All the solutions above are MMS clients with a view to sending multimedia messages, a progress from SMS or EMS. The MMS Peer was developed with a view to making not only messaging a more pleasant and easier experience but also to provide features that would facilitate access to a variety of content. The searching and sharing of content from peers in the vicinity (shoppers) as well as content stores (kiosks) make it a compelling multimedia messaging solution.

FUTURE TRENDS

MMS Message Receiver Module for the PDA

The next step is to implement a receive module for the PDA so the MMS Peer is able to achieve two-way messaging. When a message is retrieved directly from the MMS Proxy-Relay using the HTTP GET method, the MMS Proxy-Relay will return with a message along with the HTTP headers. The HTTP headers can be easily skipped by looking for two consecutive carriage returns and line feed pairs. After this, the encoded MMS header are read byte by byte until the byte of number of body parts is reached. In this way, the MMS Peer will be able to both send and receive messages with other peers.

Service Client Plug-In Feature

The Service Client Plug-In feature refers to the client download option. The current implementation assumes the client for a service to be there on the peer. As the peer already has core Jxta functionalities, it is a good idea to

Figure 4. MMS Player and Sender

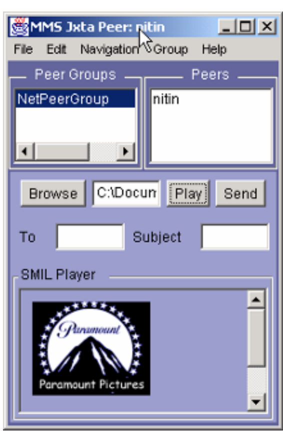


Figure 5. MMS Search

use them to provide this feature. The advertisements of a service could specify the location of a client, which could be transferred over to the peer and dynamically loaded. This is possible in Java using the API for loading classes. To enable this feature, one could create a Jxta Service that has clients registered with it.

PDA to PDA Messaging

With the existing application framework, PDA to PDA MMS messaging can be easily enabled using the Jxta messaging layer. As PDAs are more capable than mobile phones, even video could be enabled for PDA to PDA messaging. All it would mean is using another media type in the SMIL or encoded message.

To account for different PDAs communicating, the User Agent Profile Specification (UAProf) could be used for capability negotiation. The UAProf schema for MMS characteristics (client transactions) could be adapted to the PDA situation. The XML messaging layer for Jxta would enable the use of this XML scheme effectively.

CONCLUSION

The Jxta platform Personal Java port came out very recently and the application was designed and implemented with it in mind. If the basic platform functionalities have been ported correctly, then it should not take long to port this whole application to the PDA. The application conforms to the Personal Java standard when checked with the compliance tool. This implies it should work on the PDA without requiring any changes.

Currently, the MMS client by itself works on the PDA. An MMS Player and sharing of content were developed. The former was implemented while searching for a reasonably priced Bluetooth SDK for WinCE and trying various Bluetooth PCMCIA cards with the freely available Bluetooth stack called CStack. This project will have a commercial value when shopping malls in Singapore install wireless networks or have wireless kiosks.

In conclusion, with the increase in memory and processing power of a plethora of mobile devices found in the market, and the ongoing improvements in available bandwidth to the user, MMS is a service to look forward to, and more so with peer-to-peer technologies like Jxta, which will make it truly ubiquitous.

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KEY TERMS

Application Programming Interfaces (APIs): Programming tools that provide developers with a simple, consistent mechanism for extending the functionality of an application and for accessing existing computing systems.

Distributed System: A system made up of components that may be obtained from a number of different sources that together work as a single distributed system, providing the run-time infrastructure supporting today's networked computer applications.

Multimedia: Involving or encompassing more than one concurrent presentation medium, such as text, sound and/or motion video.

Peer-to-Peer: A communications model in which each party has the same capabilities and either party can initiate a communication session.

Plug-In: Programs that can easily be installed and used as part of a Web browser. A plug-in application is recognized automatically by the browser and its function is integrated into the main HTML file that is being presented.

Protocol: A special set of rules that end points in a telecommunication connection use when they communicate with each other.

WAP Stack: A set of protocols that covers the whole process of wireless content delivery, from the definition of WML and WMLScript for creating and layout of the actual content and the specification of security measures in the WTLS to the lowest parts of the stack dealing with the actual transport of content.

Category: Concepts, Trends, and Challenges

Mobile Electronic Commerce

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INTRODUCTION

Mobile electronic commerce (or m-commerce) is generally defined as the set of financial transactions that can be carried out over a wireless mobile network (Pierre, 2003; Varshney, 2001; Varshney, Vetter, & Kalakota, 2000). According to this definition, m-commerce constitutes a subset of all electronic commercial transactions (electronic commerce or e-commerce) from business-to-consumer (B2C) or business-to-business (B2B). Thus, short personal messages such as those from short messaging system (SMS) sent between two individuals do not fall within the category of m-commerce, whereas messages from a service provider to a salesperson or a consumer, or vice versa, do fit this very definition. M-commerce appears an emerging manifestation of Internet electronic commerce which meshes together concepts such as the Internet, mobile computing, and wireless telecommunications in order to provide an array of sophisticated services (m-services) to mobile users (Paurobally, Turner, & Jennings, 2003).

Before purchasing a product, clients need services such as those used to search for a product and a merchant who offer the lowest price for this product. Consumers also like to participate in auctions and analyze the quality/price ratio of a product for a certain number of suppliers (Jukic, Sharma, Jukic, & Parameswaran, 2002). Online shopping for a given product is becoming increasingly popular, and electronic purchasing and bargaining consist of looking up and deciphering the contents of electronic catalogues prior to making a decision. To automate this process and to ensure that these documents are comprehensible to computers, they must have a standard format. Such services exist in standard commerce; however, in e-commerce, they require further consideration such as those related to the market dynamics, the variety of platforms, and the languages used by various merchant sites (Itani, & Kayssi, 2003; Lenou, Glitho, & Pierre, 2003).

Just as in standard commerce, e-commerce includes an initial step wherein consumers search for products they wish to purchase by virtually visiting several merchants. Once the product is found, negotiation for this possible transaction can take place between the customer and the merchant. If an agreement is reached, the next step is the payment phase. At each step of the process, a number of problems arise, such as transaction security, confidence in the payment protocol, bandwidth limitations, quality of service, shipping delays, and so forth (Paurobally et al., 2003). The peak withdrawal periods have always presented a major challenge for certain types of distributed applications. The advent of m-commerce further highlights this problem. Indeed, in spite of rather optimistic predictions, m-commerce iss plagued by several handicaps which hinder its commercial development.

This article exposes some basic concepts, technology and applications related to mobile electronic commerce. The background and key technological requirements needed to deploy m-commerce services and applications are discussed, some prominent applications of m-commerce are summarized, future and emerging trends in m-commerce are outlined, and a conclusion of these topics are presented.

BACKGROUND AND RELATED WORK

E-commerce relies upon users' interventions to initiate a transaction and select the main steps of the process. Users' actions are based upon a succession of virtual decisions. Indeed, when shopping with a virtual catalogue, customers can select products that meet their needs, tastes, and respect their price range. Such decisions consistently require the users' input, thus costing them both time and money. These costs are even more exorbitant when a search is launched for an order that includes a variety of products from different providers that have different characteristics (price range, delivery dates, etc.).

Mobile commerce refers to an ability to carry out wireless commercial transactions using mobile applications in mobile devices. M-commerce applications can be as simple as an address-book synchronization or as complex as credit card transactions.

In standard commerce, negotiating a contract or a commercial transaction is a standard practice in purchasing or sales. An agreement between a customer and a merchant can involve various components (price, delivery, warranty, etc.). For example, a volume price can be negotiated (e.g., 20% off the purchase of 100 items or more), price can fluctuate according to the demand (flight and hotel room prices vary according to seasons), and so forth. Once the client has obtained the best offer possible for the product of interest, the negotiation comes to a close. Obviously, the result of such negotiation can vary from one merchant to another. By providing a machine with the appropriate strategies and algorithms, negotiation can be automated and taken over by a computer, hence the concept of electronic negotiation, or e-negotiation.

Significant growth of m-commerce cannot be expected until the required technology (such as SMS services, Bluetooth, WAP, or i-mode) is developed and deployed. Indeed, due to the widely available GSM wireless networks, the SMS service allows GSM users to send short messages of up to 160 characters. These messages are saved and sent within a few seconds, which makes them unsuitable for real-time applications. SMS can become increasingly more important with future improvements once they allow users to send longer messages, multiple messages at once and when they allow users to create mailing lists. Such features will make m-commerce much more accessible.

Bluetooth is a low-powered wireless standard that allows a certain level of communication between many devices. Currently, it is a global specification for close proximity wireless connections. Given the wide flexibility associated with the variety of terminals it supports, it is expected to play a significant role in m-commerce. It can be deployed on a large scale for short-range m-commerce where terminal proximity is minimal. However, its nonlicensed 2.4 GHz frequency is problematic as it can be encumbered by interference from other devices which use the same frequency.

The design of such applications requires a number of functional components. One of the major components is a mobile terminal that is equipped with sufficient power for its memory, display and communication functionalities. Many of these terminals are currently emerging, such as the Palm Pilot (a PDA with a wireless modem) or the Nokia Communicator (a mobile phone with computer functionalities). These devices offer various capacities involving communication, processor, battery, memory and display. Many of them are actually mobile phones enhanced with laptop features.

Given the enhanced functionalities of the mobile terminal and its improved processing and storage capacities, an operating system to manage the internal resources of the various applications and processes will become an essential requirement. However, operating systems require large storage capacities and they are not adapted to mobile terminals constrained by real-time requirements, limited processing capabilities, mini screen and small memory sizes. Mobile middleware can be defined as a functional layer of software provided by application developers to link their e-commerce applications to an OS and various mobile networks to allow their applications to bypass certain mobility issues.

With the emergence of mobile application environments in the recent years, Europe has focused on WAP technologies, whereas Japan has successfully developed with the i-mode. North American countries use other systems, which can include either of the previous two technologies. Indeed, in order to adapt Web contents to mobile users, Europeans use the Wireless Application Protocol (WAP). The WAP was designed to ensure interoperability amongst various wireless networks, mobile terminals, and applications which use the same type of protocols. It thus allows developers to design e-commerce applications from existing technology, which can function on a large number of mobile terminals.

The i-mode, a proprietary system developed by NTT DoCoMo, has been available in Japan since February 1999. It is a device that allows users to access the Internet from a cellular phone with a color display. It uses the packet switching technique with a bandwidth of 9.6 kbps (CDMA). The i-mode pages must be defined by a tag language called compact HTML (cHTML), which is, actually, a subset of HTML with additional adapted tags. Moreover, instead of paying for the amount of connection time, users pay for the quantity of data transmitted (0.3 penny/packet of 128 bytes).

Java i-mode phones have been available on the Japanese market since the beginning of 2001. These telephones allow users to download Java server applets (called i-appli) for games, agent-type services and other applications. There were nearly 19 million subscribers to the i-mode systems at the beginning of February 2001, and the number is increasing by 1 million every month. This system, which supports 11,000 Web sites and 30 search engines, is completely adapted to m-commerce.

One of the key aspects of m-commerce remains transaction security (Cai et al., 2004; He, & Zhang, 2003; Katsaros, & Honary, 2003; Kim & Chung, 2003). A new protocol for m-commerce was proposed by (Katsaros, & Honary, 2003). Fully applicable to third generation mobile networks, this protocol is characterized by three novel properties, as opposed to the existing methods of m-commerce. In fact, it provides a simplified and secure transaction method, minimizes the number of entities involved in the transaction, and reduces the source of security threats, thus reducing the risk of fraud.

MOBILE COMMERCE APPLICATIONS

There are a great number of m-commerce applications (see Table 1). According to reliable estimates, in the next few years, over half of European m-commerce will consist of

Table 1. Applications classes of m-commerce

Application Classes	Type	Examples
Mobile financial applications	B2C, B2B	Banks, brokerage firms, mobile-user fees
Mobile advertising	B2C	Sending custom made advertisements according to user's physical location
Mobile inventory management	B2C, B2B	Finding products and people
Proactive service management	B2C, B2B	Sending information to salespeople regarding age of components (car industry)
Finding products and shopping	B2C, B2B	Locate/order certain products from a mobile terminal
Mobile reengineering	B2C, B2B	Improve quality of service
Mobile auctions	B2C	Customer service to buy or sell certain products
Mobile entertainment services	B2C	Video on demand; other mobile services
Mobile office	B2C	Work from the car, from airports, at conferences
Wireless database	B2C, B2B	Information is downloaded by mobile salespeople or users
Mobile music on demand	B2C	Music is downloaded and listened to while using a mobile service

financial services, advertising, and purchasing. Various classes of applications along with their requirements in terms of services, platforms, and networks, are presented here, and four of those classes will be addressed in more detail.

Mobile Financial Applications

Mobile financial applications are likely to become a fertile niche for m-commerce. They include a wide variety of applications, from the banking environment, brokerage firms, mobile money transfers and mobile micro-payments. These mobile financial services can transform a mobile terminal into a business tool that replaces the bank, the ATM and credit cards and allows users to carry out financial transactions with mobile currency. However, to develop these applications, it is necessary to provide the users of these services with better applications and better network infrastructure. Moreover, security issues must be addressed prior to deploying such applications on a large scale.

An interesting mobile financial application is the micropayment, which consists of little purchases involving small transactions. A mobile terminal user can communicate with a sales machine via a wireless local area network (WLAN) to purchase these products.

The micropayment system can be implemented in several different ways (Kim, Lee, Kim, Lee, & Kang, 2002; Renaudin et al., 2004). For example, a user dials a number, and the cost for this call equals the price of the product. Sonera (http//www.sonera.net/asiakaspolvelu/wop.asetukset.html), a wireless service supplier, has tested this approach with a soft drink machine; the soda machine debits a certain amount of money from the user before crediting the same amount to the cola company.

Another way of carrying out these micropayments would consist of using prepaid amounts, bought from, for example, service suppliers, banks, or credit card companies. In order to support the financial transactions, including the micropayments, a mobile-service supplier must play the role of the banker.

Mobile Advertising

Mobile advertising can also constitute a significant part of m-commerce applications. Indeed, using demographic information compiled by mobile-service suppliers and information about the physical location of the user, a highly targeted advertisement can be launched. Advertisements can be tailored to target a given user, according to the information previously provided, during a preliminary stage, or a past shopping expedition. Advertisement can also take advantage of the user's physical location. For example, users could be alerted to sales and feature events occurring in their neighborhood stores and restaurants. This type of advertising functions with a short message service or a pager.

When more wireless bandwidth becomes available, advertisements will become contain more audio, photo, and video content to fit users' specific needs, interests, and habits. Moreover, the network service suppliers will be able to use push-pull methods to make mobile advertising best suited to the user's profile.

The number of advertisements and the level and type of content they include are interesting elements. The number of advertisements must be limited in order to avoid user frustration and network congestion. Wireless networks could consider this type of service as low priority when solving congestion problems that affect the quality of service of the entire network. Because these services require information about the user's physical position, a third module could be used in order to provide localization services. However, this would result in profit sharing among the network service and the position information provider.

Mobile Inventory Management

The mobile inventory management application is used to locate products and, possibly, people. Locating products can help service suppliers specify delivery time to customers, thus improving customer service, a competitive advantage. A very interesting application is the mobile inventory, which could allow a fleet of trucks to transport a significant inventory. As soon as a store requires a certain article or product, the application would locate a truck, preferably one in the area, and obtain just in time delivery of the product. The mobile inventory and delivery applications could significantly reduce inventory cost and space for the store. Moreover, it would also decrease the time span between the moment the merchant sends and receives an order.

The mobile inventory is a B2B type of application, whereas the localization of the products can be considered a B2C application. A wireless network can locate products and services by using a radio/microwave. Since the satellite signal can be disrupted inside a truck, a separate local area network can be deployed for internal communication and to locate products. Determining an appropriate correspondence between the inventory transported in the trucks within a certain geographical area and the requests which vary dynamically remains an interesting challenge to be addressed. Note that road conditions, traffic, and construction in one area can affect just in time delivery to nearby zones.

Prospective customers for mobile inventory management could include shipping companies (UPS, USPS, FedEx, etc.), factories (e.g., automobile, construction), airline companies, the transport industry, and supermarkets. In this context, one of the problems is the integration of the localization information into a geographical information system (GIS). Progress has been made in this field, which led to the development of products which can find the position of a vehicle and relay this information to a SIG.

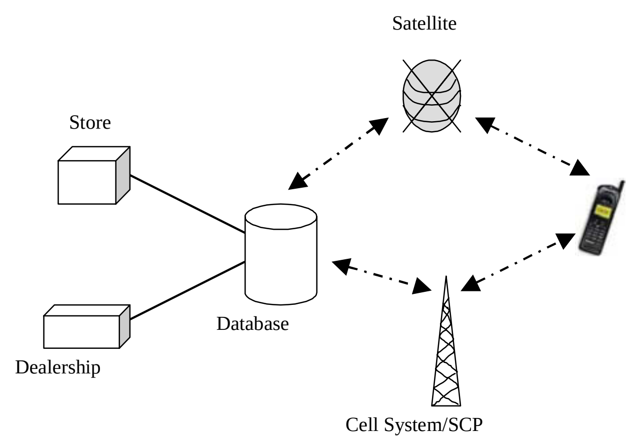
Finding Products and Shopping

The finding-products-and-shopping type of application can locate an article within a certain zone or neighborhood. It differs from the previous class because it is focused on finding a specific article or a person who offers a given service within a restricted zone, which can be delimited by the user. A specific article or an equivalent one (if indicated by the user) can be available through many different stores. In standard shopping, for major purchases (such as a new television, a videotape recorder, a car), many people visit several stores to compare various merchants' offers. By using a mobile terminal (e.g., a Palm Pilot, a Nokia Communicator or a Net Phone) and a database that includes information on the products, a user should be able to find the exact address of a store that carries this article. A list of the places as well as the distance from a specific point could be displayed. Then, the user can order this article online using the browser on his mobile terminal. If several stores carry the desired article, they can compete to earn the client's business by offering remote rebates or enticing prices in real time. This type of application can also include other forms of mobile shopping such as retail mobile sales, mobile ticketing or mobile booking.

As shown in Figure 1, a user can send a request to a central location, which can be interfaced with several stores to monitor whether a certain article is available or not, and if so, at what price. Conversely, the stores can connect their inventory systems to this site. Because the inventory systems of various stores generally use different product codes, a uniform product labeling system will be necessary to allow intelligible Web communication. If a database is unused, the mobile user will have to query stores one by one. However, the quantity of wireless traffic can quickly become problematic if the total number of requests per article and person surpasses the capacity of the wireless network. In order to avoid bottlenecks, it is preferable to use codes rather than specific data to refer to the articles. Thus, two factors must be considered:

- How will the database invoice users?
- How can one verify the database or Web site reliability concerning the availability and pricing of the goods and services?

Figure 1. Locating products and shopping



The use of mobile agents can be very efficient for these types of applications (Lenou et al., 2003). Thus, many cooperating and negotiating agents can be deployed to carry out transactions in various places.

FUTURE TRENDS

Some important issues and concerns must be addressed and solved in order to embrace and deploy mobile commerce. Future and emerging trends include three main challenges: security (Cai et al., 2004; Itani, & Kayssi, 2003; Renaudin et al., 2004), service discovery and transaction management (Veijalainen, Terziyan, & Tirri, 2003; Younas, Chao, & Anane, 2003).

Mobile commerce offers an exciting new set of capabilities that service providers can leverage to increment their revenue base while attracting new services that enhance the end-user's experience. With these new opportunities, the risk of new security threats also arises (Cai et al., 2004). New mobile devices such as PDAs and GSM/UMTS terminals enable easy access to the Internet and strongly contribute to the development of e-commerce and m-commerce services, whereas Smartcard platforms will enable operators and service providers to design and deploy new m-commerce services. This development can only be achieved if a customer's information and transactions are guaranteed to be protected by a high level of security (Renaudin et al., 2004). Thus, establishing security mechanisms which allow diverse mobile devices to support a secure m-commerce environment in wireless Internet is critical (Kim et al., 2003).

Providing security provisions for the m-commerce community is also challenging due to the insecure air interface of wireless access networks, limited computational capability of mobile devices, and users' mobility (He & Zhang, 2003). The limited equipment resources in terms of equipment require the e-payment protocol in the wireless Internet environment to be designed in consideration of the efficiency of the computing functions and the storage device.

Until now, much of the research on m-commerce has focused on the problem of service discovery. However, once a service is discovered, it needs to be provisioned according to the goals and constraints of the service provider and consumer. In this context, automated negotiation protocols and strategies that are applicable in m-commerce environments must be proposed (Paurobally et al., 2003). Specifically, time-constrained bilateral negotiation algorithms that allow software agents to adapt to the quality of the network and/or their experience with similar interactions must be developed and evaluated.

Finally, transaction management is a major issue in m-commerce. It enables people to order goods and access information anywhere, anytime. Given the nature of mobile computing, there is a need for a generic approach that adapts to the needs of m-commerce applications (Younas et al., 2003).

CONCLUSION

This article exposed some basic concepts, technology, and applications related to mobile electronic commerce. After having presented the background and related work, it summarized some prominent applications of m-commerce and outlined future and emerging trends in m-commerce.

End-to-end security remains a fundamental priority for large-scale deployment of m-commerce applications. It is also important to provide mobile terminals with a generic cryptographic functionality in its own right, which is accessible from the application layer. Moreover, because m-commerce transactions imply sharing confidential information such as credit card numbers, it is important that mobile terminals be equipped with a safe storage unit for data as well as mechanisms for authentication and access control. In addition, an infrastructure equipped with a public key is essential to authenticate both actors and ensure secure transactions. Finally, m-commerce applications should provide a consistent user interface for easy and intuitive access to security functionalities.

Because people are becoming increasingly more nomadic, many interesting services can be offered through mobile terminals and mobile networks, such as buying and selling shares on demand or simply entertainment or information services. Such services could also include mobile games and mobile music.

Finally, remember that the user plays the key role in accepting and deploying m-commerce applications. According to studies and market analysis carried out in this field, this technology still remains somewhat immature and large-scale deployment cannot occur until security problems are solved. However, long-term projections offer a very promising future for m-commerce, which is currently gaining ground with the younger generation.

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KEY TERMS

Business-To-Business Transaction (B2B): Electronic commercial transaction from business to business.

Business-To-Consumer Transaction (B2C): Electronic commercial transaction from business to consumer.

Electronic Commerce (E-Commerce): A set of financial transactions that can be carried out over a network. E-commerce relies upon users' interventions to initiate a transaction and select the main steps of the process.

Electronic Negotiation (E-Negotiation): Standard practice in purchasing or sales consisting of using a networked environment to negotiate in order to reach an agreement (price, delivery, warranty, etc.) between a customer and a merchant.

Mobile Commerce (M-Commerce): A set of financial transactions that can be carried out over a wireless mobile network.

Mobile Middleware: A functional layer of software provided by application developers to link their e-commerce applications to an OS and various mobile networks to allow their applications to bypass certain mobility issues.

Category: Concepts, Trends, and Challenges

Mobile Handheld Devices for Mobile Commerce

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INTRODUCTION

With the introduction of the World Wide Web, electronic commerce has revolutionized traditional commerce and boosted sales and exchanges of merchandise and information. Recently, the emergence of wireless and mobile networks has made possible the extension of electronic commerce to a new application and research area: mobile commerce (MC), which is defined as the exchange or buying and selling of commodities, services, or information on the Internet through the use of mobile handheld devices. In just a few years, mobile commerce has emerged from nowhere to become the hottest new trend in business transactions. Despite a weak economy, the future of mobile commerce is bright according to the latest predictions (Juniper Research Ltd., 2004). Internet-enabled mobile handheld devices are one of the core components of a mobile commerce system, making it possible for mobile users to directly interact with mobile commerce applications. Much of a mobile user's first impression of the application will be formed by his or her interaction with the device, therefore the success of mobile commerce applications is greatly dependent on how easy they are to use. This article first explains the role of handheld devices in mobile commerce systems and then discusses the devices in detail. A mobile handheld device includes six major components: (a) a mobile operating system (OS), (b) a mobile central processor unit (CPU), (c) a microbrowser, (d) input and output (I/O) devices, (e) memory, and (f) batteries. Each component is described, and technologies for the components are given.

BACKGROUND

Internet-enabled mobile handheld devices play a crucial role in mobile commerce as they are the devices with which mobile users interact directly with mobile commerce applications. This section first introduces a mobile commerce system and then illustrates how it is used to carry out a mobile transaction. A mobile commerce system is inherently interdisciplinary and could be implemented in various ways. Figure 1 shows the structure of a mobile commerce system and a typical example of such a system (Hu, Lee, & Yeh, 2004). The system structure includes six components: (a) mobile commerce applications, (b) mobile handheld devices, (c) mobile middleware, (d) wireless networks, (e) wired networks, and (f) host computers.

To explain how the mobile commerce components work together, Figure 2 shows a flowchart of how a user request is processed by the components in a mobile commerce system.

Figure 1. A mobile commerce system structure

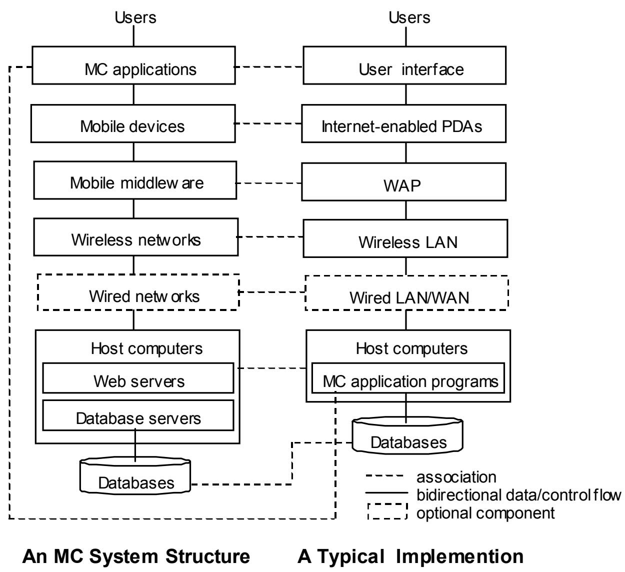
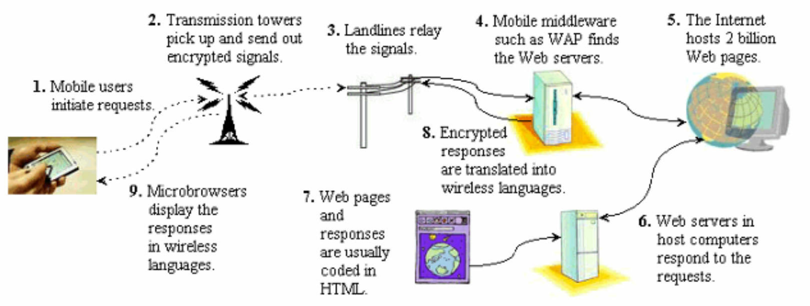


Figure 2. A flowchart of a user request processed in a mobile commerce system



MOBILE HANDHELD DEVICES

Mobile users interact with mobile commerce applications by using small wireless Internet-enabled devices, which come with several aliases such as handhelds, palms, PDAs (personal digital assistants), pocket PCs (personal computers), and smart phones. To avoid any ambiguity, a general term, mobile handheld devices, is used in this article. Mobile handheld devices are small general-purpose, programmable, battery-powered computers, but they are different from desktop PCs or notebooks due to the following special features.

- Mobility
- Low communication bandwidth
- Limited computing power and resources such as memory and batteries

Figure 3 shows a typical system structure for handheld devices, which includes the following six major components: (a) a mobile operating system, (b) a mobile central processing unit, (c) a microbrowser, (d) input and output devices, (e) memory, and (f) batteries. Brief descriptions of all the components are given in the coming sections.

Mobile Operating Systems

Simply adapting desktop operating systems for mobile handheld devices has proved to be a futile endeavor; an example of this effort is Microsoft Windows CE. A mobile operating system needs a new architecture and different features in order to provide adequate services for handheld devices. Several mobile operating systems are already available and each employs a different architecture and implementation. Figure 4 shows a generalized mobile operating system structure, which can be visualized as a six-layer stack.

Although a wide range of mobile handheld devices are available in the market, the operating systems, the hubs of the devices, are dominated by just three major organizations. The following two lists show the operating systems used in the top three brands of smart cellular phones and PDAs in descending order of market share.

- **Smart Cellular Phones:** Microsoft Smartphone 2002, Palm OS 5, and Symbian OS 7 (Vaughan-Nichols, 2003)
- **PDAs:** Palm OS 5, Microsoft Pocket PC 2002, and Symbian OS 7 ("Mobile Computing," 2003)

Figure 3. System structure of mobile handheld devices

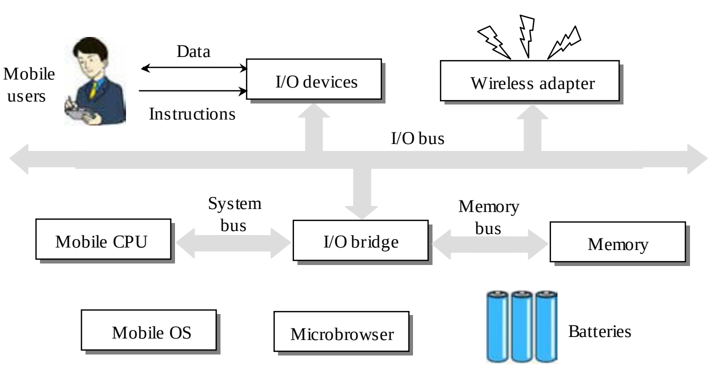


Figure 4. A generalized mobile operating system structure

1.	**Applications**
2.	**Graphical user interface (GUI)**
3.	**Application programming interface (API) framework**
4.	**Multimedia** **Communication infrastructure** **Security**
5.	**Computer kernel** **Power management** **Real-time kernel**
6.	**Hardware controller**

The market share is changing frequently, and claims concerning the share vary enormously. It is almost impossible to predict which will be the ultimate winner in the battle of mobile operating systems.

Mobile Central Processing Units

The core hardware in mobile handheld devices are the mobile processors, and the performance and functionality of the devices are largely dependent on the capabilities of the processors. There used to be several brands available, but recently mobile processors designed by ARM Ltd. have begun to dominate the market. Handheld devices are becoming more sophisticated and efficient everyday, and mobile users are demanding more functionality from the devices. For example, in 2002, *In-Stat/MDR* predicted that worldwide mobile Internet-access device unit shipments would increase from approximately 430 million that year to approximately 760 million in 2006 ("Demand Increasing," 2002). To achieve this advanced functionality, in addition to the obvious feature, low cost, today's mobile processors must have the following features.

- **High Performance:** The clock rate must be higher than the typical 30 MHz for Palm OS PDAs, 80 MHz for cellular phones, and 200 MHz for devices that run Microsoft's Pocket PC.
- **Low Power Consumption:** This prolongs battery life and prevents heat buildup in handheld devices that lack the space for fans or other cooling mechanisms.
- **Multimedia Capability:** Audio, image, and video applications are recurring themes in mobile commerce.
- **Real-time Capability:** This feature is particularly important for time-critical applications such as voice communication.

Microbrowsers

Microbrowsers are miniaturized versions of desktop browsers such as Netscape Navigator and Microsoft Internet Explorer. They provide graphical user interfaces that enable mobile users to interact with mobile commerce applications. Due to the limited resources of handheld devices, microbrowsers differ from traditional desktop browsers in the following ways.

- smaller windows
- smaller footprints
- fewer functions and multimedia features

Several microbrowsers, such as Microsoft Mobile Explorer and Wapaka Java Micro-Browser, are already available. America Online (AOL), Inc., the parent company of the Netscape Network, and Nokia are developing and marketing a Netscape-branded version of Nokia's WAP microbrowser, with AOL-enhanced features, for use across a wide variety of mobile handheld devices. Figure 5 shows a typical microbrowser, Mobile Browser version 7.0 from Openwave Systems, which includes the following features: compatibility with WAP (Open Mobile Alliance Ltd., n.d.) or i-mode (NTT DoCoMo, n.d.), multimedia support, color images and animation, and dual network-stack, HTTP (hypertext transfer protocol) and WSP, support (Openwave Systems Inc., n.d.).

Figure 5. Openwave® Mobile Browser version 7

Input and Output Devices

Various I/O devices have been adopted by mobile handheld devices. The only major output device is the screen, whereas there are several popular input devices, including the following:

- **Keyboards:** There are two kinds of keyboards: built-in keyboards and external, plug-in keyboards. The problem with the former is that they are too small for touch-typing, whereas the latter suffers from inconvenience. Fabric keyboards that can be rolled up or folded around the handheld devices are being developed to relieve the problem of external keyboards.
- **Touch Screens and Writing Areas with Styli:** A touch screen is a display that is sensitive to human touch, allowing a user to interact with the applications by touching pictures or words on the screen. A stylus is an input device used to write text or draw lines on a surface as input to a handheld device. A handheld device equipped with a writing area and a stylus needs a handwriting-recognition function, but existing systems do not yet have a satisfactory recognition rate. Graffiti, employed by many handheld devices, is the most popular writing software.

Some mobile handheld devices can also react to voice input by using voice-recognition technology.

Memory

Desktop PCs or notebooks usually have between 64 to 256 MB of memory available for users, whereas handheld devices typically have only 4 to 64 MB. PDAs normally have more storage space than smart cellular phones. The former commonly have 16 MB, and the latter may have a memory size as low as a few kilobytes. Three types of memory are usually employed by handheld devices.

- **Random Access Memory (RAM):** There are two basic types of RAM: dynamic RAM (DRAM) and static RAM (SRAM). Dynamic RAM, the more common type, needs to be refreshed thousands of times per second in order to hold data, whereas static RAM does not need to be refreshed, making it faster but also more expensive than dynamic RAM.
- **Read-Only Memory (ROM):** ROM is manufactured with fixed contents, and it is usually used to store the programs that boot the device and perform diagnostics. It is inherently nonvolatile storage, in contrast to RAM.
- **Flash Memory:** This is a kind of nonvolatile storage similar to EEPROM (electrically erasable, programmable read-only memory), but updating can only be done either in blocks or for the entire chip, making it easy to update. Flash memory is not as useful as random access memory because RAM can be addressable down to the byte (rather than the block) level.

It is expected that hard disks, which provide much more storage capacity, will be adopted by handheld devices in the near future. A comprehensive survey of storage options can be found in Scheible (2002).

Batteries

Rechargeable lithium ion batteries are the batteries most commonly used by handheld devices. The life of this kind of battery is short, generally only a few hours of operating time. Battery technology will not significantly improve unless and until manufacturers begin to switch to fuel cells, which is unlikely in the near future. A fuel cell operates like a battery, but unlike a battery, a fuel cell does not run down or require recharging and will continue to produce energy in the form of electricity and heat as long as fuel is supplied. Since the fuel cell relies on chemical energy rather than combustion, emissions would be much lower than emissions from the cleanest existing fuel-combustion processes.

Synchronization

Synchronization connects handheld devices to desktop computers, notebooks, and peripherals in order to transfer or synchronize data. The traditional method of synchronization uses serial cables to connect handheld devices and other computing equipment. Now, however, many handheld devices use either an infrared (IR) port or Bluetooth technology to send information to other devices without needing to use cables.

- IrDA Data, a standard formulated by the Infrared Data Association (n.d.) to ensure the quality and interoperability of infrared hardware, is designed for data transfer over distances of up to 1 meter, acting as a point-to-point cable replacement.
- Bluetooth wireless technology is a specification aiming at simplifying communications among handheld devices, printers, computers, and other devices based on short-range radio technology. The Bluetooth 1.1 specification (Bluetooth SIG, Inc., n.d.) consists of two documents: the core, which provides design specifications, and the profile, which provides interoperability guidelines.

FUTURE TRENDS

Mobile handheld devices are usually divided into two types: smart cellular phones and Internet-enabled PDAs. These two kinds of devices started out as very different products, but they have gradually blended into each other. In the near future, it will be difficult to tell the difference between these two types of devices. The newest products such as tablet PCs belong to the category of PDAs because both have similar functionality. There are numerous mobile devices available in the market today. Table 1 lists some major mobile-device specifications, although several table entries are incomplete as some of the information is classified as confidential due to business considerations.

From Table 1 and previous discussions, the future trends of mobile handheld device components are observed.

1. **Operating Systems:** There are several popular operating systems available; the big three are (a) Palm OS, (b) MS Pocket PC/Smartphone, and (c) Symbian OS. It is hard to tell the eventual winner at this moment.
2. **CPU:** The ARM processors (Cormie, 2002) have already dominated and will dominate the market.
3. **Microbrowsers:** Most HTML pages cannot be displayed on microbrowsers, which will be gradually improved to adopt more HTML pages.
4. **Input Methods:** The two major input methods are and will be touch screens and styli, and keyboards.
5. **Memory:** 64 MB or even 128 MB memory for a handheld device will be common.
6. **Batteries:** Fuel cells are likely the most promising method for extending battery life. However, they will not be available in the near future.

CONCLUSION

The emerging wireless and mobile networks have extended electronic commerce to another research and application area: mobile commerce. Internet-enabled mobile handheld devices are one of the core components of mobile commerce systems as they are needed for mobile users to directly interact with mobile commerce applications. Understanding the devices and knowing their functions and capabilities is vital for the success of mobile commerce applications. A handheld device relies on a wide range of disciplines and technologies for its suc-

Table 1. Specifications of some major mobile handheld devices

Vendor & Device	Operating System	Processor	Installed RAM/ROM	Input Methods	Key Features
Compaq iPAQ H3870	MS Pocket PC 2002	206 MHz Intel StrongARM 32-bit RISC	64 MB/32 MB	Touch screen	Wireless e-mail/Internet
Handspring Treo 300	Palm OS 3.5.2H	33 MHz Motorola Dragonball VZ	16 MB/8 MB	Keyboard/ stylus	CDMA network
Motorola Accompli 009	Wisdom OS 5.0	33 MHz Motorola Dragonball VZ	8 MB/4 MB	Keyboard	GPRS network
Nokia 9290 Communicator	Symbian OS	32-bit ARM9 RISC	16 MB/8 MB	Keyboard	WAP
Nokia 6800	Series 40			Keyboard	Innovative keyboard integration
Palm i705	Palm OS 4.1	33 MHz Motorola Dragonball VZ	8 MB/4 MB	Stylus	Wireless e-mail/Internet
Samsung SPH-i330	Palm OS 4.1	66 MHz Motorola Dragonball Super VZ	16 MB/8 MB	Touch screen/ stylus	Color screen
Sony Clie PEG-NR70V	Palm OS 4.1	66 MHz Motorola Dragonball Super VZ	16 MB/8 MB	Keyboard/ stylus/ touch screen	Multimedia
Sony Ericsson T68i			800 KB	Keyboard	Multimedia messaging service
Toshiba E740	MS Pocket PC 2002	400 MHz Intel PXA250	64 MB/32 MB	Stylus/ touch screen	Wireless Internet

cess. To facilitate understanding, this article broke down the functions of a handheld device into six major components, which can be summarized as follows.

1. **Mobile Operating Systems:** Simply adapting desktop operating systems for handheld devices has proved to be futile. A mobile operating system needs a completely new architecture and different features to provide adequate services for handheld devices. A generalized mobile operating system structure can be visualized as a six-layer stack: (a) applications, (b) a GUI, (c) an API framework, (d) multimedia, a communication infrastructure, and security, (e) a computer kernel, power management, and a real-time kernel, and (f) a hardware controller.
2. **Mobile Central Processing Units:** Handheld devices are becoming more sophisticated and efficient everyday, and mobile users are demanding more functionality from their devices. To achieve this advanced functionality, in addition to the obvious feature, low cost, today's mobile processors must have the following features: (a) high performance, (b) low power consumption, (c) multimedia capability, and (d) real-time capability. The cores and architectures designed by Cambridge-based ARM Holdings Ltd. have begun to dominate the mobile CPU market.
3. **Microbrowsers:** Microbrowsers are miniaturized versions of desktop browsers such as Netscape Navigator and Microsoft Internet Explorer. They provide graphical user interfaces that allow mobile users to interact with mobile commerce applications. Microbrowsers usually use one of the following four approaches to return results to the mobile user: (a) wireless language direct access, (b) HTML direct access, (c) HTML to wireless-language conversion, and (d) error.
4. **Input and Output Devices:** Various I/O devices have been adopted by mobile handheld devices. The only major output device is the screen, but there are several popular input devices; among them are (a) keyboards and (b) touch screens and writing areas that need styli.
5. **Memory:** Three types of memory are usually employed by handheld devices: (a) RAM, (b) ROM, and (c) flash memory. Hard disks, which provide much more storage capacity, are likely to be adopted by handheld devices in the near future.
6. **Batteries:** At present, rechargeable lithium ion batteries are the most common batteries used by handheld devices. However, the life of this kind of battery is short, and the technology will not significantly improve unless and until manufacturers begin to switch to fuel cells, which may not happen for at least several years.

Synchronization connects handheld devices to desktop computers, notebooks, or peripherals to transfer or synchronize data. Without needing serial cables, many handheld devices now use either an infrared port or Bluetooth technology to send information to other devices.

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KEY TERMS

Electronic Commerce: It is the exchange or buying and selling of commodities, services, or information, or the transfer of funds on the Internet through the use of desktop computers.

Flash Memory: This is a kind of nonvolatile storage similar to EEPROM, but updating can only be done either in blocks or for the entire chip, making it easy to update.

Microbrowsers: They are miniaturized versions of desktop browsers such as Netscape Navigator and Internet Explorer. Microbrowsers, due to the limited resources of handheld devices, are different from the traditional desktop browsers in the following features: (a) smaller windows, (b) smaller footprints, and (c) less functions and multimedia features.

Mobile Commerce: It is the exchange or buying and selling of commodities, services, or information, or the transfer of funds on the Internet (wired or wireless) through the use of Internet-enabled mobile handheld devices.

Mobile Handheld Device: It is a small general-purpose, programmable, battery-powered computer that can be held in one hand by a mobile user. It is different from a desktop or notebook computer due to the following features: (a) mobility, (b) low communication bandwidth, and (c) limited computing power and resources such as memory and batteries. There are two major kinds of handheld devices: (a) smart cellular phones and (b) PDAs.

Stylus: A stylus is an input device used to write text or draw lines on a surface as input to a handheld device.

Synchronization: Synchronization connects handheld devices to desktop computers, notebooks, and peripherals in order to transfer or synchronize data. Other than using serial cables to connect handheld devices and other computing equipment, many handheld devices use either an infrared port or Bluetooth technology to send information to other devices.

Mobile Information Filtering

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INTRODUCTION

Information filtering techniques have been continuously developed to meet challenges arisen from new requirements of Information Society. These techniques gain even much more on importance in the facet of grater mobility of people. One of the most dynamic and compelling areas is the environment of wireless and mobile devices. Just recently, information filtering and retrieval have begun to take into consideration circumstances in which they are being used. As information needs of mobile users are highly dynamic, this points out the necessity of considering additional set of attributes describing user situation—context. This article presents an information filtering system for mobile users (mobileIF) being developed in the Department of Management Information Systems at The Poznań University of Economics. Architecture of the mobileIF is a result of research done in the field of contexts, their taxonomies and influence on information relevance in dynamic user's environment. The paper shows our approach to contexts, discusses time perspective on filtering systems and finally, describes mobileIF architecture and basic data flow within it. At last, we present our current research in fields related to the mobileIF system.

BACKGROUND

The process of providing a user with relevant information can be viewed in two different ways. On the one hand, it can be described as the process where single query is performed on a set of documents (information retrieval—IR). On the other hand, it can be understood as applying a set of queries to a single document (information filtering—IF). Although, the aim of both methods is serving users with relevant documents, the way of processing content in information retrieval and information filtering systems significantly differs from each other (Belkin & Croft, 1992). What is more, queries performed in IR represent short-term information needs, whereas profiles, representing information needs in filtering, stand for relatively constant interests in a particular subject (Baeza-Yates & Ribeiro-Neto, 1999). There are many different applications of IR and IF in various areas, however, majority of them utilizes similar techniques such as Boolean model, vector space, and probabilistic models, as well as some brand new ones, like neural network or Bayesian models. Baeza-Yates et al. (1999) provide exhaustive comparison of those techniques.

In the central point of our interests is information filtering domain, that could be divided itself into several additional subdomains according to methods used. The most important ones are content-based (cognitive) filtering and social (collaborative) filtering. The idea that stands for the content-based filtering is to select the right information (relevant to user) by comparing representations of information being searched to representations of user profiles' contents (Oard & Marchionini, 1996). This method of IF has turned out in many systems to be very effective, especially in dealing with textual objects. The latter one overcomes some limitations of content-based filtering (such as problems with filtering multimedia objects, difficult to use for novices, etc.). The collaborative filtering improves results of IF by taking advantage of judgements of multiple users who have similar interests on the read documents (Shardanand & Maes, 1995). Basis for this technique is the assumption that users who judged the same documents in the similar way to others in the group, will most probably proceed like that in future, while judging new documents.

Both of those methods have many specific advantages as well as some drawbacks. The natural way of evolution is combining these techniques in order to achieve better results of filtering. Claypool, Gokhale, Miranda, Murnikov, Netes, and Sartin (1999) and Li and Kim (2003) proposed some hybrid methods.

There are many definitions of context provided in literature. Among them, several deserve special attention as stimulus to our further considerations. In one of the earliest definitions Schilit (1995) distinguishes the following types of context: computing context (network capacity, connectivity, communication costs, and available devices), user context (user's profile, location, people nearby, and social situation), and physical context (lightning, noise level, temperature, and traffic conditions). According to Schmidt, context is divided into two categories, namely: human factors (information of the user, social environment, and user's tasks) and physical environment (location, infrastructure, and conditions) (Schmidt, Beigl & Gellersen, 1999). Both presented definitions try to identify context by simple division of some characteristics into several groups of potentially distinct attributes. However, neither of them is suitable for inferring more aggregated and complex information. This inconvenience is reduced in the definition by Chen and Kotz (2000) who distinguish low-level and high-level context. The former group contains raw contextual information such as location, temperature etc. (mainly acquired from physical sensors), whereas the latter one is specified on the basis of supplied low-level contexts. More formal definition is provided by Dey and Abowd (1999) who argue "context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves."

Systems that take into account context changes and adapt to them (to some degree) are defined as context-aware (Pascoe, 1999). Such adaptation may involve adjustment to user's device capabilities (e.g., screen resolution, memory, software attributes, network bandwidth, and user preferences). Context-aware information delivery system takes into account not only semantic information relevance, but also context of the user. Changes in context may suggest changes in user information needs. Information delivery systems that are based on these assumptions are often defined as context-aware retrieval (CAR) systems (Brown & Jones, 2001). Korkea-aho (2000) provides a wider spectrum of CAR application examples.

MOBILE INFORMATION FILTERING

Contextualization in MobileIF

A citizen of Information Society wants to be provided only with such information he or she requires. In case of filtering domain, user information needs are depicted by user profile that expresses rather long-term goals. On the contrary, active goals and current tasks can be supported by contextual information. It is obvious that the latter ones are more significant for mobile users as they can better adjust to their daily rapidly changing activities.

In order to fulfil this requirement, the system has to be able to process several types of user contexts. The notion of contextual information in mobileIF has to be examined from two different points of view.

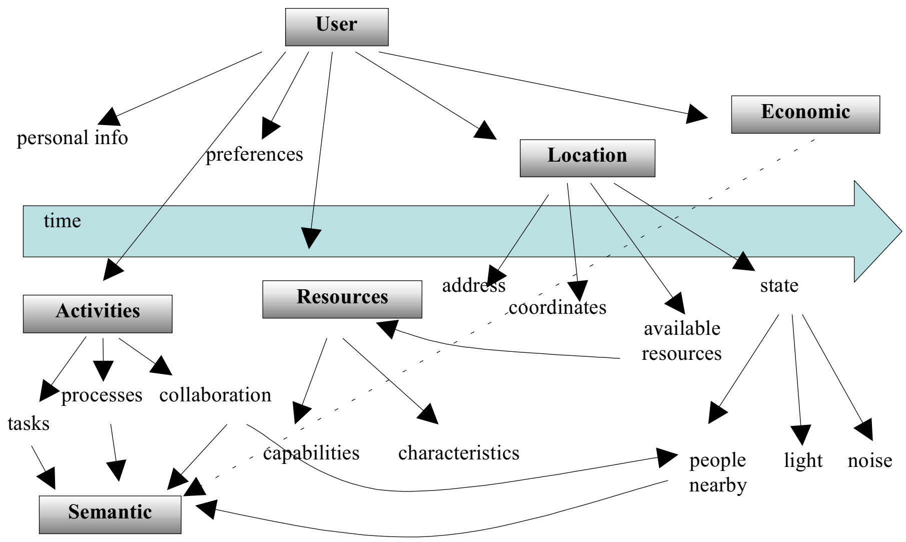
In the first one, we distinguish two new groups of contexts that influence:

- User information needs (named as semantic contexts). They are used to more precisely define queries to the system obtained out of the user's profile. The context can extend the query with some additional concepts as well as narrow it down (Wen, Lao, & Ma, 2004).
- The way the information is delivered to mobile users (named as distributive context). Such contexts allow an adaptation of the filtering results in order to provide the optimal presentation and delivery. This may be done according to the capabilities of devices or user preferences (Costa, 2003; W3C, 2005).

From the second point of view, both described groups may address several dimensions that are crucial for mobileIF system.

- **Time:** The time context is connected with the occurrence of other contexts.
- **Location:** The location context is intrinsically linked to the geographical context, given by the street-network and other infrastructure, points of interest, environmental and topological features etc.
- **Resources:** They correspond to characteristics and capabilities of utilized resources (e.g., user devices).
- **Social Context:** This interpersonal context gives information about relationships between user and other persons or organizations
- **User Activities:** Describing the user's current tasks, and in a broader sense, the existence of specific conditions or steps in a process.

Figure 1. Context dependencies



- **Economic Context:** That handles with relations among various dynamic economic metrics and constraints connected with acquisition of information.
- **Semantic (Cognitive) Context:** Represents current (or future) information needs acquired from user's current tasks, contacts, roles, and preferences. It may be directly derived from other contexts

Most of presented contexts influence each other and should not be treated separately (as shown in Figure 1). It is better to consider user context as a point in a multidimensional space with an unbounded number of dimensions. However, the most significant context in our model is time. The special treatment of this context is driven by the nature of mobileIF. As a dynamic system its main characteristic is changeability and continual adaptability to user's future situations.

Attention should be put to duality of time interpretation. On the one hand, it is linked to information and determines its actuality. On the other hand, it is the point of reference for other contextual dimensions. Another crucial assumption of our context model is ability of aggregation of basic contextual information to form more complex contexts. Therefore, it is essential to develop context representation that is interoperable and usable in many cases, independent from the context sources, and also flexible enough to accommodate future needs.

Time Perspective of Information Filtering

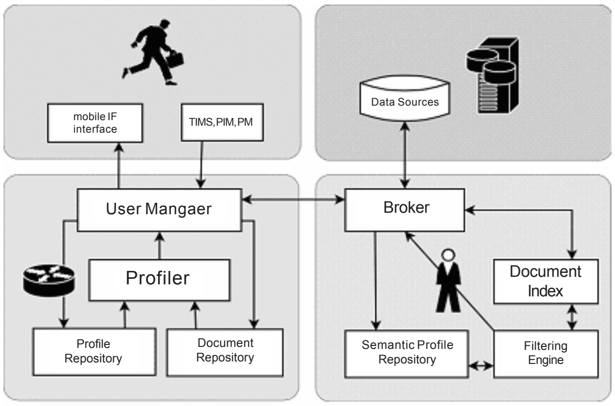
An information filtering process consists of several steps (Belkin & Croft, 1992). Although it is not explicitly stated, some of them start in distinct time moments. The most interesting are:

- Publishing texts
- Indexing texts
- Expressing user's information needs
- Comparison of profiles and indexed documents
- Dissemination of retrieved texts to users

Two of them are of a special importance: the time of specifying user needs and the time of delivery. They are related to the semantic context and to the distributive context respectively. A consequence of an existing time gap is that contextual information that influenced retrieval of a particular document is not the same when the document is delivered to the user (and should comply with his information needs). If we want to fully utilize contexts, both moments should be considered and each time moment ought to be treated differently.

Time management systems (TMS) allow the user to plan his future activities, record them in a computer manageable form, and finally trace their execution.

Figure 2. MobileIF architecture



Scheduled jobs enable distinguishing the time of filtering and the time of delivery. A planned task gives two important pieces of information: due time of the task and its description. That information is a source of distributive and semantic context, respectively. On one hand, a task description is an implicit expression of user needs, and on the other one, it instantiates a particular semantic context state in some point in future. When a task reaches its due time the semantic context becomes the current one (the semantic context changes along with time flow). Distributive contextual information can be obtained by analyzing user's resources and time-related properties of scheduled tasks. At each time moment we always have up-to-date state of both components of the context (semantic and distributive).

Architecture of the MobileIF System

In this article we describe prototype architecture of mobileIF system. One of the mobileIF's objectives is to provide the most relevant, quality-oriented information available from well-defined, specific web sources. Developing our system architecture, we assumed possible cooperation with a few predefined web portals. We concentrate on relevance and quality of information that will be presented on different mobile devices with diverse technical capabilities.

To improve information filtering we need to define user profile as precisely as possible. The system extracts the required information from the user's time or project management applications and sends it to proper mobileIF's modules. Raw data is processed and converted into specific parts of user profile. Semantics of an entry and related resources are stored in a form of semantic subprofile and are used later in the filtering process. Context tags determine a distributive profile that helps presenting filtered documents. All filtered documents are stored within an internal repository and are easily accessible within mobileIF system. With help of a GUI, documents are available anytime, anywhere. The mobileIF architecture is presented in Figure 2.

The whole system is divided into four parts:

- User-end module
- User manager module
- Broker module
- Data sources

The User-end module is an interface to mobileIF. We distinguished two main functions of this module: to present results and to extract data defining all parts of a user's profile. When a new entry within a user's TMS application appears for the first time, mobileIF creates a new profile. In this profile we put semantic content extracted from the entry (subject, description, related resources, etc.) as well as preferred time of presenting filtered documents, entry deadline, date of creation, mobile device currently in use.

The User Manager is a central part of the mobileIF system. That is the place, where information is being processed, organized into semantic and distributive profiles, and dispersed among different parts of the system. User data (user's profile) is stored within the Profile Repository. The Profile Repository is a dynamic module in the sense that all changes made by the user within an associated entry are always updated in the module. Furthermore, the Profile Repository is responsible for managing user's profiles linked to tasks marked by the user as done or expired. The next part of the User Manager is the Document Repository, a place where all downloaded documents are stored. The third part of the User Manager is the Profiler. This module is responsible for binding all the filtered documents with appropriate TMS entries and determining, which documents should be presented at a given time, according to distributive profiles.

The Broker module manages filtering processes and collaboration with external sources. The Semantic Profile Repository is a part where copies of all the semantic profiles are stored. The second part of the Broker is the Document Index that manages creation and updating of full-text documents' indices. The actual filtering process (comparisons) takes place within the Filtering Engine. The results are sent back to the User Manager.

An Exemplary Scenario

A new user starts his cooperation with the mobileIF system by creating a new task (entry) in his TMS application. He fills in a subject, an exact date of meeting, all necessary resources (e.g., people involved), a task category, its priority and marks the whole entry as information need. The user can also provide more details in the task's body.

MobileIF automatically extracts data from this particular task and sends it to the User Manager. There, a new profile connected to the initial task is created. This is the moment of determining all the crucial word entities that will be utilized during the process of information filtering.

Afterwards, the User Manager creates the semantic and distributive subprofiles. The first one is based on entities gathered from textual fields of task's description like subject, body and category. The latter one consists of data extracted from resource fields, mobile device currently in use, and task deadline.

Both the subprofiles are stored in the Profile Repository. The semantic part of the profile is transferred to the Semantic Profile Repository (within the Broker). The Broker keeps the semantic profile as long as an associated entry is valid within user's TMS application. When the entry is removed or its deadline expires, the associated profile is deleted from the Semantic Profile Repository.

In the meantime, the Broker downloads documents from an external web source on a regular basis and stores them in the Document Index. Each new semantic profile that appears in the Semantic Profile Repository is compared against the set of documents indices.

Relevant documents are sent back to the User Manager and are stored in the Document Repository. The User Manager binds them with an appropriate task in the user's TMS. When the user wants to see some relevant documents, Profiler determines the best set of relevant documents with respect to user's distributive subprofile.

FUTURE TRENDS

MobileIF is implemented only partially. There are many several areas that still require further research and testing. One of them is adjusting of graphical form of documents with respect to device capabilities. Many documents are considered relevant because only few parts of them really are interesting. We will try to extract only those relevant excerpts. We expect the task to have more in common with query answering.

Lack of precision in matching document content and user needs is another issue. The use of ontologies, shallow text processing, and automatic building of knowledge bases are approaches that may increase effectiveness of mobileIF system. At first they allow us to smartly expand our queries (from TMS entries) and to index documents.

Another issue we would like to investigate are index structures. Vector based information representation seems to be inappropriate as far as graph-based ontologies will be concerned.

CONCLUSION

Literature brings a great number of definitions of context, however, none of them have been adopted as a standard yet. They were usually developed for the purpose of specific use and for specific systems. They deal mainly with basic and easy detectable contexts like location, temperature, or devices. We present a novel approach to utilization of contextual data for information filtering purposes. There are seven basic contexts we take into account: time, location, resources, social, activities, economics and semantics. Those contexts can be used twofold. On one hand, they raise content's relevance (according to a semantic profile) and on the other hand they influence the process of a document delivery (according to a distributive profile). Such a partition allows us to use a planning or calendar application as a source of user's context. The architecture we have described addresses contextual issues related to the whole process of information filtering.

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KEY TERMS

Context: All information about current user's situation.

Data Source: An external provider of information; the information is accessible either in passive or active way.

Distributive Profile: A part of a user's profile that defines which documents (from the relevant ones) and how should be presented to him/her in a particular time moment.

Information Filtering System: A system whose goal is to deliver to a user only this information that is relevant to her/his profile; system operates on large streams of unstructured data.

Mobile User: A user who needs an access to unstructured data anytime and anywhere.

Semantic Profile: A part of a user's profile that defines what kinds of information (topics) he/she is interested in.

Time Management System (TMS): Calendar based application that allows user to schedule her/his tasks, monitor they execution and provide various descriptions for them.

Mobile Public Relations Strategies

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INTRODUCTION

Public relations is about the "ethical and strategic management of communication and relationships" (Johnston & Zawawi, 2004, p. 6) with individuals and groups ("publics") important to an organization. At one time such publics could safely be thought of in relatively static terms such as geographic location. This is, of course, still possible—but such fixed categories are of diminishing importance when it comes to building relationships with modern publics and communicating organizational messages to them. Even the motor vehicles that facilitate physical movement are becoming "smarter" and converging with technologies such as mobile telephony, personal entertainment systems and handheld computing (Sherry & Urry, 2000, as cited in Sheller, 2002).

This article aims to explore the idea that mobile technologies mean PR practitioners must rethink both the notion of publics and also how to relate to them. A "mobile PR" will undermine taken-for-granted views about the nature of media, messages, and the kinds of relationships public relations people can expect to create on behalf of their clients. Many practitioners are still getting to grips with the online public relations they have known—through activities such as arranging the building of corporate Web sites, monitoring online discussions relevant to client interests and both disseminating company information online and responding to inquiries about it. The idea of an even more flexible communications environment enabled by mobile technologies may seem very daunting. No-one has so far worked out how to "do" PR in this new communications climate—there are no prescriptions or generally accepted approaches. Yet if practitioners do not confront the dilemma of how to reach mobile audiences they risk becoming irrelevant to many clients who must communicate in the mobile space or face unacceptable decay in their business.

BACKGROUND: WHY MOBILE IS DIFFERENT

The Internet and mobile marketplaces have important differences. As Lindgren, Jedbratt, and Svensson note, "The mobile marketplace has a much wider reach than anything before it. It becomes synonymous with everywhere" (2002, p. 5). Siau, Lim, and Shen agree that, "the emerging mobile commerce operates in an environment very different from e-commerce conducted over the wired Internet" (2003, p. 2). It is important that PR practitioners understand the differences and adjust their thinking and practice accordingly.

Siau et al. list mobile market features they consider are *not* characteristic of "traditional" e-commerce:

- **Ubiquity:** Users can get any information they want, whenever they want it, wherever they are (including, now, RSS feeds delivered via mobile internet services).
- **Reachability:** Businesses can reach customers anywhere, anytime—equally, a user can be in touch with and available for other people anywhere, anytime.
- **Localization:** Knowledge of a user's physical location allows locality-specific services to be provided.
- **Personalization:** Mobile commerce applications can be personalized to represent information or provide services in ways appropriate to a specific user.
- **Dissemination:** some wireless infrastructures support simultaneous delivery of data to all mobile users within a specific geographical region. (Siau et al., 2003, pp. 2-3)

As wireless technologies evolve, customer relations will experience dramatic change (Siau et al., 2003, p. 16). To what extent can these relations be called *public* relations and be the domain of PR practitioners rather than marketers? Lines of demarcation can be very blurry. But PR is foregrounded when the prime purpose is to use mobile technologies to create connections–relationships—where the end game is the nature of the relationship rather than an immediate output such as a purchase decision. Examples include:

- Viewer voting via SMS or mobile calls associated with television pop contests, where the goal is to create a broad community of fans who feel they are helping shape the outcome. Their sense of involvement and connection to the contestants—and to other contest followers—is something the promoters hope will morph into long-term enthusiasm for, and purchasing of, products associated with the winner.

- Free delivery of information to mobile devices where consumers have opted-in to receive it—such as notifications of airline or public transport schedule changes. Individuals who are thereby saved a fruitless trip to the train station will value such a convenience—and the organization which provides it, enhancing the organization's reputation for being accessible (if not always for making the trains run on time).
- Personalized, user-specified content delivery. This can range from downloading a daily prayer to getting top news points from the daily paper sent to a mobile device. The organization providing the service is extending its reach to consumers who may not otherwise stop to access their content, or in fact may not be able to access it by other means. This extended reach is valuable to the organizations concerned as a larger pool of customers creates more opportunities to piggyback paid services on free ones.
- Research conducted by SMS, where members of a group which may be dispersed through several countries both receive and respond to researchers' questions through their mobile devices. The group is connected to the research company solely through their mobile equipment but their relationship with the company is essentially no different in nature from that of a focus group meeting in the company's home office.

These examples draw on some of the characteristics of mobile commerce noted by Siau et al. (2003) such as ubiquity, reachability, and personalization to highlight the fact that mobile technologies are enabling new forms of connectivity between organizations and publics that differ from the previous concept of cyberspace as something entered through fixed, location-specific devices. In their difference, the examples also highlight the need for PR practitioners to rethink their approaches to electronic public relations, recognising they now need to do more than designing conventional public relations campaigns that may (or may not) incorporate some online activity. "Mobile PR" may constitute only one part of a public relations initiative—but it should be seen as one that cannot be ignored.

Public relations has developed a range of strategies and tactics to influence publics, most focused on using mass media. Audiences are assumed to be susceptible to media-based persuasion expressed in fact and logic-based statements that frame a particular advocacy position. When the Internet became widely available, public relations practitioners began using it as just a new tool for doing what they had long done, such as publishing media statements and other corporate information and disseminating advocacy material. E-mail meant that some interactivity could be introduced. A new field known variously as cyber-PR, online public relations, electronic PR or "E-PR" developed. Online press conferences were held and some companies began monitoring online chat groups where discussions could highlight an emerging issue that might affect their business. E-PR was used alongside traditional public relations approaches in campaign implementations. Discourse about it focused on translating questions of communication efficiency to the online environment, such as how organizations can integrate the Internet into their existing investor relations activities (Kuperman, 2000) and how they may identify issues that need to be managed (de Bussy, Watson, Pitt, & Ewing, 2000). Interest has focused on exploiting the technology to deliver communication efficiencies for the organization rather than on delivering experiences consumers may want, such as a sense of "connectedness", which Dholakia et al*.* (2000) describe as "the feeling of being linked to a world outside the specific site" (Gustafson & Tilley, 2003).

RECONCEPTUALIZING PR FOR A MOBILE WORLD

Existing E-PR tactics are not longer sufficient for mobile-driven markets. E-PR needs to encompass "M-PR" (mobile public relations). The fluid nature of mobile communications means some core, generally accepted notions of public relations planning need redefinition. PR campaign planning models vary (Bobbitt & Sullivan, 2005, p. 32). There are, however, common elements used in communication processes that aim to build a mutually beneficial relationship with a public – a best-practice goal of contemporary public relations. They include:

- The need to identify priority audiences ("target publics")
- Selecting appropriate media
- Designing effective messages

Mobile communication also reworks the idea of relationship.

Table 1 attempts to point to both similar and dissimilar aspects of the mobile and traditional electronic public relations environments, necessarily making generalizations as it does so.

Table 1.

Mobile PR	"Traditional" Electronic PR
Consumers access cyberspace from mobile devices	Consumers access cyberspace from fixed devices
Target publics form fluid communities linked by mobile communication	Target publics self-select by "pulling" information to themselves
Messages abbreviated, "burst-y", often in TXT and symbols—"emoticons"	Messages use symbols and plain text; facility for delivery of extensive content
Devices allow multimedia experience	Multimedia delivered via fixed devices
Demand to satisfy emotional needs such as sense of involvement is a strong driver for relationship formation	Greater opportunity to influence relationships with rationales for advocacy positions

Target Publics

The world of mobile commerce calls for a wider way of thinking about relating to publics, one that recognizes that mobile communicators—one description of them is "global knowledge-nomads" (Lindgren, Jedbratt, & Svensson, 2002, p. 10)—are consuming content and managing relationships, including with commercial organizations, every bit as much as those consumers who are working with fixed technologies. Mobile communicators cannot be unambiguously defined by familiar psychographic, demographic or even geographic characteristics. "Fleetingness" is the key characteristic, with audiences seeming to be always just beyond reach (Proctor & Kitchen, 2002).

This means the idea of "target publics" must be reconceptualized, taking into account that "in a global context mobile telephony is used by a far broader spectrum of the population than PCs and the Internet" (Lacohee, Wakeford, & Pearson, 2003, p. 206). To PR practitioners raised on linear, structured campaign planning models, elusiveness of audiences is as frustrating as it is demanding. Yet, as Proctor and Kitchen suggest, inconstancy of targets need not justify inactivity: a key may be to "adopt an open, untargeted, ill-defined approach which leaves scope for imaginative consumer participation" (2002, p. 154). Such an approach is ideal for the interactivity of mobile communication, acknowledging that "mobility does not only relate to our physical bodies. We are also mentally mobile and are adept at migrating between various mental states, various identities" (Lindgren et al., 2002, p. 24). Computer and mobile phone-supported social networks are enabling communities of shared interest to form in both physical and online spaces (Wellman, 2001, as cited in Sheller, 2002) and such communities may form the basis of new publics (Sheller, 2002, p. 46).

Media

Commonly used PR planning approaches based on a stage-by-stage implementation concept include a point where media are chosen to carry the messages intended to influence a target audience. Complementing traditional print and broadcast media, the internet has been used as a medium to reach online audiences. Mobile devices capable of supplying voice, video, and text (including RSS feeds) to a user constitute a new, rich and challenging medium for the E-PR practitioner. It is demanding because familiar tactics such as issuing press statements cannot be deployed as before: they require reconstitution for convergent mobile media use.

Messages

The "intensity, brevity, and the absence of narrative continuity" (Lash, 2002, p. 206) that characterize mobile-enabled communication are incompatible with delivering extended logic-based PR advocacy material. Post-modern audiences are likely to be influenced as much by emotion, experience and a desire to find meaningful connection with others as they are by logic (compare Caru & Cova, 2003; Ito & Daisuke, forthcoming, p. 3). Mobile communication's interactivity can offer this kind of intense connectivity.

On-the-move consumers not only seek to be accessible themselves most of the time—Ito and Daisuke's "persistent connectivity" (forthcoming, p. 19)—increasingly they also want to draw down needed information to their mobile devices. Many may remain consumers of traditional media such as newspapers, television and radio while relying largely on mobile devices to function in cyberspace. The condensed nature of much mobile communication means mobile communicators may be less exposed to the extended information and advocacy material available on organizational Web sites, thus obsoleting the press release in its traditional form. That in itself is a big challenge for E-PR practitioners, who must also take into account the mobile field's rapid technological change, which may lead to unexpected applications (Lacohee, Wakeford, & Pearson, 2003, p. 206).

PR people now face the task of designing and delivering content to mobile publics that meets their less tangible need for connection with others: according to Fox (2001) mobile telephones provide a "'social lifeline' in a fragmenting and isolating world" and even the gossip that comprises much mobile-based chat "restores our sense of connection and community" (2001, p. 1). They may need to consider an approach that has been dubbed "dynamic touch" (Galloway, 2005) because it relies on creating an *experience* of connectivity rather than on getting prose published or images broadcast. One example is the sense of connection with contestants that fans develop during the *American Idol* television contests through voting via SMS, e-mailing messages of support and discussing their favorite's progress on their telephones.

Public relations people may need to design more such virtual experiences as part of building and maintaining relationships with mutable, mobile publics, recognizing that "the mobile marketplace merges the virtual and physical marketplaces" (Lindgren et al., 2002, p. 6). This is not the stuff of PR "as we know it" but rather, largely uncharted territory for professional communicators who will need to learn how to imagine and deliver experiences that connect with people in ways that have a planned, overall consistency to them.

Relationships

Increasingly, today's markets are driven by many organizations' perceived need for a "continuous personalized dialog with customers" (Lindgren et al., 2002, p. 17). In the light of this pressure, any concept of E-PR as merely managing familiar tasks in an electronically-enabled environment falls far short. It does so for a number of reasons. One is simply the strong and sustained growth in mobile telephony and in wireless data usage. More than 20% of the world's population uses a mobile telephone and usage is increasing at more than 10% a year (Rerisi, 2003, as cited in Grant & Meadows, 2004). Such surging growth and the changes it is bringing in the way people connect with organizations and individuals that matter to them is simply too significant safely to ignore.

As Levy points out, "major technological inventions not only enable us to do 'the same things' more quickly, better or on a greater scale, but also allow us to do, feel or organize ourselves differently" (2001, p. 199). People now use mobile technologies to negotiate coordination of their activities, permitting "direct contact that in many ways is more interactive and flexible than time-based coordination" (Ling, 2004, p. 58), enabling users to "have a foot in both the here and now as well as the there and now" (2004, p. 190). According to Lacohee, Wakeford, and Pearson (2003), the linking of communication to mobility is central to contemporary social networks. As they point out, such communication need not be in a close social network: the BBC has found with text messages that "New technologies are giving us a level of interaction with out audiences that we have never seen before" (Chapman, quoted in Lacohee, Wakeford, & Pearson, p. 206).

Internet and mobile-linked consumers are primarily interested in building a sense of *connectedness* with others (individuals, groups, and organizations) rather than in consuming particular types of media content. As Proctor and Kitchen note, "Postmodern consumers seek to feel good in separate, different moments by acquiring self-images that make them marketable, likeable, and/or desirable in each situation or moment" (2002, p. 148). People choose to group themselves in shifting "neo-tribes" which share emotions and a "more spiritual sense of community" (compare Patterson, 1998, p. 70). While text messages are often low in informational value they are considered high in social grooming (Lacohee, Wakeford, & Pearson, 2003, p. 206).

FUTURE TRENDS

In the United States, the number of mobile device users exceeds the number of people who use personal computers (Lim & Siau, 2003). As more computing features become not only available on mobile devices but also easier and cheaper to use, this trend can be expected to continue. Wireless capabilities are being incorporated into more technologies and extended for others—and there is the prospect of "unheard of transmission rates" (Meadows, 2004, p. 356, as cited in Grant & Meadows). As more and more functions are offered on wireless devices, it is likely that those with one predominant use will give way to those with multiple capabilities (compare Banks & Fidoten, 2004, as cited in Grant & Meadows, 2004).

For public relations practitioners this means coming to terms with more than a need to understand these converging capabilities and how to deliver content in a way that is both technically and "culturally" compatible—culturally in the sense of being viewed by users as appropriate to the environment of the hybrid communication and computing devices. It also means learning to surf the fluid waves of the mobile market as "members of the communities in which they wish to communicate" (Nicovich & Cornwell, as cited in in Rettie, 2002, p. 261).

CONCLUSION

Public relations practitioners must learn to use mobile devices as new media for campaigns, not just as tools for managing their schedules or arranging the next client function. Doing so will demand a fundamental reworking of familiar concepts to adapt to the new mutable world of mobiles.

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KEY TERMS

Cyberspace: The boundaryless virtual world accessed through computer networks, whether one's access device is fixed or mobile.

Dynamic Touch: An experience in cyberspace designed by a professional communicator to stimulate emotional responses that will help advance the interests of the communicator's client organization.

Media: In a public relations context, these are channels for delivery of organizational messages to target publics.

Message: Any content (audio/written/visual) an organization wishes to deliver to a public in order either to inform or to motivate them to a desired response.

Mobile-PR: The application of public relations strategies and tactics in cyberspace accessed through mobile devices.

Public: Any group of people an organization wishes to reach because their interest or influence is relevant to the organization in some way. People may belong to more than one public and shift between them quickly, depending on the issue in question. For example, an Internet user who is also an environmental activist who uses SMS to coordinate times and places of protests with other activists.

Public Relations: The planned and sustained effort to build mutually beneficial relationships between an organization and those individuals or groups whose interest or influence makes them relevant to the organization.

Multi-Agent System for Web-Based Customization

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INTRODUCTION

Web-based customization refers to an e-commerce business model whereby customers can individualize their products via the electronic channel. The success of this business model to a great extent depends on the appropriateness of the information system, which supports online interaction between customer and supplier (Franke & Piller, 2003). For example, computer manufacturers offering their products online enable customers to select the type of components to be built in the final product (e.g., type of processor, motherboards, graphic and sound cards, etc.). This type of interaction is referred to as Web-based product configuration. In order to increase the chances that customers find suitable products, Web-based customization offers large variety. However, due to the limited information processing capacity of humans and lack of technical product knowledge, excessive product variety confuses customers (Piller, Koch, Moeslein, & Schubert, 2003). It triggers decision-making difficulties and uncertainty concerning the suitability of choices. In effect, customers are generally unaware of their needs and not capable of making optimal buying decisions. Furthermore, the support provided by common information systems is more consistency check than real assistance, since their main task is to verify the compatibility of components between each other.

On the other hand, the resulting variety brings about an increasing complexity of operations and manufacturing-related tasks on the supplier's side. The complexity that is perceived by customers during the interaction process is called "external complexity," whereas complexity that is experienced inside manufacturing and operations is referred to as "internal complexity." Therefore, a suitable information system that supports Web-based customization should simultaneously address both challenges. It should provide customers with appropriate assistance during the search for adequate products and support suppliers in managing variety. In the following, an information system that is capable of coping with both types of complexity will be developed.

BACKGROUND

In order to avoid customer confusion in Web-based customization, information systems should be capable of assisting customers through advisory (Blecker, Abdelkafi, Kreutler, & Friedrich, 2004a; Blecker, Friedrich, Kaluza, Abdelkafi, & Kreutler, 2005). They have to capture a customer's preferences and only display via the Internet the subset of product variants that would be interesting for customers. In this manner, external complexity can considerably be reduced because customers have to make decisions out of a few alternatives. In addition, since the product variants proposed to the customer have higher potential to contribute to the supplier's success, they should be retained in the product assortment. The product variants in which customers are not interested rather increase complexity and should be eliminated from the product assortment. Thus, the condition of success is to reach the final subset of product variants presented to the customers. The most successful product variants ensure long existence in the supplier's offer, while "losers," which cannot establish themselves over a period of time, should be discarded.

It can be imagined that the product variants compete against each other in order to be more successful. For the specification of the competition rules, a market mechanism supported by multi-agent technology (e.g., Jennings, 2000; Wooldrige, 2002) is a suitable solution approach. In fact, it is not practical to associate with each product variant an autonomous rational agent because the extent of product assortments can be very large (billions of possible variations). However, it is common in practice that suppliers providing Web-based customization use modular product design in order to manage high variety (e.g., Gilmore & Pine, 2000; Piller, 2003). Modularity enables one to mix and match product building blocks with standard interfaces in order to create many product variations. Thus, the problem can significantly be simplified if an autonomous rational agent is assigned to a module variation. Subsequently, the extent of the multi-agent population can be kept at a low level. Note that a module variation is an instance of a specific product module (e.g., an engine is a module, while 1.6 Diesel and 2.0 Diesel are two different engine variations). The corresponding agents are referred to as "module agents" and compete against each other for the sake of success, which means formation of product variants with high chances to be proposed to customers.

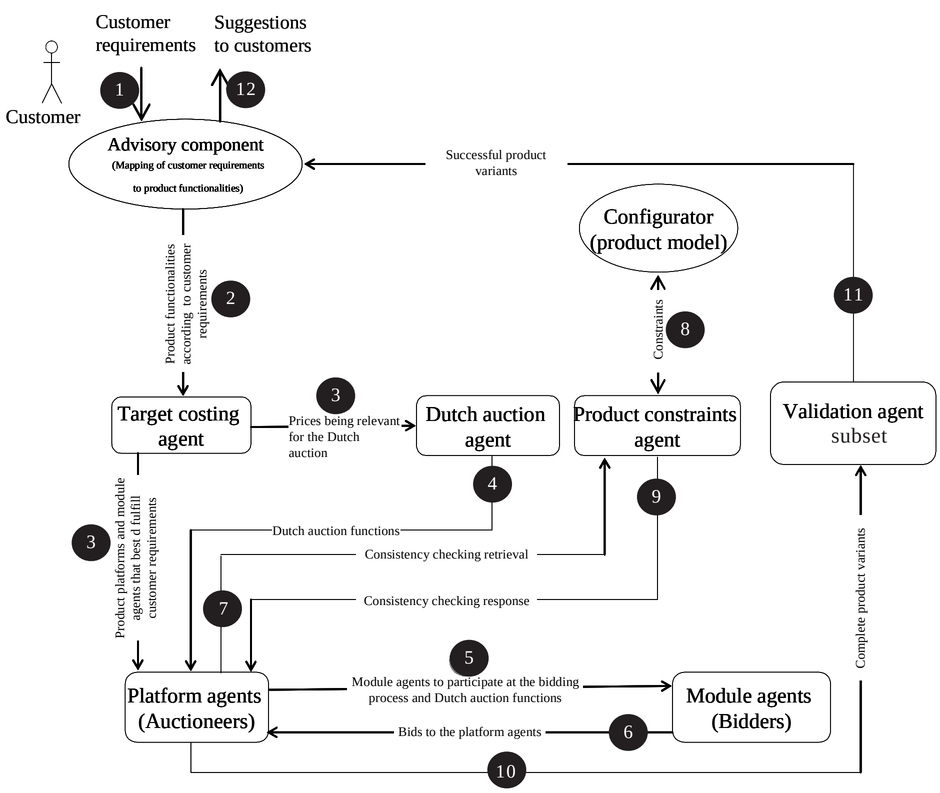
In industrial practice (e.g., automotive industry, computer industry, etc.), suppliers make use of an additional variety management concept called product platforms in order to alleviate the negative effects of variety on manufacturing performance (Nilles, 2002; Wildemann, 2003). A platform is a basic component (module) that is built into a large number of product variations (e.g., A-Platform of Volkswagen). The corresponding agents are called platform agents, which differ from the module agents in that their lifecycles are much longer. In effect, product platforms are cost intensive and developed to serve as the basic module of a product family for a long period of time. It follows that the platform agents should not compete with each other in order to survive, and the decision about their removal is left to managers.

The multi-agent-based system should dynamically assist users during interaction. It should generate and refine product variants that meet customer requirements. Variety formation refers to the process, by which module agents cooperate with each other in order to form customer-focused product variants. On the other hand, the module agents should provide useful information to support variety steering, which is the process of introducing or eliminating module variants so that variety offer can be optimized.

INFORMATION SYSTEM FRAMEWORK

The module and platform agents require some data that should be provided by other software systems. Therefore, the complete information system additionally includes four other agents (target costing agent, auction agent, product constraints' agent, and validation agent) and two components (an advisory component and a configuration system) as shown by Figure 1. The advisory component is a software system that initiates an interactive dialog (e.g., Meissner, 2002) with customers and captures their requirements in terms of product

Figure 1. Framework supporting the multi-agent system for Web-based customization (Blecker, Abdelkafi, Kreutler, & Kaluza, 2004b)



functionalities or other criteria such as emotions and feelings. It reacts on customers' inputs and adapts dialogs during the interaction process. The output of the advisory component consists of product functions and the product price range that the customer would accept. These functional requirements are mapped to technical product description in terms of modules by the target costing agent. This appellation is mainly due to a management tool called target costing that was used for the first time by Japanese companies in order to improve product design. The target costing method computes product target costs by subtracting the target profit that the supplier wants to achieve from the target prices, which are dictated by the market. Subsequently, the target costs of the components are estimated and compared to the actual costs so that specific design improvements can be generated (Seidenschwarz, 2001).

In our case, the target costing agent stores data concerning the contribution level of each module to the fulfillment of the product sub-functions. For instance, it can be set that the sub-function "entertainment" in a car is satisfied up to 60% by a hi-fi system. Using this data, the target costing agent determines the module variations with high chances to fulfill customer requirements. Due to the flexibility of modular product architectures, the combination of the proposed modules mostly results in many product variants. Consequently, a module variants' refinement process is necessary. This is ensured by the auction mechanism and validation agent that will be described later on. After translating the functional description to technical product specifications, the target costing agent has to carry out three main tasks:

- selection of the main platform agents that would best fulfill a customer's profile—the selected product platforms can be chosen more than once, so that many product variants can be formed on the basis of one platform;
- communication of the module agents that would suit customer's requirements to each selected platform agent, which initiates the auction process; and
- communication of the module variants' cost ranges to the auction agent.

On the basis of the module variants' costs, the auction agent derives the auction functions which specify the protocol that makes auctions run. The module agents are the bidders that strive to take part in successful product variants. The platform agents are the auctioneers and regulate the bidding process. When a module agent wins the bid, the platform agent asks the product constraints' agent to verify if the corresponding module variant violates product constraints. If there are no compatibility problems, the module agent is allowed to join. Otherwise, it is rejected and the auction will continue until a module agent with no compatibility problems wins the bid. Thus, in order to ensure the formation of consistent product variants, the product constraints' agent must have access to the configuration system logic which contains a representation of the different constraints between modules.

After the bidding processes terminate, it may result that some product variants are incomplete because some relevant modules are missing. These should be excluded, thereby only communicating the complete product variants to the validation agent. This agent selects the product variants' *subset,* which consists of the final products with the best specifications to suit customers' requirements. Finally, the advisory component displays the narrow range of selected product variants to the customer. In the following, the most important agents for the definition of the market mechanism are considered in more detail. These are the module agents, platform agents, and auction agent, which will be described according to their capabilities, tasks, and properties.

Module Agents

For the regulation of the bidding mechanism, it is necessary to introduce the module agent's account, in which a fictive amount of money is stored. In effect, each new module agent starts with a sum of money supposed to decrease in a linear fashion in the course of time. In addition, each time the module agent wins a bid; it has to pay the auction price. If the agent's account reaches zero, it risks "death" and the corresponding module variant should be considered for eventual elimination. However, module agents have the possibility to compensate their decreasing accounts by means of a reward mechanism. In effect, the number of product variants that come through the validation agent is inferior or equal to the number of all formed product variants. Thus, the collected sum of monetary units from all bidding agents can be distributed on the agents that participate in the successful product variants. The reward of a module agent is equal to the difference between the amount of money received and the auction price. Therefore, some agents make a profit, while others incur a loss. The successful agents more rapidly gain money and achieve better profits, which help them achieve longer survival.

Platform Agents

These are the auctioneers who initiate online auctions on the basis of the bidding functions received from the auction agent. Platform agents only handle product-specific information, but no customer requirements.

During auctions, the platform agents communicate with the product constraints' agent in order to check consistency between the module agents. Furthermore, they do not have to strive for their survival because their accounts are assumed to be infinite.

Auction Agent

The auction mechanism that suits our case has to satisfy the following characteristics:

- The formation of product variants should take place progressively, so that the platform agents can check compatibility between the module agents after each bid.
- Since the successful product variants should be displayed to the customer at once, it is necessary that all running auctions terminate at the same time.
- The auction should enable module agents to track product variants while forming. In this way, the module agents can evaluate their chances of success.
- The auction mechanism should drive the module agents to bid as early as possible. In effect, if a module agent bids early, say at the point in time when the auction starts, it avoids eventual restrictions, which could be imposed by other module agents.

Blecker et al. (2004b) demonstrate that the Dutch auction is the only mechanism that satisfies the proposed requirements. The corresponding agent is called "Dutch auction agent" and determines the functions on which basis platform agents initiate the bidding process. Two main parameters should be ascertained in order to completely define the auction: the opening price and the rate at which price decreases in time. It is noteworthy that the auction opening price is determined on the basis of the module agents' starting accounts, whereas the importance of the product functions depends on the fulfilment level of customer requirements.

Module Agents' Behavior

Because of the complexity of module agents, it is relevant to discuss their main properties. The bidding strategy of a module agent depends on its account and bidding behavior of other agents. The account is private information of the module agent as is usual in real-world auctions. A module agent has the capability of tracking its environment and pursues two types of strategies: a long-term and short-term strategy. The long-term strategy is the plan set by the module agent in order to ensure lengthy existence. To define the long-term strategy, two main inputs are required, namely *Acc (t=0)*, which is the starting account, and T_{∞}, the period of time the agent strives to survive. *Acc(t=0)* determines the period of time T_{∞} that the agent would survive even when it participates in no auctions. T_{∞} can be achieved if the module gains a sum of money called *Profits* during its lifecycle. Subsequently, the term $\frac{Profits}{T_{\infty}}$ indicates the amount of money that should be gained per unit of time in order to achieve T_{∞}. The higher $\frac{Profits}{T_{\infty}}$ is, the more aggressive is the agent. The aggressiveness level (Benameur, Chaib-draa, & Kropf, 2002) of a module agent characterizes its intention to bid early. It depends on the level of its account and the sum of money still to be gained in order to achieve T_{∞}.

The connection between the long- and short-term strategies of a module agent is achieved through the budget concept. It represents the sum of money allocated to the running auctions. An agent schedules its budgets in such a way that it can reach T_{∞}. Suppose that an agent recognizes *n* auctions to be good opportunities for achieving gains. It assigns accordingly a specific budget for these auctions. At the beginning of auctions, the module agent sets a plan and ranks the bidding times in an ascending way. After the auctions start, the module agent may lose, for example, the first bid it has planned. Therefore, it can reallocate the available budget differently, thus increasing its chances of winning the remaining auctions.

Description of the Market Mechanism

The process by which the market mechanism works can be described by four main steps:

1. The advisory component, target costing agent, and Dutch auction agent prepare relevant information for auctions. The number of module agents proposed by the target costing agent depends on the sharpness of information gained from customers. If this information is accurate (e.g., customer is a product expert and exactly knows what module variations are required for its customized product), then the target costing agent suggests a few modules. However, if the gained information is fuzzy, it is expected that the number of module variations is higher.
2. Then, the auction market mechanism determines consistent and complete product variants that would fulfill customers' requirements.
3. These product variants are submitted to the validation agent which…

4. selects the best variants to be displayed to customers.

Benefits of the Multi-Agent System for Variety Steering

The module agent's account level is the most relevant information used for variety steering. It documents the past successes and failures of the module agent, and provides interesting clues concerning its suitability to fulfill customer requirements. Variety steering depends on two parameters: *Acc (t=0)* and T_∞, which must be carefully ascertained. *Acc(t=0)* determines the time period that a module variant is allowed to exist in the supplier's offer even when it is not built into any product variant over time. On the other hand, T_∞ defines the longest period that the module variant can spend in the supplier's offer. It is determined by taking into account future technological innovations and changes in customers' preferences. Recall that the proposed information system suggests the elimination of the module variants whose accounts are equal or inferior to zero.

From a business administration point of view, this concept is a novelty. In the technical literature, it is frequently proposed to eliminate the product variants, which are not purchased by customers (e.g., Wildemann, 2000). However, this method is disadvantageous because the single truth after eliminating a product variant is that it no longer exists in the assortment and its turnover is dropped out. The introduction of the market mechanism enables one to avoid these shortcomings since variety steering is based on a market mechanism that only retains variants with high potential to fulfill customer requirements.

FUTURE TRENDS

There are two important trends that should be pointed out. The first trend is that the acceptance of the Internet as a transaction medium will continue to increase. The second trend concerns the increasing heterogeneity of customer requirements with respect to the buying experience and physical product. Subsequently, Web-based customization will become more and more important in order to survive in the competitive environment. Multi-agent technology provides a good support for industrial enterprises in order to cope with the problems encountered on the shop floor and during customer interaction. Furthermore, concepts such as "virtual reality" will find increasing popularity for the improvement of the buying experience in the digital world.

CONCLUSION

In Web-based customization, two main challenges should adequately be addressed: external and internal complexities. External complexity is faced by customers during the interaction process, while internal complexity is experienced inside operations and manufacturing-related tasks. Both problems should respectively be solved within variety formation and variety steering. An information system based on agent technology is proposed in order to mitigate both types of challenges. Due to the complexity of the problem, the developed system is also complex. Implementation difficulties concern the ascertainment of the parameters' initial values, which are necessary to make the system work. These difficulties are mitigated by simulating the market mechanism for the specific Web-based customization case.

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KEY TERMS

Agent: An intelligent computer system that is capable of acting autonomously and proactively in some environment in order to achieve specific design objectives.

Configuration System: A software system in which the product components and the constraints existing between them are stored. A configuration system allows consistent and completely structured product variants that can be produced by the manufacturing system.

Customer Confusion: Refers to the difficulties and uncertainties encountered by customers when they have to make an optimal choice out a product assortment with large product variety.

Dutch Auction: A descending-bid auction, in which the price of an item is lowered until it gets the first bid, which is the highest price the customer is willing to pay.

Interaction Process: The process customers go through in order to find or configure the product variations that meet their requirements via the online channel.

Multi-Agent Systems: A population of autonomous intelligent agents, which coordinate their knowledge, goals, skills, and plans jointly to take action or solve problems.

Product Modularity: An attribute of the product that characterizes the ability to mix and match independent and interchangeable product building blocks with standardized interfaces in order to create product variants.

Web-Based Customization: An e-commerce business model that provides customers with the possibility to individualize their products via the electronic channel.

Multi-Channel Retailing in B2C E-Commerce

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INTRODUCTION

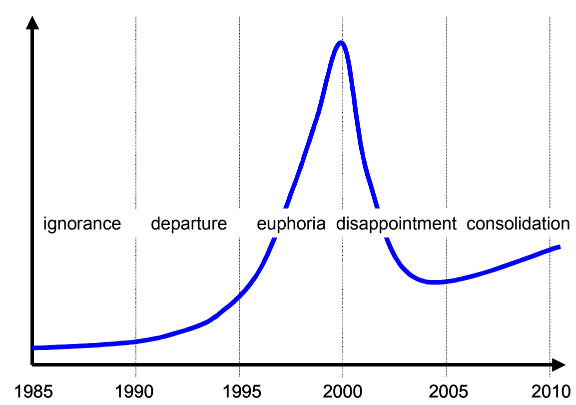
The Internet is not only a significant communication medium, it is also largely used as a channel of distribution. In the very beginning of the e-commerce era, most researchers and practitioners forecasted a sharp increase in Internet-based commercial applications, leading to a threat of existing business models. Already in 1980, Rosenberg and Hirschmann argued that in-home shopping could threaten store-based retailing, as consumers would tend to choose among a larger amount of competing retail formats. Early investigations by Moschis, Goldstucker, and Stanley (1985) revealed crucial conditions that can influence success of online marketing instruments. The conceptual work by Alba et al. (1997) provides basic implications of electronic shopping for consumers as well as for the supply chain and helps understanding key issues in Internet-based shopping. In contrast to the mainly positive discussions on the emerging e-commerce, George (1987) found significant obstacles to non-store retail formats and stated an uncertain future for Internet-based business.

The actual development of online shopping supported George's (1987) assumptions. In the late 1990s, the number of online shops as well as venture capital for them increased sharply. A few years later, many online shops broke down, mainly due to ignorance of business administration fundamentals. One of the most well-known examples is the U.S.-based online grocery retailer Webvan, which wanted to build a nationwide network of food distribution centers in order to replace supermarket shopping. Webvan's collapse was mainly caused by its misalignment between marketing and operations strategies (Delaney-Klinger, Boyer, & Frohlich, 2003). The large number of similar bankruptcies led to skepticism on e-commerce in general and a broad refusal of any e-commerce-related business activities. But with increasing particularity of e-commerce research and practice, this business area is supposed to recover and show growth again, although to a smaller extent than during the "hype." This development is depicted in Figure 1.

One important business area of e-commerce is the business-to-consumer (B2C) sector—that is, using the Internet as a channel of distribution towards consumers. Firms that run B2C online shops are regarded as retailers. In the e-commerce world, one type of retailer proved to be most successful: retailers that use the Internet as an additional channel of distribution, supplementing their network of physical stores. These so-called multi-channel retailers account for a large portion of e-commerce sales. In the U.S., they achieved 72% of online sales in 2002. They also show a higher profitability compared to retailers that operate solely on the Internet (dot-coms). Eighty percent of retailers that operate online shops and stores were profitable in 2002. In contrast, only 50% of the dot-coms were profitable (Haeberle, 2003).

This raises the question of which mechanisms enable a multi-channel retailer to achieve benefits that are not applicable to dot-coms. In order to understand the fundamentals of multi-channel retailing, a discussion on electronic retailing as a retail format and the main characteristics of multi-channel and dot-com retailing is provided. Starting from these considerations, this article presents benefits that arise from a multi-channel strategy and provides an overview for practitioners who want to assess their own as well as their competitors' opportunities and risks in electronic retailing. The conceptual findings are illustrated by examples of successful multi-channel retailers in practice. Finally, a short outlook on future developments is provided.

Figure 1. Expectations on e-commerce business models (Hansen & Neumann, 2005)



BACKGROUND

Any retailer acts as an intermediary and fulfills a number of different functions that are beneficial to consumers as well as to manufacturers. Their main contribution for consumers is bundling assortments of different suppliers and offering them in an appealing way to consumers. In practice, there exists a number of different, industry-specific retail formats (Levy & Weitz, 1992; Berman & Evans, 2001; Gilbert, 1999). On an aggregate level, retailers can be differentiated between store-based, mobile, and remote retail types, with a wide range of retail formats within these types. They show various assortment structures, price levels, and store- (or Web site) related particularities. Store-based and non-store-based retailers differ most from each other (Burton, 2000).

Internet-based retailing is referred to as electronic retailing or e-tailing (Yao & Liu, 2005; Lee, Katerattanakul, & Hong, 2005; Wilde, Kelly, & Scott, 2004; Carter & Sheehan, 2003) and is regarded as the part of B2C e-commerce dedicated to selling and buying goods (Madlberger, 2004). E-tailing fulfills the same functions as classical retailing, although performance and requirements of certain functions differ from store-based retailing (e.g., distribution, product presentation).

E-tailing can be operated as the sole channel of distribution. Such retailers are referred to as dot-coms (Razi & Tarn, 2004; Xing, Tang, & Yang, 2004) or, as expressed chiefly among practitioners, pure players (Janoff, 2001). If a retailer operates one or several other channels of distribution besides the e-tailing activity, it is denoted as a multi-channel retailer (Reynolds, 2002; Berman & Thelen, 2004; Webb, 2002; Schoenbachler & Gordon, 2002; Balabanis & Reynolds, 2001; Madlberger, 2004). A synonym is "bricks and clicks". In the following, synergies of multi-channel retailing are discussed.

SYNERGIES OF MULTI-CHANNEL RETAILING

Multi-channel retailing exists for several reasons. According to Moriarty and Moran (1990), retailers often run multiple channels because they add channels incrementally in order to expand their businesses. Academic literature has extensively investigated business models of multi-channel retailing (Webb, 2002; Schoenbachler & Gordon, 2002; Balabanis & Reynolds, 2001) and analyzed the chances and risks of this strategy. One key issue in multi-channel research is customer's channel choice. Early research in this field focused on channel choice between direct and retail store-based channels (Balasubramanian, 1998; Alba et al., 1997). With increasing relevance of e-commerce and Web-based distribution channels, more intensive research was performed on channel choice and attitudes toward a multi-channel retailer's Web site.

Empirical research has shown that consumers do not automatically switch from one channel to another. In fact, in many cases they would rather stick to existing stores and reject online presences, or use the Internet only as a source of information, but not for purchasing (Kaufman-Scarborough & Lindquist, 2002). A well-integrated multi-channel retail strategy is characterized by cross-channel promotions, consistent product assortments, an information system that supports both channels, and a high degree of channel integration in logistics (Berman & Thelen, 2004). Multiple channels are also an appropriate means of enhancing customer loyalty (Wallace, Giese, & Johnson, 2004). Attitude toward the existing distribution channels and time spent browsing the Web site are the most important influencing factors on attitude toward a multi-channel retailer's online shop (Balabanis & Reynolds, 2001). Multiple channels are associated with higher sales performance but lower channel profitability (Coelho, Easingwood, & Coelho, 2002). Conceptual work on antecedents of channel choice suggested to include perceived risk, past direct marketing experiences, motivation to buy from a channel, the product category, and Web site design into a causal model (Schoenbachler & Gordon, 2002).

Due to the recent emergence of e-commerce, there is one fundamental difference between multi-channel retailers and dot-coms. As dot-coms are directly resulting from the commercial use of the Internet, they are by nature recently established firms with little experience. In contrast, multi-channel retailers have gained knowledge on markets, products, and customers over time, which leads to a competitive advantage vis-à-vis the dot-coms.

In addition, there are several areas in which a multi-channel retailer can obtain synergies (Friedman & Furey, 1999). According to Steinfield, Bouwman, and Adelaar (2002), a multi-channel retailer can obtain four types of synergies: lower costs, differentiation through value-added services, improved trust, and product market extension.

Costs can be decreased in the areas of labor, inventory, and delivery costs (Steinfield et al., 2002), but also in marketing and advertising (Krishnamurthy, 2003). A multi-channel retailer has already established a store brand that is well known by the consumers. Labor costs can be reduced for routine and administrative processes like looking up product information, filling out forms, or online technical assistance. In distribution, a physical outlet can be used as a pick-up point for online orders and contribute to cost savings. Compared with dot-coms, the existing inventory infrastructure and vehicle fleet of a

Table 1. Summary of synergies in multi-channel retailing

Synergy potentials	Characteristics
Costs	Decrease of - labor, - inventory, - delivery, - marketing, - and advertising/branding costs
Differentiation through value-added services	- Complementary product information - Cross-channel promotional activities
Trust	- Confidence and experience by existing channel - Opportunity for customers to return products or give feedback
Market extension	- Entering new markets - Addressing new customer target groups - Offering new or larger assortments
Flexibility	- Financial complementarity of distribution channels (subsidization) - Use of customer-related information

store-based or mail-order retailer can be used for the e-tailing activities as well, and their costs can be spread over more distribution channels (Webb, 2002).

Differentiation through value-added services can be achieved by offering additional and complementary information in the different transaction phases (Otto & Chlung, 2000). Examples are product ratings in the pre-purchase phase, account information, or buying histories after purchase. A recent initiative of this kind has been launched by Sears that provides a virtual decoration feature for home furnishing at its online shop (Anonymous, 2005). Also cross-channel promotional activities can contribute to differentiation. A successful example was a campaign launched by the large Austrian retailer Spar. Consumers could participate in an online lottery. They received online coupons, printed them out, and redeemed them in the stores in order to get price reductions on selected products (Madlberger, 2004).

Trust can be improved through customers' confidence in the existing distribution channel that leverages their trust in the online shop (Balabanis & Reynolds, 2001). The presence of physical stores gives consumers an opportunity to return goods or register complaints (Steinfield et al., 2002). Also the retailer's brand is a source of confidence, as consumers are already familiar with it.

Geographic and product market extension denotes the opportunity for a multi-channel retailer to enter new markets and address new target groups. Especially when a retailer decides to position its online channel differently from the store-based channel, it does not only attract new consumer groups, but also relies on existing back-end infrastructure. This approach, however, is related to largely increased marketing costs and annuls the above-mentioned synergy of improved trust. The extension can also entail advantages for the assortment size. A retailer that has limited inventory space in the stores can extend its product range to slower moving items without need to increase store size. This leads to a benefit for the customer in the form of a larger product variety.

Beyond these synergies, there is also a strategic and financial perspective. A multi-channel retailer spreads its risks and can cross-subsidize less successful distribution channels by means of more successful ones. This allows a multi-channel retailer to be much more flexible than a dot-com that relies on one single distribution channel. As the Internet can provide a retailer with a large amount of customer-related information, multi-channel retailers can also use their additional knowledge about their customers for their store-based distribution channel (Otto & Chlung, 2000).

The higher the degree of channel integration, however, the higher is the risk of channel conflicts and cannibalization (Steinfield et al., 2002). This risk cannot be avoided reasonably by operating parallel channels without any interrelation, but only by careful customer segmentation and channel differentiation.

Table 1 summarizes the synergies and their main characteristics as described above.

Successful Multi-Channel Retailing in Practice

The most famous example of a successful multi-channel retailer is the British supermarket chain Tesco that claims to be the largest online grocer worldwide. Due to the comprehensive loyalty program that is strongly supported by the online shop, Tesco has a reputation for innovation concerning technology use and delivering customer value (Rowley, 2005). On the distribution side, Tesco uses its existing logistics infrastructure instead of building up new resources. Tesco communicates its delivery service as a value-adding process to the consumers thus allowing a charge for delivery fees (Delaney-Klinger et al., 2003). Off-line and online distribution channels are strongly integrated and complement one another (Madlberger, 2004).

Office Depot sells office products via 1,200 retail stores, catalog mailings, and several global online shops. It regards customer relationship as a key driver for e-tailing success. Cornerstones of its multi-channel strategy are loyalty programs and rewards, as well as a strong integration of all distribution channels. Office Depot's goal is to account for the consumer's wish to change between the channels without noticing any differences (Quinton, 2005).

The U.S.-based retailer Sears is another interesting case, as it acquired the online apparel retailer Lands' End and used its experience in e-tailing. This step allowed Sears to extend the online assortment and supplement its appliances and hardware assortment with a large number of apparel brands. Sears used Lands' End's technology for individualized product offerings and improved its online shop that way (Moin, 2004).

FUTURE TRENDS

In the e-tailing world, there seems to be a considerable separation of players in two directions. On the one hand, it will be the multi-channel retailers that dominate the scene and account for the mass business in the online retail sector. This trend will be fostered not only by the higher success rate among multi-channel retailers, but also by dot-coms that are establishing stores and therefore become multi-channel retailers coming "from the other side." Many of the above-mentioned synergies make multi-channel retailers more successful than their virtual competitors (Bertele, Balocco, Gandini, & Rangone, 2002), which is also reflected in market developments. A look at the top global retailers reveals that dot-coms still account for a very small proportion. Among the top 250 retailers of 2004, there are only two real dot-coms, namely Dell at the 65th rank and Amazon at the 116th rank. eBay lies beyond the 250 mark (Stores, 2005).

On the other hand, a consolidation process in e-tailing takes place. Among the large number of start-ups in the late 1990s, only a few dot-com e-tailers have survived. But they have become considerably stronger. Hence we can assume that the rules in the dot-com world are tougher and selection of players is stricter.

From a research perspective, we need deeper insights into consumers' perceptions of multi-channel retailing and relevant influencing factors like trust or experience with the retailer. Also, more knowledge on differences between product groups or industries is necessary.

CONCLUSION

The Internet has become a channel of distribution that allows a wide range of innovative business models and marketing opportunities. The obvious tendency that online retailers would threaten or even drive out traditional store-based retailers, however, did not become reality. Instead, multi-channel retailers are the players who dominate B2C e-commerce.

This article gives an overview of the fundamentals on online and off-line distribution channels and the characteristics of multi-channel retailing. The different synergies that are discussed can be used as a first orientation for practitioners who want to evaluate what opportunities can be achieved by running off-line and online distribution channels. The examples of success stories in multi-channel retailing strengthen these considerations and show that multi-channel retailing requires customer-orientation and a high degree of integration. As an e-tailer is mainly in competition with multi-channel retailers, it is vital to be familiar with the chances and risks that arise from multi-channel retailing.

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KEY TERMS

Distribution Channel: The sum of all organizations or parts of an organization that are involved in making a product or service available to a customer. Distribution channels can also apply media (e.g., the Internet or TV) in order to address customers. Also called channel of distribution.

Dot-Com: An electronic retailer that operates exclusively through this one distribution channel. By nature, dot-coms are non-store-based retailers. Also known as pure player.

Electronic Commerce (E-Commerce): The usage of electronic networks, especially the Internet, as a channel of distribution and a support of inter-organizational business processes. E-commerce can be differentiated into the business-to-business (B2B) and business-to-consumer (B2C) sector. It includes selling and buying goods and services, exchanging business data, and providing information.

E-Commerce Business Model: A structured description of an organization's activities in order to operate a business based on electronic commerce. It consists of three main parts: the architecture for the flow of products, services, and information; the generation of value; and the source of revenue.

Electronic Retailing (E-Tailing): The application of electronic networks, especially the Internet, as channel of distribution, in order to address final consumers. Like traditional retailing, e-tailing is restricted to buying and selling physical or digital goods, but no services.

Multi-Channel Retailing: Also called bricks and clicks. It is the simultaneous application of more than one channel of distribution in retailing. A multi-channel retailer operates at least one electronic and one non-electronic (physical stores, catalog, etc.) channel of distribution.

Retail Format: The sum of different retail marketing instruments—such as assortment size, price level, service policy, and access points to the customer—that describe a type of retail policy. In practice, a wide range of different retail formats exists that are in many cases industry specific.

Multilingual Web Sites in Global Electronic Commerce

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INTRODUCTION

The World Wide Web (the Web), a distributed hypermedia information system that provides global access to the Internet, has been most widely used for exchanging information, providing services, and doing business across national boundaries. It is difficult to find out exactly when the first multilingual Web site was up and running on the Internet, but as early as January 1, 1993, EuroNews, the first multilingual Web site in Europe, was launched to simultaneously cover world news from a European perspective in seven languages: English, French, German, Italian, Portuguese, Russian, and Spanish. (EuroNews, 2005). In North America, Web site multilinguality has become an important aspect of electronic commerce (e-commerce) as more and more Fortune 500 companies rely on the Internet and the Web to reach out to millions of customers and clients. Having a successful multilingual Web site goes beyond just translating the original Web content into different languages for different locales. Besides the language issue, there are other important issues involved in Web site multilinguality: culture, technology, content, design, accessibility, usability, and management (Bingi, Mir, & Khamalah, 2000; Dempsey, 1999; Hillier, 2003; Lindenberg, 2003; MacLeod, 2000). This article will briefly address the issues related to: (1) language that is one of the many elements conforming culture, (2) culture that greatly affects the functionality and communication of multilingual Web sites, and (3) technology that enables the multilingual support of e-commerce Web sites, focusing on the challenges and strategies of Web site multilinguality in global e-commerce.

BACKGROUND

When the Internet was originally created as APARNET in 1969, it was only a small computer network interlinking four universities in the southwestern United States. Nowadays, the Internet has become a primary communication medium, with 820 million computers and one billion users all over the world (Computer Industry Almanac, 2004, 2005). Throughout the years, both the Internet and the World Wide Web have evolved with the monolinguality of English into the multilinguality of more than 1,000 languages (Crystal, 2001). In 1998, the majority (70%) of the Web content was in English (Nadeau, Lointier, Morin, & Descôteaux, 1998), but it dropped to 56.4% in 2002 (Netz-tipp.de, 2005). Also in 1998, the newly created non-English Web sites outnumbered the newly created English Web sites (Crystal, 2001). Global Reach, a marketing communications consultancy that specializes in global electronic commerce, has been tracking the evolution of the English and non-English Internet populations since 1995. In 1996, 80% of the Internet population spoke English while the other 20% were non-English speakers. The English dominance was gone when the non-English Internet population (52%) surpassed the English Internet population (48%) in 2000. In 2004, the non-English Internet population reached 71% while the English Internet population dropped to 29% (Global Reach, 2004). Furthermore, current Internet usage is growing strongly in non-English-speaking countries such as China, Japan, Germany, India, South Korea, Italy, France, Brazil, and Russia (Computer Industry Almanac, 2004). As the number of non-English-speaking Internet users around the world increases, Web site multilinguality has become an important aspect of the Internet and the Web, and is becoming indispensable for companies that want to meet the needs of this increasing non-English Internet population via global e-commerce (Hillier, 2003; Lebert, 1999; Schneider, 2005; Westland & Clark, 2002).

E-commerce refers to the commercial activities that take place over a computer network, usually the Internet and the Web. These activities generally involve the buying or selling of marketing products, providing or obtaining services, seeking or acquiring information, and requesting or transmitting funds (Wikipedia, 2005). E-commerce can be between or among entities in the private sector, government institutions, and/or members of the public, hence the categories of business-to-business (B2B), business-to-customer (B2C), business-to-government (B2G), government-to-government (G2G), government-to-consumer (G2C), and customer-to-customer (C2C). E-commerce makes the best use of any of the Internet applications, such as Web sites, e-mail, instant messaging, online auctions, online forums, Web services, and Weblogs (Fiore, 2001; Reynolds, 2004; Schneider, 2005). Because of the international nature of the Internet and the Web, the companies that engage in e-commerce would ultimately use the Web sites to conduct their commercial and noncommercial activities in a global e-commerce environment (Schneider, 2005; Westland & Clark, 2002). Furthermore, for any company that is serious about winning the competitive edge in global e-commerce, the better way to success is to build and maintain a multilingual Web site (Ott, 1999; Payne, 2005).

WEB SITE MULTILINGUALITY: CHALLENGES AND STRATEGIES

A multilingual Web site provides the same information in different languages. There have been different approaches to develop and implement a multilingual Web site, and two have been historically adopted for many of the e-commerce Web sites. One is Web site globalization and the other is Web site localization. The former globalizes the content for broadening a businesses appeal to a general international audience, and the latter localizes the content to appeal to customers of a particular nation or culture (Chen, 2002; Dempsey, 1999; Seilheimer, 2004). A typical mature corporate Web site uses both approaches and thus contains a mixture of global content and local content. The global content need be presented in many languages for customers all over the world, and usually covers product information, technical support documents, tutorials, corporate profiles, worldwide branding messages, and the design of the Web itself. The local content has to be written for each target language audience, and usually includes locally available products, local promotions, sales and advertising campaigns, and local points of purchase indices. While the global content is applicable everywhere and is relatively insensitive to national or cultural differences, the local content provides the most relevant information to convince the users that the Web site fits in their culture (Schneider, 2005; Yunker, 2003).

A properly designed multilingual Web site targets information to a given audience and adequately meets their information needs. For example, having a Chinese Web site will make it easier to promote information relevant to a Chinese audience. It would also help to overcome potential cultural barriers when users are able to navigate, understand, and interact on the Web site in the native language. Also, a properly designed multilingual Web site is one of the most cost-effective ways of marketing the company, giving its brand an international outlook, building relationships with clients, and showcasing the company across the globe. By having the Web site accessible to non-English-speaking users looking for products or services, it would be easier to capture their attention and they would be more likely to become new customers. In addition, a properly designed multilingual Web site has potential for an increase in sales. If an e-commerce Web site is translated into a few of the major world languages, such as Spanish, French, German, and Italian, there is potentially a 400% increase in sales (Payne, 2005).

One of the most visible challenges of Web site multilinguality includes overcoming the barriers of language, culture, and technology in global e-commerce, which have been observed and studied since the early days of the Web (Ott, 1999; Schneider, 2005; Vehovar, Batagelj, & Lozar, 1999). The language barriers not only refer to the historical dominance of the English language, but also refer to the present multilinguality of the Internet and the Web. Since 2000, there have been more non-English-speaking users than English-speaking users on the Internet (Global Reach, 2004). The culture barriers mean that cultural differences may cause misinterpretation in communication. Something that is appropriate and acceptable in one culture may not be appropriate and acceptable in another culture. The technology barrier mainly refers to the problems with character sets—there is no ASCII analogue for the non-Latin characters used by the Chinese, Japanese, Arabic, Hebrew, and other languages. Furthermore, on a multilingual Web site, the use of symbols, icons, images, colors, values, rituals, idioms, metaphors, and salutations needs be appropriately chosen according to cultural contexts, thus avoiding being misunderstood or offensive (Chen, 2002; Hillier, 2003; Singh & Matsuo, 2004; Schneider, 2005; Sun, 2001). When designing a multilingual Web site, the content and structure of the Web site should make sense for the eyes of people in that culture. If only the language was translated, the users in different cultures would experience difficulties of using and understanding the Web sites (Hillier, 2003).

Another major challenge of Web site multilinguality is related to the minority of non-English-speaking countries (Vehovar et al., 1999). Non-English-speaking countries face several language-related problems. In general, it is unrealistic to globally promote a company's Web site in a non-English language. If a non-English-speaking country were technologically undeveloped with a small number of Internet users, it would be very difficult to establish an audience large enough to justify the investment needed for elaborated applications on the Web. Such small non-English-speaking audiences can hardly enable the development of Web applications such as bookstores, travel agencies, search engines, portals, and news agencies in their own language (Ott, 1999).

Another major challenge of Web site multilinguality is the extremely high cost of designing and maintaining a multilingual Web site (P923-PF, 2000). Multinational companies such as IBM and Microsoft may find it a must to invest millions of dollars in developing multilingual Web sites to compete in international business. But, many small and mid-sized companies (SMEs) may find it very difficult to justify the high cost of multilingual Web sites because it would be very hard to generate enough online revenues from the Web-based applications to make a profit or keep balance. While the Web sites of large companies, usually Fortune 500 companies, can be in dozens of languages, these of the SMEs may be limited to much fewer languages due to the budget constraint. But, any company, whether large or mid-sized or small, cannot afford not to have a multilingual Web presence on the Internet if it wants to succeed in global electronic commerce (Vehovar et al., 1999; Schneider, 2005).

The other major challenge of Web site multilinguality is dealing with the common mistakes in the design of global e-commerce Web sites. In his book entitled, *Engineering Global E-Commerce Sites,* James Bean discussed in detail how to avoid some frequent mistakes in global e-commerce Web site design. Firstly, do not assume (1) a market is North American only, (2) an audience is exclusively English speaking, and (3) "globalization" simply means support for multiple languages. Secondly, do not ignore geography and time zones. Thirdly, do not neglect the importance of information and transaction data. Finally, do not transact business exclusively in U.S. dollars, and finally, be aware of regulatory acts (Bean, 2003).

As the combination of globalization and localization, "glocalization" is "a term that was invented in order to emphasize that the globalization of a product is more likely to succeed when the product or service is adapted specifically to each locality or culture it is marketed in" (Whatis.com, 2005). There are many examples of glocalization. For example, McDonalds' in China has changed the menu to serve rice to local Chinese customers, and McDonalds' in France has replaced the familiar Ronald McDonald mascot with Asterix the Gaul, a popular French cartoon character. When applied to global e-commerce, Web sites glocalization means thinking global and acting local. In a study on the Chinese Web sites of the 100 top global brands, Maynard and Tian (2004) found that a "glocal" strategy, as opposed to a standardized global strategy, was being practiced in cyberspace by many of the companies with top brands. These companies glocalized their Chinese Web pages by integrating local cultural characteristics into their brands' strategies, thus presenting themselves as being socially accommodating to the local market.

One of the emerging technologies associated with the creation and rendering of non-Latin alphabets is Unicode, which has been recognized and widely adopted as an international standard. As the alternative to ASCII coding scheme, Unicode allows more than 65,000 non-Latin characters and makes storing, displaying, and accessing non-Latin characters on the Web much easier. It enables a single software product or a single Web site to be targeted across multiple platforms, languages, and countries without re-engineering (Ott, 1999; Yunker, 2003).

JavaServer Pages (JSP) technology has been used to solve problems in the development of multilingual Web applications, for example, language, locale determination, and localization; character encoding; JSP source files encoding; number formatting and parsing; date and time formatting and parsing; and message formatting (Lindenberg, 2003).

Human language technology (HLT) enables multilingual support of global e-commerce Web sites that goes beyond Web site localization or text translation, improving Web site usability in terms of natural languages. Such a support implements cross-language information retrieval technologies that are able to handle searches made in the user's local language across knowledge bases coded in any number of other languages. The language technologies on HLT-enabled Web sites include applications of multilingual user interfaces and services, multilingual content management, multilingual trading, and multilingual customer relationship management, hence making multilingual Web sites more competitive in a global marketplace.

Machine translation systems connected by the Internet may allow cross-language communication with anyone, from anywhere, and at anytime. The Web-based translation makes it possible to instantly interpret regional dialects and idiomatic expressions in various languages. With the machine translation systems, the products and services can be obtained or provided in a local language, thus helping international businesses and markets to grow, and allowing local cultures and languages to thrive (Lehman-Wilzig, 2001).

In addition, there are various companies and organizations that specialize in providing software and service for multilingual Web site development and maintenance. The following are some of the more popular ones.

- **Lionbridge (http://www.lionbridge.com/):** A leading provider of globalization, testing, and development services. Enables Global 1000 organizations to develop, release, manage, and maintain technology applications and enterprise content worldwide.
- **TRADOS (http://www.trados.com):** Provides the world's leading localization and computer-assisted translation software to improve the consistency and quality of the clients' multilingual content.

Supports more than 72 languages, including English, all European languages, Arabic, Russian, Japanese, Chinese, Korean, and Hebrew.

- **GlobalSight (http://www.globalsight.com):** Enables companies to improve global business, manage multilingual information, and deliver time-critical content worldwide. Its flagship product, Ambassador, is the leading multilingual content management software solution and the only technology that allows for the development and reuse of all types of content throughout a global enterprise.
- **LISA (http://www.lisa.org/):** LISA (Localization Industry Standards Association) is the premier nonprofit organization for the GILT (Globalization, Internationalization, Localization, and Translation) business community. Membership includes 400 leading IT manufacturers and services providers. It has created the LISA's best practice guidelines and language-technology standards for enterprise globalization.
- **MultiLingual Computing (www.multilingual.com):** The information source for the localization, internationalization, translation, and language technology industry. The printed magazine *MultiLingual Computing & Technology* is the flagship product, and the Web site covers topics ranging from technical internationalization to project management to language histories.

FUTURE TRENDS

Every year in the next 10 years or longer, there will be more than 100 million non-English-speaking people going onto the Internet and the Web (Mosquera, 2001). To meet the needs of such a growing online population, the future of global e-commerce is dependent on the development and maintenance of quality multilingual Web sites, which is not easy at all. But, as pointed out by Crystal (2001)—"The future looks good for Web multilingualism"—there would be a great demand for multilingual Web sites. The triangular relationship among language, technology, and culture would continue to create new challenges for global e-commerce. Therefore, Web site multilinguality would remain as an important aspect of the Internet and the Web.

There are two immediate future research directions that are within the domain of Web site multilinguality. One future research opportunity is to include all of the other issues of Web site multilinguality in a further study of the challenges and strategies in developing and maintaining multilingual e-commerce Web sites. The other future research opportunity is to study the impact of glocalization on non-English e-commerce Web sites, such as the e-commerce Web sites in traditional and simplified Chinese, focusing on the correlation of global content and local content of the Web sites.

CONCLUSION

It has been shown in this article that Web site multilinguality plays a very important role in global e-commerce. As more and more non-English e-commerce Web sites are mushrooming on the Web, the issues of Web site multilinguality should be seriously taken into consideration, because they are closely related to language, culture, technology, content, design, accessibility, usability, and management. In this article, some important aspects of Web site multilinguality have been addressed with respect to: (1) language, which is one of the many elements conforming culture; and (2) technology, which is a useful and helpful tool enabling multilingual support of global e-commerce Web sites. The challenges and strategies involved in developing and maintaining successful multilingual e-commerce Web sites have been discussed in detail with examples, and the future trends have been provided, with future research opportunities for global e-commerce.

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KEY TERMS

Global Electronic Commerce: Commercial activities that take place over a computer network, usually the Internet and the Web, across national borders.

Globalization: International exchange or sharing of labor force, production, ideas, knowledge, cultures, products, and services across national borders.

Glocalization: Creation of products or services intended for the global market, but customized to suit the local culture.

Human Language Technology: Branch of information science that deals with natural language information.

Localization: Process to create a product that looks as though it was created in the target country or market.

Multilingual Content Management: Processes of organizing, categorizing, and structuring information resources for multilingual storage, publishing, and reuse.

Web Site Multilinguality: Presence of Web sites in more than two languages on the Internet.

Web Site Translation: Process of transforming content of a Web site from one language into another language.

Multimedia Proxy Servers

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INTRODUCTION

On the Internet, multimedia objects are stored in content servers. The clients behind some proxy servers are located over a wide area network (WAN) far from the content servers (Figure 1). When a client accesses multimedia objects from a content server, the content server must either allocate sufficient disk and network resources to multicast or unicast the objects to the client (Ma & Shin, 2002). Otherwise, it rejects the client. Thus, the popular content server becomes the bottleneck in delivering multimedia objects.

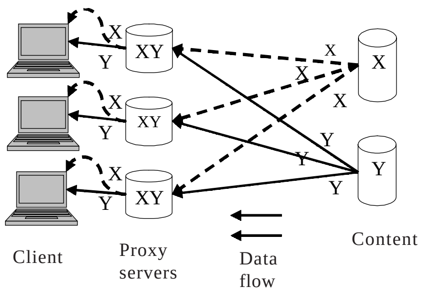
Proxy servers have the disk cache space, network bandwidth, and availability to cache parts of the multimedia objects for clients, making them good candidates to solve the bottleneck problem. However, large multimedia objects are not cached or only partially cached in current proxy servers. When fast optical networks are widely deployed, this problem is becoming more severe. Therefore, proxy caches must be enhanced to alleviate the bottleneck in popular content servers with multimedia objects.

Multimedia proxy servers perform several functions in accessing multimedia objects over the Internet. We first present the background in the next section. Next, the *cache replacement* policies being used in proxy servers are described. Then, the *object partitioning* methods are described. After that, the *transcoding* method that converts high-resolution objects into low-resolution objects is described. Afterward, we present the *cooperative caching* method that can be applied to cache objects on proxy servers. Lastly, we describe a method to distribute proxy-server load using a depot.

BACKGROUND

One of the main research issues in multimedia object delivery is the provision of *quality-of-service (QoS)* streaming. A multimedia stream is a group of periodic requests that are separated from each other at a fixed time interval. In order to support QoS streaming, the network bandwidth from the content server to each client needs to be able to support the variable data rate of the object stream. Otherwise, some blocks will be missed and jitters will occur. If many blocks are missed, the multimedia stream may even be discontinued.

Figure 1. Delivery of multimedia contents over the Internet using proxy servers

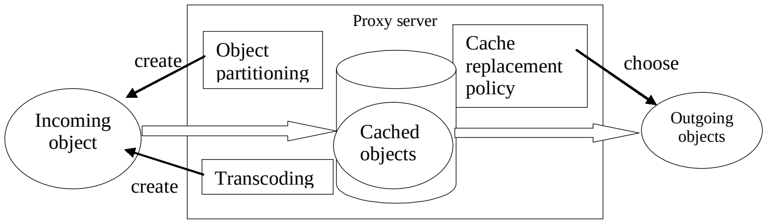


There was much research on enhancing individual proxy servers for multimedia streaming (Chang & Hock, 2000; Ham, Jung, Yang, Lee, & Chung, 1999; Nam & Lee, 1997; Xiang, Zhang, Zhu, & Zhong, 2001). The use of proxy servers, as virtual servers between the servers and the clients, was proposed to manage server-client connections, data delivery, and transcoding (Acharya, Korth, & Poosala, 1999; Chandra, Ellis, & Vahdat, 1999; Nam & Lee). The proxy server is becoming the centre of management to handle server bandwidth limitation and client bandwidth adaptation.

When a proxy server is placed between the content server and its clients, it may store some of the delivered objects in its local cache storage for repeated retrievals. When the cache storage is fully used, it deletes some cached objects to release space for new objects. The cache replacement policy will choose which object should be deleted. The cache content and the cache performance thus depend on the *cost function* of the cache replacement policy (Figure 2). In the literature, many cost functions have been proposed and studied for multimedia objects in a single proxy-cache environment (Acharya et al., 1999; Aggarwal, 1997; Bahn, Koh, Noh, & Min, 2002; Hosseini-Khayat, 1998; Paknikar, Kankanhalli, Ramakrishnan, Srinivasan, & Ngoh, 2000; Sohoni, Min, Xu, & Hu, 2001; Su et al., 2000; Wu, Yu, & Wolf, 2001; Xiang et al., 2001).

When a proxy server caches a large multimedia object, the cache space may not be able to store many objects.

Figure 2. Relationship among different functions in a single multimedia proxy server



Instead of storing the entire object, the proxy server may store only a part of it. The cached part can thus be directly retrieved from the local storage and only the missing part is accessed from the content server. The position and size of the cached part affect the network bandwidth requirement and the response time of new streams. In the literature, three object partitioning methods, namely, leader, *staging*, and hot spot, have been proposed for individual proxy servers (Fahmi, Latif, Sedigh-Ali, Ghafoor, Liu, & Hsu, 2001; State & Festor, 2001; Zhang, Wang, Du, & Su, 2000).

When multiple proxy servers are present in a regional network, they may exchange their cache contents to serve client requests more efficiently. The only found research works on the cooperative caching of multimedia objects are on the leader method (Park, Park, & Son, 2001) and the *multiple hot-spot* method (Tse, Leung, So, & Lau, 2003).

CACHE REPLACEMENT POLICIES

The main contribution or responsibility of proxy servers to the clients is their cache content. The cache content depends on the cost function in the cache replacement policy that determines the cache performance. Hence, the cache replacement policy must be optimized to achieve the lowest capacity miss rates on the cache.

Traditional cache replacement policies considered recency and frequency in the cost function of the cached objects to replace the oldest object in the cache. Xiang et al. (2001) added delays into the cost function. Acharya et al. (1999) added resolution size. Paknikar et al. (2000) added the object size and layer number. Aggarwal (1997) and Wu et al. (2001) increased the segment length when the position of a segment is far from the beginning of a video. This is advantageous when many users stop playing the media after only some initial blocks. Using these cost functions, either the cache hit rate or byte hit rate is optimized for each individual proxy server. In general, Bahn et al. (2002) described the cost function as

$$\text{Cache Value} = \frac{\left(d_i^{r1} * n_i^{r2}\right)}{\left(t_i^{r3} * s_i^{r4}\right)},$$

where d_i is the latency to fetch an object i, n_i is the number of references made to i since it has been brought into the cache, t_i is the last reference time, s_i is the size of object i, and $r1$, $r2$, $r3$, and $r4$ are constants with default values $r1 = 0.1$ and $r2 = r3 = r4 = 1$.

Web *prefetching* obtains the Web data that a client is expected to need on the basis of data about that client's past surfing activity. It reduces access latency by actively preloading data for clients. Bianchi and Mancuso (2003) minimize the connection outage probability by controlling the buffer size among connections. The prediction by the partial match model (PMM) makes prefetching decisions by reviewing the universal resource locators (URLs) that similar clients have visited (Chen & Zhang, 2003). The model forms a Markov predictor tree structure of these URLs. The standard PMM builds a tree for every visited URL. A fixed threshold is used to limit the length of each prediction branch. In order to achieve accurate prediction on future requests, the tree being built is very large and consumes too much space.

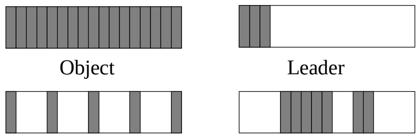
The longest repeating-sequence (LRS) PMM reduces the size of the prediction tree by storing only long branches with frequently accessed URL predictors. The tree size is reduced at the expense of lowered prediction accuracy.

The popularity-based (PB) PMM ranks a URL's relative popularity (RP) into four grades:

- Grade 3: 10% < RP <= 100%
- Grade 2: 1% < RP <= 10%
- Grade 1: 0.1% < RP <= 1%
- Grade 0: RP <= 0.1%

It assigns long branches to popular URLs and shorter branches to less popular URLs (Chen & Zhang, 2003). Thus, only frequently accessed paths are kept to reduce the storage requirement of the predictor tree.

Figure 3. Object partitioning methods



Web prefetching involves an overhead of extra traffic due to two reasons. First, the prediction of Web accesses is inaccurate. Second, the dynamic content may become stale and outdated after prefetching. Caching and Web prefetching at the proxy server reduce the number and latency of accesses for static contents at the Web server. Further investigations will be needed to improve prediction accuracy and cache performance on dynamic Web content.

OBJECT PARTITIONING

If the local proxy server caches only a part of a large multimedia object, the cached part can be directly retrieved from the local proxy and only the missing part will be accessed from the content server. The position and size of the cached part affects the response time of new streams and the minimum network bandwidth needed to deliver the object. In the literature, three object partitioning methods, namely, leader, staging, and hot spot, have been proposed (Figure 3) and studied for individual proxy servers (Fahmi et al., 2001; State & Festor, 2001; Zhang et al., 2000).

Some research has been done on delivering QoS multimedia streaming by caching the leader (or front part) of the objects (S. Park et al., 2001, Y. W. Park, Baek, & Chung, 2000; State & Festor, 2001). In this leader method, each object is divided into a front part and a rear part. The front part is placed in the proxy cache that is nearest to the client, and the rear part is placed in other LAN (local area network) proxy servers. This method allows more front parts to be cached close to clients and reduces startup latency. The rear part in other LAN proxy caches can reduce network traffic for repeated accesses from the same LAN.

The hot spot of an object can provide a preview of the object. The size of a hot spot is only a fraction of the object size. It is useful to provide previews of many objects from local proxy caches. Hot-spot caching thus improves the storage retrieval efficiency and scalability of a single proxy server (Fahmi et al., 2001). The proxy server's physical proximity to clients reduces the response time to a random seek when a video is being previewed.

In video staging, the portion of a video above a certain bandwidth to the proxy server is cached in advance to reduce the necessary WAN bandwidth for usage (Zhang et al., 2000). Zhang et al. proposed heuristic algorithms to choose the videos to be staged according to the temperature of the video or the highest reduction in WAN bandwidth.

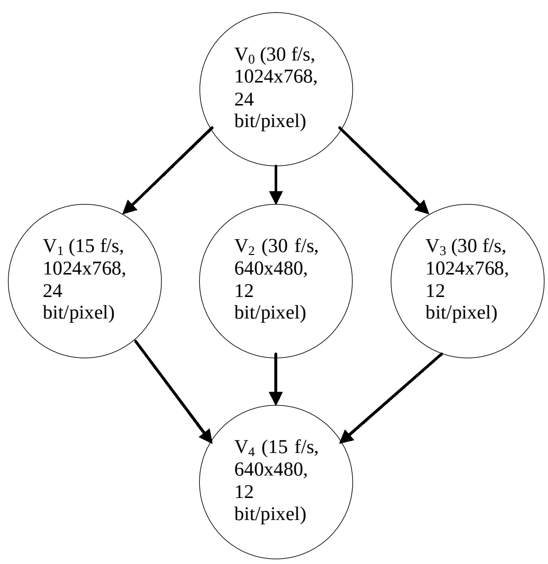
Each of the above object partitioning methods has its merits. The leader method reduces the start-up delay in viewing an object. The staging method minimizes the amount of WAN bandwidth. The hot-spot method provides a local preview prior to viewing the object.

Current object partitioning methods only cater the delivery of cached content to local clients. When multiple proxy servers are present within a region, it is helpful if each proxy server caches a different part of the object. The union of the cached contents in the regional proxy servers can thus form a bigger portion of the object. This can then reduce the size of the missing parts that must be accessed from the content server. Further investigations are thus needed to optimize the object partitioning method among cooperative proxy servers for the highest cache efficiency.

TRANSCODING FUNCTIONS

While proxy servers are continuously connected to the Internet at high bandwidth links, clients may be connected with a modem or a mobile device. The connection speed and storage capability of each client may be much lower than that of the proxy server. In this situation, the proxy server may reduce the resolution of the transmitted

Figure 4. Transcoding is an irreversible process to reduce the object resolution. An object is filtered in one or more of the resolutions.



objects so that the data rate will meet the capability of the client.

Transcoding is an irreversible process of adapting the spatial and temporal resolutions of objects (Figure 4) to that of the user specification, client limitations, and wireless-device characteristics (Cardellini, Yu, & Huang, 2000; Ham et al., 1999; Kassler, Neubeck, & Schulthess, 2000). Since a transcoded object cannot be converted into another object that is higher in any resolution, the transcoding process needs to be done carefully to avoid accessing the original object from the server again.

After transcoding, the proxy server should cache the transcoded objects only. Otherwise, repeated transcoding may erode the processing power of the proxy server. Since different clients at different network-link capacities may access from the same server, the proxy server may need to cache different transcoded objects for different clients.

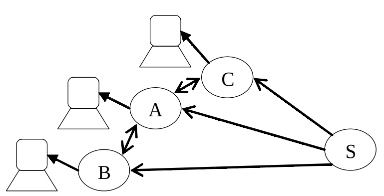
COOPERATIVE CACHING MECHANISMS

When multiple proxy servers have the capabilities to exchange their cached contents, they can cooperate to serve client requests (Figure 5). This cooperation mechanism may induce overhead that could erode its benefits. Thus, the cooperation mechanisms must be carefully designed to facilitate QoS retrievals from other proxy servers with minimal overhead.

The only found research works on the cooperative caching of multimedia objects include those on the leader method (S. Park et al., 2001) and the multiple hot-spot method (Tse et al., 2003). To be more comprehensive, we also consider research works on the cooperative caching of Web documents in this article. Three proxy cooperation mechanisms for Web documents, namely, the hierarchical, directory-based, and hash-based mechanisms, have been proposed and investigated (Cardellini et al., 2000; Dykes & Robbins, 2001; Law, Nandy, & Chapman, 1997; Lee, Amiri, Sahu, & Venkatramani, 2002; S. Park et al.; Y. W. Park et al., 2000; Wolman, Voelker, Sharma, Cardwell, Karlin, & Levy, 1999; Wu & Liao, 1997).

The hierarchical approach builds a proxy tree with one parent proxy server above a number of child proxy servers

Figure 5. Cooperative proxy servers B and C help content server S in delivering objects to proxy A



(Cardellini et al., 2000; S. Park et al., 2001; Y. W. Park et al., 2000). Each level of the parent proxy keeps some contents that are commonly accessed by the child proxies. A proxy server forwards its cache misses through its parents and finally to the content server. Large extra cache space is needed in the parent proxies to store the commonly accessed cache contents. When the proxy tree is deep, the miss penalty time (extra time in searching through the parent proxies) erodes the reduction in the miss rate.

The proxy servers in the directory-based approach exchange their directory contents with other cooperative proxy servers (Cardellini et al., 2000; S. Park et al., 2001; Y. W. Park et al., 2000). The proxy servers thus need extra space to store the directories of other proxy caches and extra bandwidth to exchange the directory contents.

In the hash-based approach, each document is assigned to one of the cooperative proxy servers (Lee et al., 2002; Wolman et al., 1999). If a document is fetched, it is either cached in the assigned proxy server or not cached at all. Thus, this approach minimizes the amount of cache space and the message overhead, but it involves many false-positive hits.

Cooperative proxy caching has been shown to be positive for Web document retrieval. The investigation on Web documents is, however, limited to the regional level. It is expected that cooperative proxy caching will become more appealing for streaming multimedia objects (Wolman et al., 1999).

An individual proxy cache may not be large enough to store several multimedia objects, but the aggregate size of multiple proxy servers can be large enough to store many popular objects. Thus, cooperative caching can be used to enhance the cache performance for multimedia objects (Tse et al., 2003).

The cooperative caching of multimedia objects will affect the local hit ratio and byte hit ratio of proxy caches. Each proxy server may decide the percentage of cache for its local clients and for the cooperative proxy servers. This percentage can be adjusted by tuning the cache replacement function.

DISTRIBUTED PROXY SERVERS

Another approach to use multiple proxy servers at a client is to add a depot between the client and the proxy servers. The depot distributes and balances the load by scheduling the Transport Control Protocol (TCP) sessions via proxy servers in a round-robin manner (Law et al., 1997). The performance of the depot proxy system falls in between two stand-alone proxy servers.

FUTURE TRENDS

Multimedia proxy servers may be enhanced in various ways. Some of the future research is described here. First, existing functions in proxy servers will be enhanced. In Web prefetching, prediction accuracy will be optimized to enhance cache performance. Object partitioning techniques will be optimized for the highest cache efficiency of cooperative proxy servers. Transcoded objects may be selectively cached among cooperative servers to improve the overall cache performance. Each cooperative proxy server may decide the percentage of cache size for its local clients and for other regional clients.

Second, new functions will be added to the proxy servers to handle multimedia objects more efficiently. The proxy servers may repair the missing data blocks in a transmission by caching some parity blocks. These parity blocks will be compared against the accessed blocks to recover the missing blocks. The methods to create these parity blocks will be investigated to repair the missing blocks efficiently. The placement of these parity blocks in cooperative proxy servers will also need to be investigated.

Third, the multimedia proxy servers will be placed in emerging networks, such as peer-to-peer networks, mobile ad hoc networks, and sensor networks. They may be placed in front of the servers to provide caching for content servers in order to share the workload of popular content servers. They may be placed among peers in peer-to-peer networks. The performance of multimedia proxy servers in these networks will be further investigated to provide their functions optimally in the new environments.

CONCLUSION

We have described the multimedia proxy server in this article. Multimedia proxy servers are virtual servers between clients and content servers to deliver multimedia objects on the Internet. They provide necessary functions to manage the QoS streaming of multimedia contents over the Internet.

Multimedia proxy servers store popular objects in local cache storage to reduce the access to content servers. When clients are connected with the proxy server using low-bandwidth links, the proxy server transcodes an object into lower resolutions to reduce the data rate of the object stream to the clients. Proxy servers cache only parts of large multimedia objects to optimize the response time for accessing the objects. When multiple multimedia proxy servers can cooperate, they may exchange their cached contents to minimize the load at the content servers and on the network.

Multimedia proxy servers will be enhanced with optimal performance in existing functions, new functions to improve stream quality, and better techniques in new network environments.

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KEY TERMS

Access Latency: The delay time when a data item or object is accessed.

Cache Replacement Policy: The policy to choose a data item or object to be deleted from the cache when a new data item or object is stored to a full cache.

Depot: An intermediate server to choose a proxy server for a client request.

Hit Ratio: The number of times an item is found in the cache divided by the number of times an item is being matched.

Hot Spot: A collection of different portions of an object in which these portions are separated from each other at a fixed time interval.

Object Partitioning: The method to divide an object into smaller segments.

Object Resolution: The amount of details of a digital image or object. This is usually specified as the number of pixels and number of frames per second.

Proxy Server: A virtual server that serves the requests of a client. It usually stores copies of accessed data objects so that it may deliver the same objects immediately to repeated requests.

Transcoding: A process to change the resolution of a multimedia object.

Category: Concepts, Trends, and Challenges

Municipal Information Society in South Africa

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INTRODUCTION

Information and knowledge are keys to development in the knowledge-based society. Information and communication technologies (ICT) are playing an increasingly important role in the daily lives of citizens, revolutionising work and leisure, and changing the rules of doing business. ICT encompass all technologies that facilitate the processing and transfer of information and communication services (United Nations, 2002). Mbigi (2000) indicated that interdependence and "networking are part of African cultural heritage" (p. 23). The African Networking Renaissance is about business organisations finding innovative ways of doing business by harnessing ICT, cultural strengths and inspiration to meet the challenges of its local delivery needs and global competition.

In the realm of government, ICT applications are promising to enhance the delivery of public goods and services to citizens not only by improving the process and management of government but also by redefining the traditional concepts of citizenship and democracy (Pascual, 2003). Van der Waldt (2004) noted that the South African government makes provision for the use of information technology (IT) to deliver certain services electronically (electronic governance). Because there is a need for municipalities in South Africa to realise "the strength and importance of a virtual infrastructure framework, which includes…technology and innovation" (eThekwini Municipality Integrated Development Plan 2003-2007, 2003, p. 24), the concept of a municipal information society (MIS) is proposed. An MIS conceptual framework to facilitate public service delivery is this article's objective. This article is challenging because it discusses a fundamental realignment of the manner in which information, knowledge, ICT, people, and business organisations need to network within a selected municipality in South Africa to meet the challenges of public service delivery.

The ideal attributes of successful public service delivery in a developing democratic society were formulated by an authoritative study of public service reform in South Africa (PRC, 1998). Public services are supposed to improve the lives of citizens in the policy areas for which a public service organisation (such as a municipality) is legally responsible. According to this approach to service delivery, local governments can utilise Internet technology to improve quality (better services), efficiency (cost effectiveness) and effectiveness (economic development). Electronic service delivery (ESD) is a method of delivering services and conducting business with customers, suppliers, and stakeholders to achieve local government developmental goals of improved customer service and business efficiency in a sustainable manner. The capacity to deliver services in a sustainable way refers to "the ability to perform appropriate tasks effectively, efficiently and sustainably" (Grindle & Hildebrand, 1995, p. 445).

There is no more important issue in South Africa than improving the delivery of public services (van der Waldt, 2004). eThekwini Municipality sees the e-government strategy (eThekwini Municipality Integrated Development Plan 2003-2007, 2003) and its Web site (http://www.durban.gov.za) as important management tools for improved citizen service delivery and communications to the business community in the eThekwini Municipality Area (EMA) in South Africa. The Web site is seen as "key to retaining constant communications" with its constituents (Corporate Policy Unit, 2004b, p. 64). Improving service delivery calls for a shift away from inward-looking bureaucratic systems and attitudes towards a search for new ways of working that puts the needs of the public first (van der Waldt, 2004). In African Networking Renaissance, there is thus a need for "how-to" knowledge and information on modernising existing service delivery in keeping with new, appropriate ways of serving the needs of South Africans. ICT represent a key enabler for improved service delivery to both its citizens and business organisations in the EMA. Cronjé, de Toit, Marais, and Motlatla (2004) noted that the crux of social responsibility is "the insistence of the community that business should in every respect be a 'good corporate citizen'" (p.106). The focus of this article is on ICT, eThekwini Municipality, and business organisations in the EMA. Good governance assumes that public service delivery (including ESD) is the implementation of public policies aimed at providing concrete services to business organisations.

BACKGROUND

The concept of governance developed out of the descriptive, positive public management school of thought, which originally sought to give new meaning to the traditional role of government in society by focusing on the effectiveness and efficiency of the outputs and outcomes of governmental decisions. Cloete (2000) indicated that as a result of the perceived inefficiencies of the traditional public management system that were highlighted by the public management approach, this descriptive approach was in turn expanded to the more prescriptive new public management (NPM) school of thought. This then coined the phrase *governance* to describe what was regarded as a new way of governing in order to be more effective (Toonen, 1998). There are major pressures for a renewed focus on the issue of "service delivery" in South Africa. An important consequence of public service transformation in South Africa has been the changing nature of state–society interaction and exchange (van der Waldt, 2004). E-government is about transformation that helps citizens and business organisations find new opportunities in the world's knowledge economy (Pacific Council on International Policy, 2002). Governments that define e-government as simply moving services online "miss larger opportunities which will determine competitive advantage in the long run" (Caldow, 2002, p. 17).

Since its creation, use of the term *governance* has started to change over time (Cloete, 2000). For example, increasingly in South Africa "there has been recognition of the value of demonstrating accessibility, transparency and accountability beyond the traditional domain of financial performance" (eThekwini Municipality Integrated Development Plan 2003-2007, 2003, p. 48). This change in focus led to the conceptualisation of self-organising networks providing services by the governmental, private, and voluntary sectors (Rhodes, 1997). As a result of the complex interactions between these sectors, NPM scholars no longer agree about the ideal boundaries between the public and private sectors in society.

Governance is defined as "the patterns that emerge from governing activities of social, political and administrative actors" (Kooiman, 1993, p. 2). According to Kooiman, these patterns form to the emerging outcomes that constitute a more abstract framework at a higher level for day-to-day governing activities (Cloete, 2000). Inherent in Kooiman's governance definition is the idea of public-private interactions within a network of relationships aimed at achieving desired objectives for society. With the advent of new ICT, there is a need to reengineer work processes and systems. Both cybernetic and network models of governance see the task of governments (including local governments) as the establishment of effective interactions between local government and central government, business organisations, and civil society in catering for social needs. In such interactions, ICT plays an important role. Rhodes (1997) noted that governance "is the result of interactive socio-political forms of governing" (p. 51). Good governance assumes that public service delivery (including ESD) is the implementation of public policies aimed at providing concrete services to citizens and business organisations.

Definitions of e-government range from "the use of information technology (IT) to free movement of information to overcome the physical bounds of traditional paper and physical based systems" to "the use of technology to enhance the access to and delivery of government services to benefit citizens, business partners and employees" (Deloitte and Touche, 2003, p.1). However, it is not a simple matter. Ultimately, e-government aims to enhance access to and delivery of government services to benefit citizens (Pascual, 2003). This effectively means the business community's use of innovative ICT (e.g., Internet and associated technologies) to deliver to all business organisations improved services, reliable information and greater knowledge in order to facilitate access to the governing process thereby improving customer satisfaction, improving cost effectiveness and efficiency, and promoting economic development in the EMA. E-government needs to find a positive developmental role. Heeks (2003) suggested that without this, "e-Government runs the risk of being a 21st century 'rusting tractor,' cast aside as it fails to fulfil its promise" (p. 1). E-government services focus on four main customers: citizens, the business community, government employees, and government agencies. The focus of this article is on the business community in the EMA.

eTHEKWINI MUNICIPALITY AREA IN SOUTH AFRICA

The population of eThekwini Municipality is 3.09 million citizens (Statistics South Africa, 2001). The population is an amalgamation of racial and cultural diversity. The eThekwini Municipality has a capital budget of US$337,760,000 (approximately ZAR2,29 billion) and an operating budget of US$1,262,537,000 (approximately ZAR8, 56 billion) for the 2004-2005 financial year (see http://www.durban.gov.za). The EMA's gross geographic product income is US$3,770 (approximately ZAR25,529) per person per annum, which is higher than the South African average of US$2,620 (approximately ZAR17,756) per person per annum. Thirty-eight percent (38%) of citizens in EMA are employed (URBAN-ECON, 2003). During 2004, eThekwini Municipality was voted the best metropolitan municipality in South Africa. It is the local authority governing the City of Durban, South Africa's major port and the second largest industrial hub after Johannesburg. Durban is becoming recognised for its ability to contribute towards building a knowledge and learning network not on on the African continent but also on an international scale (Corporate Policy Unit, 2004b).

ICT is seen as an effective mechanism to access municipal information and development information in general. ICT can be defined as the electronic means of capturing, processing, storing, and communicating information (Heeks, 1999). E-readiness can be defined in terms of availability of ICT infrastructure, the accessibility of ICT to the general citizen population, and the effect of the legal and regulatory framework on ICT use (Manyanga, 2002). In building a model of ICT, two separate elements exist: IT and information on which it operates. Heeks (1999) suggested that in order to make this model useful, two further processes should be added: processes of purposeful activity and the people to undertake those processes. Together these constitute an "information system," such as a support system that helps business organisations interact with their local municipality. The eThekwini Municipality plays a vital role in the cultural life of Durban (Corporate Policy Unit, 2004a). The spawning of a MIS is only possible if the availability of multilingual and multicultural information is encouraged, thereby espousing African Networking Renaissance.

Erwin and Averweg (2003) indicated that there is a need for organisations to adapt to constantly changing business conditions. During this adaptation and, in particular, during the African Networking Renaissance, transformation occurs that consists of rapid change in all the facets of an organisation. These changes may be so significant that they may result in a new identity. Van der Waldt (2004) suggested that transformation is thus "a process of becoming" that reorganises organisational knowledge and operations (p. 85). It creates new collaborative relationships between an organisation (such as eThekwini Municipality) within its environment (such as EMA). These new relationships in turn alter both the organisation and its environment in a knowledge-based society. Transformation comes not from moving services online but from redesigning the organisation and processes to place both its citizens and business organisations at the centre, integrating across agencies to simplify interaction, reducing costs, and improving service delivery. This redefines existing supply chain mechanisms into collaborative networks and the promotion of e-collaboration.

The eThekwini Municipality embarked on an initiative to understand the needs of business organisations in utilising ICT as a tool to improve service delivery and establishing effective communication between itself and its business organisation constituency. Public participation is a powerful tool; it informs and educates citizens and therefore enhances the democratisation processes in South Africa (van der Waldt, 2004). Public participation balances the tension between democracy and bureaucracy (Brynard, 1998). A requirement for effective e-governance requires an understanding of the e-readiness of business organisations. A survey of the e-readiness of business organisations in the EMA was conducted. The results of this survey provide some insights towards a proposed MIS conceptual framework.

A survey instrument was developed to gauge business organisations' information needs in the EMA. This survey tool represents an attempt to ascertain the current interaction (if any) with the eThekwini Municipality Web site, the manner in which business organisations receive information from eThekwini Municipality and the manner in which they will like to receive information. The survey instrument comprised two sections:

- **Section 1 (General Information):** Section 1 contains three subsections: (a) business organisation's information; (b) access and usage of Internet for business purposes; and (c) focus on the eThekwini Municipality Web site.
- **Section 2 (Business Organisation's Information Needs):** Section 2 contains three subsections: (a) how business organisations currently receive and will like to receive information about eThekwini Municipality; (b) how business organisations currently interact and will like to interact with eThekwini Municipality; and (c) business organisations' perceptions regarding eThekwini Municipality.

During May 2003, the questionnaire was telephonically administered to 100 business people in 100 different business organisations in the EMA. Fifty small and 50 large organisations were selected. Selection of organisations surveyed was undertaken on a random basis.

From Section 1 of the survey instrument, 30% of respondents surveyed were from the Upper Management organisational level, 22% from Middle Management level, 21% from Supervisor level, 11% from Secretarial level and 16% were Employees. The 100 respondents surveyed were spread across 43 different core businesses. Eighty-six respondents (86%) reported that their organisations have Internet access. The Internet access for the four highest reported core businesses is as follows: manufacturing 19 (86.4%), retail 11 (91.7%), accounting 6 (85.7%) and repair 3 (50%). An analysis of the number of employees in a business organisation requiring Internet access to accomplish their daily tasks was the "1-10" employee range that constitutes more than half (52.5%) of the employee number ranges. However, the success of the Internet should be measured in terms of accessibility and contribution to social progress, rather than in terms of numbers of connected individuals (Kamel & Hussein, 2000).

An analysis of the primary purpose for which the surveyed business organisations use Internet access is as follows: searching for information (39.1%), marketing (26.1%), e-administration (20.3%) and purchasing (14.5%). More than half (55.2%) of respondents surveyed reported that their business organisations had a Web site. However, only 23.0% of respondents surveyed were aware of the eThekwini Municipality Web site (http://www.durban.gov.za).

From Section 2 of the survey instrument, the predominant method in which business organisations receive information about eThekwini Municipality is via the South African Post Office (89%). This method is followed by municipal publications (7%). Other methods include information received via the telephone and at municipal offices. Respondents surveyed were satisfied (48%) or on average satisfied (30%) with the manner in which they receive information from eThekwini Municipality. Only 18% of respondents surveyed were not satisfied with the manner in which they receive information from eThekwini Municipality. When respondents surveyed were asked how their business organisations will like to receive information from eThekwini Municipality, more than half (54%) reported that they will like to receive information via the South African Post Office, followed by e-mail (34%) and then the Internet (9%). The aim is not simply to deliver services electronically in the EMA but to encourage business organisations to make use of the Internet for catalysing a MIS in the EMA.

When respondents surveyed were asked whether their business organisations will be interested in interacting with eThekwini Municipality using the Internet as a communication medium, 59% reported positively. This tends to suggest a need for effective ICT infrastructures and interaction mechanisms that will facilitate business organisations accessing and interacting with eThekwini Municipality using the Internet (i.e., better use of ICT for the delivery of services). It is argued that this will lead to virtual communities and spawn an MIS in the EMA. Similar societies could be propagated in other municipal regions in South Africa and southern Africa

FUTURE MUNICIPAL INFORMATION SOCIETY TRENDS

Effective use of ICT will facilitate the establishment of a MIS in the EMA. With this proposed MIS concept, it is argued that changes will arise in the way business organisations relate to each other and with the eThekwini Municipality. Some future trends for a MIS in the EMA are suggested as follows:

- Being dedicated to change, virtual communities will become efficient for new social tasks
- Existing supply chains between eThekwini Municipality and business organisations will be redefined into collaborative networks
- Developing an ICT footprint in the geographical region
- Facilitating learning and knowledge creation, sharing, and use with the goal to achieve self-sufficiency and sustainable development in the EMA
- In catalysing communication between eThekwini Municipality and business organisations, allocated capital and operational funding will be utilised with more flexibility and efficiency
- A wilting of excess municipal regulations allowing eThekwini Municipality to focus on “steering” and leaving the “rowing” to others
- Making better use of ICT in the delivery of services, products and communication to business organisations
- Accelerating the ability to change processes and/or policies when problems are detected by either eThekwini Municipality and/or business organisations
- Creating more choice for business organisations, thereby promoting economic development and output growth
- Making eThekwini Municipality more responsive to the needs of business organisations
- Capacitating business organisations by improving access to services and products to them individually and core business-related collectively
- Establishing “digital democracy” (e.g., informing citizens by improving access to information)
- Promoting virtual collaboration (or e-collaboration), whereby business organisations use ICT to collaboratively plan, design, develop, manage and research products and services, and innovative ICT and e-Commerce applications in partnership with eThekwini Municipality
- Catalysing African Networking Renaissance

van der Waldt (2004) indicated that there needs to be better use of technology in the delivery of services. It is important that innovative ICT be adopted to deliver to all business organisations in the EMA-improved services, reliable information and greater knowledge in order to facilitate the e-governance process by encouraging their participation. If this approach is not adopted, it may result in the envisaged ESD image being a few pixels short. Although this is no panacea for “perfect” ESD, the importance of spawning a MIS is a step in the right direction. This will facilitate the establishment of a digital democracy, thereby leading to improved customer satisfaction with eThekwini Municipality to achieve local government developmental goals.

CONCLUSION

South Africa's national government wants to see strong, vibrant, innovative, and responsive local municipalities delivering the quality of local leadership and public services that their communities and business organisations need. E-government is not just about municipal Web sites, e-mail, and SMS. It is not about service delivery using ICT via the Internet. It is not about digital access to eThekwini Municipality information. It is about how business organisations in the EMA change in relating to their eThekwini Municipality and the degree to which e-governance changes business organisations relating to each other in a MIS virtual infrastructure framework. Municipalities in South Africa need to accept both the challenges and opportunities presented by innovation, collaboration, and service delivery by adopting appropriate ICT infrastructures. This will lead to improved ESD and communication, satisfying business organisation needs, enabling African Networking Renaissance, and thereby propagating MISs in South Africa and southern Africa.

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KEY TERMS

African Networking Renaissance: African Networking Renaissance is about business organisations finding innovative ways of doing business by harnessing information and communication technologies (ICT), cultural strengths and inspiration to meet the challenges of its local needs and global competition.

E-Collaboration: E-collaboration (or virtual collaboration) refers to the use of ICT by citizens and business organisations to collaboratively plan, design, develop, manage, and research products and services and innovative ICT and e-commerce applications.

E-Governance: E-governance refers to a local government's inventiveness to electronically govern areas under its jurisdiction.

E-Government: E-government refers to the use of technology to enhance the access to and delivery of government services to benefit citizens, business partners, and employees.

Electronic Service Delivery: Electronic service delivery (ESD) is a method of delivering services and conducting business with customers, suppliers, and stakeholders to achieve local government developmental goals of improved customer service and business efficiency.

E-Readiness: E-readiness may be defined in terms of availability of ICT infrastructure, the accessibility of information and communication technologies (ICT) to the general citizen and business organisation population and the effect of the legal and regulatory framework on ICT use.

Municipal Information Society: *Municipal information society* (MIS) is a term used to describe a society and an economy that makes best possible use of information and communication technologies (ICT). Citizens and business organisations in a municipality receive the full benefits of ICT in all aspects of their lives.

Virtual Communities: Groups of people with similar (business) interests who interact, collaborate, and communicate via the Internet.

Negative Effects of Advertising Techniques in Electronic Commerce

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INTRODUCTION

Companies who engage in online commerce find themselves dwelling at the intersection of the real and the virtual, and facing a task that is more complex than delivering an attractive Web site (Mitra, 2003). Practitioners and scholars have paid attention to techniques used in site and product promotion, which include the overall structure of the online retailing interface and individual features like banners, animation, sound, video, interstitials, and pop-up ads (Rodgers & Thorson, 2000; Westland & Au, 1998). Banner size, image maps, audio, and Web site interactivity have been found to enhance site appeal (Coyle & Thorson, 2001; Li & Bukovac, 1999;). Banner ads effectiveness was also found to be affected by incentive offerings contained in the ads, as well as the emotional appeal imbedded in the ad (Xie, Donthu, Lohtia, & Osmonbekow, 2004). Nonetheless, the use of such promotional techniques also comes with its negative effects that could influence consumers' perceptions of and attitude toward a site.

BACKGROUND

A hierarchical chain of media effects in traditional advertising research spans the spectrum of ad content to cognition, attitude, and behavior (Olney, Holbrook, & Batra, 1991). Both content and form variables were considered predictors of attention, memory, recall, click-through, informativeness, attractiveness, and attitude (Rodgers & Thorson, 2000). The study of the effects of executional factors extended to the Web involves new techniques such as banners, sponsorships, interstitials, pop-up windows, and hyperlinks that need to be considered and require a higher level of comprehensiveness than print or TV ads. They may potentially contribute to the delivery of Web content and the enhancement of Web site appeal. Consumer behavior related to online shopping experience has also been continuously explored in the information systems literature (Jarvenpaa & Todd, 1997; Koufaris, 2002; Koufaris, Kambil, & Labarbera, 2001; Van den Poel & Buckinx, 2005; Vijayasarathy, 2003). Researchers have examined Web site design from the perspective of building a cognitive framework, emphasizing enhanced usability through coherent choice of design elements and composition of the layout (Rosen, Purinton, & Lloyd, 2004).

CONSUMER ATTITUDE TOWARD WEB SITES

Attitude toward the ad (Aad) is an important traditional measure for developing marketing and advertising strategies. Aad mediates advertising responses to influence brand attitudes and purchase intentions (Brown & Stayman, 1992). Attitude toward the site (Ast) is a measure parallel to Aad and was developed in response to a need to evaluate site effectiveness, measuring a Web user's predisposition to respond either favorably or unfavorably to the content of a Web site in a natural exposure situation (Chen & Wells, 1999).

The similarity between Aad and Ast arises from the fact that a commercial Web site contains information similar to that contained in traditional advertising. An informative site appealingly organized in an entertaining form is likely to be appreciated by the visitors and hence is likely to receive a favorable attitude toward the site. Ast is a direct result of a visitor's perceptual dimensions such as perceived entertainment and perceived irritation (Ducoffe, 1996; Gao, 2003).

Online consumers place great value on the Web as a source of information. In the meantime, consumers also seek entertainment and appreciate information in an enjoyable context. Studies have also shown that product representation, the quality of the shopping experience, perceived usefulness and perceived ease of use of the Web site have a significant effect on attitude toward online shopping, intention to buy, and actual shopping behavior (Del Giudice, 2004; Gefen, Karahanna, & Straub, 2003; Koufaris, 2002; Mummalaneni, 2005).

PERCEIVED IRRITATION

The experience and perception of a visitor are individual specific. A Web site intended to be entertaining and informative may produce an unintended outcome of a user's feeling of irritation. In traditional advertising research, irritation is believed to be caused by tactics perceived to be annoying, offensive, or insulting, as well as ad features that are overly manipulative (Ducoffe, 1996). An irritating commercial is one that provokes and causes displeasure and momentary impatience (Aaker & Bruzzone, 1985). In the Web context, irritation can indicate a user's confusion and distraction or the messiness of the site.

Web-based features that may have negative effects on visitor perceptions and attitude include scrolling text across the screen or the status bar, continuously running animation, nonstandard link colors, outdated information, complex URLs, broken links or anchors, error messages, and pop-up ads, among others (Nielsen, 2003). In traditional media, annoyance and irritation are the main reasons why people criticize advertising (Bauer & Greyser, 1968). Irritation leads to reduction in advertising effectiveness (Aaker & Bruzzone, 1985). Ducoffe (1996) found a negative and significant correlation of – 0.52 between irritation and the perceived value of advertising. Irritation is also a cause for visitors to leave a site (Nielsen, 2004).

Continuous Animation

A Web advertising technique that has been widely adopted is animation. It has been typically intended to facilitate the communication of product information between the Web site and its visitors. One such example is the online virtual showrooms of automakers. At sites featuring computer games and outdoor activities, animation may also increase the perceived realism of information presented. In a study of the effects of interactivity and vividness on consumer attitude, Coyle and Thorson (2001) find that a more vivid site, through the use of audio and moderate animation, was related to a more positive visitor attitude.

Animation can also be used to draw a visitor's attention. The use of continuous animation on many Web sites is for the purpose of alerting the visitor of a particular product or event, or an attempt to entertain the visitor while she or he is at the site. Nielsen (1999) suggested that animation should be done on a one-time-only basis and then the animated object should become a still image. Nielsen (1995) argued that Web users should not be constantly bombarded with the same intensity in impression an movement by the equivalent of the billboards of Times Square in New York City.

Due to the overpowering effect of moving images on the human peripheral vision, the presence of continuous animation on a page makes it very hard to read the text in the middle of a page (Nielsen, 1995). We argue that the continuousness poses a problem that is similar to TV advertising in terms of intrusiveness. Greyser (1973) found that people felt more irritated by TV commercials than by other media due to the intrusiveness of TV commercials. Continuous animation is much like scrolling text at the bottom of a television screen that cries for attention. It is a form of intrusive presentation of information to Web site visitors. Such intrusiveness demands attention like TV commercials, and will similarly cause irritation like any other intrusive means of advertising.

Pop-Up Ads

Another frequently adopted web-based promotional technique is the pop-up ad. We observe that pop-up ads, like animated banners, can be used for both cross-site and in-house advertising. Nielsen (2003) maintains that users at search sites are more receptive to targeted ads than in other contexts, because these ads often relate to what the users are after, and subsequently the users are more likely to follow the ads. Although some people often find them annoying, many others find them informative and related to their search goal and thus consider them less irritating than in other circumstances.

On the other hand we observe that, though less inclined to deploy cross-site ads, many firms use pop-up ads, along with animated banners, to inform visitors of certain promotions and events. Does the use of such techniques for in-house advertising cause a higher level of irritation than in the absence of them? Both animated site banner and pop-up ads are ways to reach the consumer within the site, but are they good delivery mechanisms for the store?

Unexpected pop-up ads could have similar negative effects. In traditional advertising, Greyser (1973) found that interruptiveness was a predominant reason why the British public considered TV advertisements more irritating than the print media. The Internet is a hybrid of the print and broadcast media. The use of unexpected pop-up ads closely mirrors the TV commercials' interruptiveness. In addition, the visitor has to find a way to get rid of the popped-up window, the process of which increases the level of irritation.

A FIELD STUDY

To test the effects of the above discussed advertising techniques, we conducted a field study with students from a northeastern college in the United States. A commercial Web site selling a variety of cameras was chosen as the stimuli. The Web site makes use of a frames page which contains a navigational header—the site banner, and a main frame underneath it.

This Web site was peripherally modified to operationalize the constructs in the study through a two by two (2×2) factorial design. Four versions were created based on the site, through the presence or absence of continuously running animation in the site banner, and the presence or absence of pop-up ads during a user's visit. The animated version included an animated logo, an animated neon sign, animated images of phone and e-mail icons, and an animated text banner linking to a prize contest. Still pictures were used in the nonanimated version. The pop-up ads included a message of quantity discount (save 5% on $200 purchase) offered by the site and a picture linking to a sweepstakes entry form then running at the site. Both were created with the theme of the Web site and used existing images of the site. Hence, the four treatment conditions were (a) animation without pop-up, (b) pop-up without animation, (c) animation *and* pop-up, and (d) *neither* animation *nor* pop-up. This experimental design maintained internal validity through the factor manipulations and external validity through the use of a slightly modified real commercial Web site.

Participants were drawn through a gift incentive (a disposable camera) and entry into a lottery of four cash prizes (one $100 and three $50 prizes). Each participant was randomly assigned to one of the four treatment conditions and was instructed to explore the site for product information and find a model of digital camera of interest.

Opinions about or attitudes toward the site formed from this initial exchange would be a key indicator of the effectiveness of the site in retaining site visitors and thus attracting return customers. Among surveys returned, 128 were substantially complete and used in data analysis of this study. These scale items have been developed, tested, and used in measuring perceived irritation of TV advertising and Web advertising, and have yielded fairly high Cronbach's alpha values (> 0.8; Coyle & Thorson, 2001; Ducoffe, 1996). Participants were asked to indicate their agreement or disagreement with each statement on the survey on a 7-point Likert scale. In particular, perceived irritation was measured through statements of a visitor's feelings of the Web site being annoying, irritating, and frustrating. Ast was measured through pairs of adjectives of "like-disklike," "favorable-unfavorable," and "good-bad."

More than 32% of the participants spent more than 10 hours per week online. With respect to the site, the participants seem to have a generally favorable attitude toward the site, with a mean Ast score of 5.47 on a 7-point scale.

Cronbach's alphas on multi-item scales adopted in this study indicate strong scale reliability.

The results of a principle component analysis with direct oblimin rotation indicate that items within each scale load on the same factor, and thus are all unidimensional. Items belonging to different scales load on their own separate factors, showing evidence of discriminant validity.

Manipulation checks were performed via one-way ANOVAs, with each fixed factor (animation or pop-up) as independent variables and a participant's acknowledgment of perceiving (or noticing) the features as the dependent variables. Those who were exposed to the animated sites were significantly more likely to agree that the site had continuous animation ($M = .8281$) than those who were exposed to the non-animated versions ($M = .1406$) ($F[1, 126] = 113.14$, $p < .001$). Those who were exposed to the sites with pop-up ads were significantly more likely to agree that they saw pop-up ads ($M = .8438$) than those that were not exposed to versions with pop-up ads ($M = .2500$) ($F[1, 126] = 69.55$, $p < .001$). Thus, the manipulations were successful. Age, gender, and weekly Web usage were not significantly correlated with either irritation or attitude and thus were dropped from further analyses.

Sample probability plots showed patterns of a normal distribution. A two-way ANOVA was performed treating perceived irritation as the dependent variable and manipulation of the presence of continuous animation and unexpected pop-up ads as fixed factors in a 2×2 design. Both continuous animation ($F[1, 124] = 9.78$, $p = .002$) and pop-up ads ($F[1, 124] = 7.87$, $p = .006$) had a significant effect on perceived irritation, at $p < .01$. No interaction effect emerged ($F[1, 124] = .026$, $p = .872$). Pearson correlation analysis also confirmed that irritation was significantly ($p < 0.001$) and negatively correlated with Ast with a correlation coefficient of - 0.613.

The direct impact of continuous animation and pop-up ads on Ast was also examined via an ANOVA model where Ast was treated as the dependent variable. Once again, no interaction effect emerged ($p = .322$). Both factors had a negative effect on Ast. Those who were exposed to animation had a less favorable attitude toward the site ($M = 5.1913$) than those who were not ($M = 5.7541$). Those who were exposed to pop-up ads also had a less favorable attitude toward the site ($M = 5.2063$) than those who were not ($M = 5.7571$). Both relationships were statistically significant, at $p = .009$ and $p = .011$ respectively, for animation and pop-up ads. With eta-squared (η^2) values at .073 and .06 for continuous animation and pop-up ads, respectively, the two techniques examined in this study had a medium to strong effect on perceived irritation, according to Cohen (1988).

FUTURE RESEARCH

Experimental research, though limited in scope, goes beyond the predictive power of observational research. It offers the advantage of being able to validate causal relationships between the treatment effects and the dependent variables.

Students are deemed appropriate subjects in that they make a significant portion of the Internet population (GVU's 10th Survey, 1998). One of the arguments for using a homogenous sample such as undergraduate college students is that it makes it easier to achieve internal validity (Greenberg, 1987). Although the use of students may threaten external validity, that threat is mitigated by the fact that our student population was from a college in a densely populated suburban area. Such students may be more representative of the general population and may be appropriate for consumer behavioral studies than more traditional college students that attend universities in remote rural areas (James & Sonner, 2001).

The findings we present in this article were based on a scenario of a visitor's initial exchange with a Web site. We believe that such an initial exchange plays a significant role in an e-store's ability to attract users and convert them to buyers. For ready-to-buy visitors, the effect of online advertising may vary. Whether similar results will be seen in the population of ready-to-buy shoppers remain to be studied in future research.

Despite the limitations addressed above, we were encouraged by the findings of this study. Future research should explore the effects of the use of such promotional techniques in combination with influences of situational factors such as portal sites vs. e-store sites, surfers vs. buyers, on visitor perceptions and attitude. Future research should also examine the impact of other media presentation factors in e-business.

Our results cast doubts on whether certain Internet advertising mechanisms are truly effective. Nevertheless, we recognize the use of cross-site ads, which are most likely used by portals and online publishing sites to generate revenue (as part of their business model). A recent study by Yoo, Kim, and Stout (2004) focused on just this type of cross-site animated banner ads and found that animated banners prompted better attention-grabbing capabilities and higher recalls as well as more favorable attitude toward the ad than static banner ads. In the meantime, Yoo et al. (2004) recognize that too much animation, though eye-catching, may reduce advertising effectiveness due to the potential negative affective responses such as irritation or annoyance. We also suspect that results could be very different from our current study in search engine sites due to the fact that users visiting those sites have an explicit intention to leave them once they find a link of interest, be it a text link or picture ad. What effects such cross-site ads may have remains to be examined in further studies.

CONCLUSION

This article discusses some common uses of Web advertising techniques and focuses its attention on the negative effects of some online techniques on user irritation and attitude. It reports findings from an experimental study examining the use of pop-up ads and continuous animation for in-house presentation of information on discounts, special offers, and announcements. Both factors were found to significantly influence perceived irritation. In turn, irritation is a significant predictor of attitude toward the site. Even though irritation is not the only factor in determining attitude toward the Web site, our results showed that it had a significant negative correlation with attitude. To Web marketers and site designers, it means that they should never overlook factors contributing to perceived irritation while exploring factors that may contribute to consumer perceptions in the positive direction. A recent study found that consumers have a generally negative attitude toward advertising through intrusive means of short messages delivered to their mobile phones without their prior consent (Tsang, Hi, & Ling, 2004).

The implication of the findings from this study is that practitioners need to exercise caution in deploying certain web advertising techniques. Nielsen (2004) advised that users have learned to stop paying attention to anything that looks like an advertisement, through what he calls banner blindness, animation avoidance and pop-up purges. This presents a new challenge to Web marketers and site designers. Thus, for researchers, it is necessary to take a rigorous and scientific look at the various components that go into doing business online, in order to help electronic business develop in a structured, efficient, and effective way.

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KEY TERMS

Attitude toward the Ad (Aad): A mediator of advertising response that influences brand attitude and purchase intentions

Attitude toward the Site (Ast): A Web user's affectionate response either favorably or unfavorably to the content of a Web site

Electronic Commerce (eCommerce): the use of computer networks for business communications and commercial transactions

Continuous Animation: Animated objects deployed at a website to catch a visitor's attention to an advertising message or to attempt to entertain visitors

Irritation: an unwanted user feeling caused by tactics perceived to be annoying, offensive, insulting, or overly manipulative

Pop-up Ad: A Web-based promotional technique that places a new window of advertising message or image over an Internet user's current active window

Web Advertising: advertising through banners, sponsorships, interstitials, hyperlinks, and pop-up and pop-under windows in the Internet media

Web Marketing: the dissemination of information, promotion of products and services, execution of sales transactions, and provision of customer support via a company's Web site

Category: Applications of E-Technologies

Negotiating Online Privacy Rights

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INTRODUCTION

The *Privacy Journal* (2003), a print newsletter and Web site devoted to privacy matters, defines the present-day use of the word privacy as "the right of individuals to control the collection and use of personal information about themselves." Similar definitions are provided by law specialists (Gavison, 1980; Warren & Brandies, 1890).

The *networked society* changes the way in which *privacy rights* are defined, used and interpreted, because:

a. The IT-enabled channels of communication change the rules of personal and commercial interaction;
b. The participation in the networked society implies a diminishing of individual privacy rights.

The fundamental principle of the networked society is information sharing and processing (Kling & Allen, 1996). Advances in computing technology—that represents the infrastructure of the networked society—make possible to collect, store, analyze, and retrieve personal information created in the process of participation.

The manifestation and the protection of individual privacy rights represent the field of conflict between various disciplines and social events. The heterogeneous nature of this phenomenon is mirrored in this paper, which aims to present the complex nature of privacy rights in the context of the networked society. The study proposes a negotiating model of online privacy rights, and analyses the necessary conditions for the implementation of this model on the *Internet*.

The new economy is redefined on the basis of information entrepreneurism (Kling & Allen, 1996; Zwick & Dholakia, 1999). This cultural paradigm emphasizes the use of data-intensive analysis techniques for designing and implementing effective marketing and management strategies. This has as a direct consequence the use of an information superpanopticon–a concept derived from Foucault's panopticon, a system of perfect surveillance and control.

Online *privacy* is a major concern for Internet users (Ackerman, Cranor, & Reagle, 1999). For the individual Internet user, the privacy threats fall into two main categories:

a. Web tracking devices that collect information about the online behavior of the user (e.g., *cookies*);
b. The misuse of the personal information provided by the online user in exchange of specific benefits: increased personalization, Web group membership, etc.

The databases, intelligent agents and tracking devices are surrounding the Internet users with a Web of surveillance, which is often hidden and unknown to the users. The surveillance is initiated by the simple act of presence on the Internet. Specialized software applications, such as cookies are tracking the online behavior of Internet users, feeding the data into databases, which create and permanently update a profile of online consumers. These profiles are then used for segmenting the market and targeting the most profitable consumers.

A company can use cookies for various valid reasons: security, personalization, marketing, customer service, etc., however, there is an important distinction between cookies, which are active only within a specific Web site, and the ones that can track the user's activity across unrelated Web sites. Recently, some aggregator networks have deployed hidden 'pixel beacon' technology that allows ad-serving companies to connect unrelated sites and overcome the site-specific nature of traditional cookies (Mabley, 2000). Additionally, some companies are now connecting this aggregated data with offline demographic and credit card data. Eventually, these resulting databases can be used or sold as powerful marketing tools.

Exercising control of information, after it was voluntarily released, presents another critical problem. The misuse of personal information covers many possible aspects, which can be defined as any use which is not explicitly defined in the company's privacy disclaimer, or which is not approved by the informed customer. For example, in 2000, Toysurus.com was subject to intense debate and controversy, when it was discovered that shoppers' personal information was transferred through an unmarked Internet channel to a data processing firm, for analysis and aggregation. This operation was not disclosed in the company's privacy disclaimer, and therefore, online customers were not aware of it.

Regulators and legislators have addressed the controversial privacy issue quite differently across the world (Nakra, 2001). The USA, the largest world's financial and Internet market, has not yet adopted a national, standard-setting privacy law (Jarvis, 2001). U.S. privacy statutes have primarily focused so far on protecting consumers' financial data, health information, and children's personal information (Desai, Richards, & Desai, 2003; Frye, 2001). In comparison with the American official opinion that online privacy protection is a matter of voluntary self-regulation by market-driven companies, the Europeans consider that it is more effective to enforce specific legislation regarding this issue.

The current European approach is based on three basic tenets:

1. Individuals have the right to access any data relating to them and have it kept accurate and up-to-date;
2. Data cannot be retained for longer than the purpose for which it was obtained, nor used or disclosed "in a matter incompatible with that purpose", and must be kept only for "lawful purposes";
3. Those who control data have "a special duty of care" in relation to the individuals whose data they keep. Data commissioners oversee these rights in each European country and require most "data controllers"—people who handle data—to register with them to track what information is being collected and where. They are charged also with investigating all complaints from citizens.

These principles have been incorporated in the European Data Directive, which came into effect in 1998, and more recently, in the European Directive on Privacy and Electronic Communications, adopted in 2002. Despite these legislative efforts, it is not yet clear how effective are the measures implemented by EU States. The direct involvement of governmental institutions can be considered as a form of censorship that can undermine the freedom and the flexibility of the Internet domain.

THE DESCRIPTION OF A NEGOTIATION MODEL FOR ONLINE PRIVACY RIGHTS

The relativism of personal rights in the networked society and the increased commodification of the digital self, indicate a *negotiation model* based on contractual rules as the most appropriate for defining and enforcing personal privacy.

A classical negotiation situation comprises a number of essential elements (Zlatev & van Eck, 2003): parties, rules (a negotiation protocol), a system of law enforcement (established and maintain by regulators), and specific benefits to be negotiated by the parties (negotiation objects).

In an online situation, the parties negotiating privacy rights are often in a position of inequality. Most privacy statements and disclaimers act as a standardized contractual clause that has to be entirely accepted by the Internet users. There is no room for negotiation, and the only alternative is non-participation in that particular transaction. On the other hand, after the Internet user discloses his or her personal information, as part of the online deal, he or she has no direct possibility to control the way in which the organization uses this information. The storage, retrieving and processing of information are fully covert, and the only hope of the Internet user is that the company will respect its promises.

Laudon (1996) proposes the implementation of National Information Accounts, a market-based negotiation system, in which information about individuals is bought and sold at a market-clearing price, to the level where supply equals demand. Within this system, individuals would create information accounts at specialised institutions, where they would deposit their personal information. Depositors would then grant to potential information users the right to use the information after paying the market price for it. The use of information would be limited to a specific period of time, and maybe, for specific purposes. The specialised information banks would have the role to aggregate the personal information deposited by their clients, retaining a part of the payment for covering the costs of their current operations.

This system implies a strict control of the information transfer in the society, possibly enforced and maintained by the government. This model, although interesting and ingenious, neglects the multiple possibilities to collect, store and process information in a networked society, centered around the Internet, as a global, unregulated communication channel.

A possible online alternative would be the use of specialised *cybermediaries* that can negotiate on behalf of their clients with online commercial organizations, in order to get a better deal and protect the use of personal information. However, the main problem remains: the negotiation would take place in the present online environment, which does not offer an appropriate protocol for a conflictual dialogue between users (or cybermediaries) and organizations. The negotiating aspects of personal privacy should be embedded into the technological tools of online interaction.

THE IMPACT OF THE NEGOTIATING MODEL OF ONLINE PRIVACY RIGHTS: THE PLATFORM FOR PRIVACY PREFERENCES

In May 1998, the Web Standards Organisation has released the first public draft of the Platform for Privacy Preferences, or P3P—a protocol meant to provide an automatic common Web language for the acceptable use of personal information (Cranor, 1998).

The *Platform for Privacy Preferences (P3P)* provides a standard way of communicating and negotiating Web site data practices. The Platform was developed by the World Wide Web Consortium, an international organization dedicated to the evolution and development of the Web, whose operations are administered by the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL) in the USA, the European Research Consortium for Informatics and Mathematics (ERCIM) headquartered in France, and Keio University in Japan, following an initiative of the Center for Democracy and Technology (Cranor, 2002).

The P3P specification includes a standard vocabulary for describing the data practices used by Web sites, a set of data elements that Web sites can refer to in their P3P privacy policies, and a protocol for requesting and transmitting Web site privacy policies.

The P3P 1.0 Specification allows Web sites to transform their current plain language privacy policy into a machine readable P3P Policy, by encoding it in XML format. Several policy-writing software programs perform this translation automatically, such as IBM's P3P Policy Editor.

During the Web interaction, a P3P-compatible browser automatically detects the Web site's privacy policy, and depending on the level of promised protection, releases or not the customer's personal information. The browser also allows users to do selective cookie blocking based on the extent of the Web site privacy policy, and provides a report of the Web site data practices. As a support to this function, Microsoft has implemented an advanced cookie-filtering mechanism in the software package of *Internet Explorer 6 (IE6)*, based upon the P3P 1.0 Specification. The software presents various levels of cookie-filtering sensitivity, which users can adjust manually using a slider contained on the "Privacy" tab, under "Internet Options". When the user has not adjusted his or her preferences, the interaction between the site and the user's browser is based on default preference settings implemented in the program.

When IE6 interacts for the first time with a cookie, a dialog window entitled "Privacy" is presented to the user, informing him/her that the browser will show a privacy icon in the status bar each time a cookie is blocked or restricted. Users can then double-click on the icon, in order to obtain a short privacy report, which contains a message about the cookies and a list of the URLs of these cookies. From this dialog window, users can choose to see the full P3P policy, and grant or block cookie privileges to specific Web sites.

The P3P protocol is still in a developing stage, and has evolved rapidly during the project (Cranor, 2002). Originally the platform was design to permit a multi-stage negotiation process between the user's browser and the Web site, based on a series of offers and counter-offers. This system was later replaced with a single-round negotiation, in which the Web site has to present all the information about its data practices, which the user can then decide to accept or to reject. The public release of the P3P 1.0 Specification allowed the developers of this project to better evaluate its effectiveness and to define the existing problems that still have to be solved.

The P3P has many critics that emphasize various problems related with the implementation and use of the platform (Clarke, 1998; Harvey & Sanzaro, 2002; Thibadeau, 2000):

- **Implementation and Maintenance:** The translation of a written privacy policy into a P3P privacy statement requires additional effort from companies. The firms have to evaluate and define clearly their data practices, for each part of their site, and to adequately describe them into a P3P compatible privacy policy; the cost and time required for these tasks might prevent some firms to implement the P3P protocol;
- **Lack of Privacy Framework and Legal Enforcement:** The platform does not operate within an existing privacy framework, does not promote a minimum set of privacy or security standards that Web sites should follow, and does not provide an privacy enforcement mechanism;
- **Unclear Legal Consequences:** Some companies might be concerned with being held accountable for statements made in a P3P privacy policy, especially when there is a discrepancy among their non-P3P policies, the P3P statement, and their actual practices. Some firms have suggested the introduction of legal disclaimers in the P3P policy, but the effectiveness of such disclaimers is still untested;
- **Internet User Confusion:** In many cases, Internet users might not be willing to learn about the P3P platform and set their privacy preferences regarding to cookies. In this case, the dialog window

offered by IE6 might increase the confusion of Internet users, since they might not understand the purpose of a cookie and the reason for which it was blocked. Finally, P3P does not guarantee the security of the accessed Web sites.

These problems are certainly real, but the advocates of P3P consider them rather as limitations, and not as valid grounds for eliminating the entire concept (Cranor & Wenning, 2002). They emphasise that the implementation and use of the P3P platform is only a first step towards the standardization of privacy policies, and facilitates the users' choice of a desired privacy level, including anonymity and pseudonymity. On the other hand, the implementation of the P3P platform should be complemented with an appropriate level of legal protection and enforcement. Some critics have outlined that the widespread implementation of the P3P platform might discourage the enforcement of specific online privacy legislation, especially in the United States, where the accent is put on a voluntary regulation of data practices. However, this might not necessarily be the case: in 1998, European Union has issued a statement declaring that a technical platform by itself is not sufficient to guarantee online privacy protection and that any technical measures should be supported and complemented with an appropriate legal framework (Cranor & Wenning, 2002).

One major issue is the necessity to improve the control over the use of personal information accounts and to track down any possible infringement of the data practices policy. This would imply an increase in the governmental and intergovernmental control over the use of online information, which is considered unacceptable by the militants against Internet censorship.

Another possible solution would be the introduction of a voluntary auditing system, in which online organizations will be monitored by independent assessors (possible specialised cybermediaries). The organizations infringing the protocol will be denied the "seal of approval", that can become a differentiating sign between ethically correct and "rogue" companies.

CONCLUSION

Privacy rights and policies represent a subject of intense concern, debate and research world-wide (Cranor, 1998). The explosive development of the Internet has only highlighted this problem of the modern-day society.

Various research approaches can be used to further study this phenomenon:

- Surveys and analyses of the level of privacy described in companies' disclaimers, as well as the real versus the perceived protection provided by these statements;
- Surveys of the public opinion regarding online privacy, and analyses of the relation between privacy standards and consumer trust;
- Studies regarding the use by individuals of specific tools of privacy protection, such as encryption programs or anonymazer applications, and their effectiveness.

Online privacy will continue to provoke debate until a dynamic, adaptable solution will be found and implemented. This solution should balance the interests of individual customers with those of commercial organizations, and with the values of the present-day society. The definition and enforcement of privacy rights should represent a compromise between responsible individuals and ethical organizations, depending on the particular circumstances of every interaction.

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Online Advertising Fraud

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INTRODUCTION

This article discusses illegitimate activities associated with online promotion activities, specifically those related to *click-through fraud*. Whether one is starting a new brick-and-mortar restaurant, managing a charity organization, or building an online information portal, prospective customers, donors, or users must be informed, persuaded, and reminded of the features and benefits that are offered by the business. Online promotion has some unique and advantageous characteristics over traditional promotion media, but those characteristics create a potential for abuse. Click-through fraud, more commonly termed *click fraud*, is a relatively recent and evolving problem that currently has few deterrents. This article outlines why and how click fraud is done, and suggests some measures that can be taken to at least recognize the potential for click fraud.

The interactive nature of the Web would seem to make it an ideal advertising medium with a potential to completely eliminate advertising *waste*. Newspaper ads for, say, a pet store reach many people who do not have pets: the number of people in this category is termed as *waste*. With online advertising, it is possible—in an ideal world—to place an ad and to pay for the ad space only when a prospective customer shows interest by clicking on a linked advertisement that transports him/her to the advertiser's online place of business. This *pay-per-click* (PPC) pricing model would seem to completely eliminate advertising waste.

Unfortunately, advertisers, ad hosts, and fraudsters are discovering that the PPC model is open to abuse. Those who click on an online advertisement could include:

- Prospective customers who actually have an interest in the product
- Competitors who want to generate high advertising costs for the advertiser
- Ad hosts who earn a commission from displaying pay-per-click advertising

The latter two categories consist of entities that have absolutely no interest in the advertiser's offerings and absolutely no intention of ever performing any *target actions* such as purchasing a product. These fraudulent *click-throughs* or *debiting clicks* could turn an ad campaign from one that has almost no waste into one that has almost 100% waste. In a survey of advertisers, the Search Engine Marketing Professional Organization found that a quarter of respondents have tracked fraud as a problem (SEMPO, 2004).

BACKGROUND

Contextual advertising is one way of increasing the likelihood that an ad is reaching people in its target audience. In Web-based advertising, contextual advertising would include banner ads or search engine links that are displayed on a page that has a context that is related to the ad; people on that page are already searching for or browsing through ad-related content. Better reaching the target audience in this way should result in less waste and, in the case of online advertising, in a higher *click-through rate* (cf. Newcomb, 2003; Smith, 2004; Sullivan, 2004).

Search engines engage in contextual advertising through the *pay-per-click* (PPC) or *cost-per-click* (CPC) pricing model. When someone does a search, many search engines not only return links to pages that have been indexed on the search terms, but also return *sponsored links* to pages that the advertiser has paid to have listed at high ranking (cf., Brendler, 2005). When someone clicks on a sponsored link in the PPC model, this *click-through* is a *debiting click* that subtracts from the advertiser's prepaid advertising click budget. The price per click is set by a bidding process, whereby the advertiser who bids to pay the most for particular keywords will be ranked the highest in the list of *sponsored links* returned by the search engine (cf., Alchemist Media, n.d.). The Fathom Online Keyword Price Index shows that in March 2005, advertisers in the consumer retail industry were paying an average of $0.51 per click, while advertisers in the mortgage industry were paying an average of $5.39 per click (Fathom, 2005). Bids on some keywords can reach into the fifty-dollar range (cf., Associated Press, 2005a; Bruce Clay, n.d.).

Both advertisers and ad hosts have experienced fraud under the PPC advertising model, but legal action is relatively new at the time of this writing. In February 2005, the gift shop Lane's Gifts and Collectables filed suit against Google, Yahoo, and others for allegedly billing for inflated click-throughs for PPC advertising, charging that many click-throughs were not generated by *bone fide* potential customers (Associated Press, 2005b). But just a few months earlier, Google had itself filed one of the first click fraud lawsuits against one of its advertising affiliates who displayed Google-generated sponsored links on its own Web site. The affiliate, Auctions Expert, contracted with Google to display PPC links, but then allegedly clicked on those links itself in order to generate a commission (Olsen, 2004). In March 2004, Michael Bradley was arrested by the U.S. Secret Service in association with his Google Clique software that he claimed could be used to generate false clicks for Google affiliates (Nariane, 2004).

ADVERTISING CLICK FRAUD

Before looking at why and how click fraud is done, we need an understanding of some basic cost or pricing methods used in online advertising.

Pricing Models

Traditional Model: CPM and Pay-Per-Impression Advertising

A traditional measure of advertising cost for print and broadcast media has been *CPM*, or "cost-per-thousand." In traditional media, this is the cost of reaching 1,000 individuals or households with the advertising message in a given medium. With online advertising, CPM tends to be associated with the cost of 1,000 *impressions*, or actual exposures to a particular advertisement. In *pay-per-impression* advertising, the advertiser pays for some predetermined number of ad impressions. When this impression budget is exhausted, the ad is removed from the display list (cf., Internet Retailer, 2005).

Performance Model: Cost-Per-Transaction or Cost-Per-Action (CPT, CPA)

Although not often discussed and apparently not often used in online promotion, pricing that is based on the ultimate visitor's *target action* (e.g., making a purchase) could be done. The terms *cost-per-action* and *cost-per-acquisition* (CPA) are sometimes used to describe this idea (cf., Gold, 2005; Stevens, 2001; Think Metrics, n.d.). Mand (1998) discussed a model that has been called *cost-per-sale*, *cost-per-trade*, and *cost-per-transaction* advertising (CPT). This equates to a sales commission in traditional media.

Bid-for-Placement Model: Pay-Per-Click or Cost-Per-Click Advertising (PPC, CPC)

In *pay-per-click* (PPC) advertising, also known as *cost-per-click* (CPC) advertising, the advertiser pays a fee for each time someone clicks an advertisement that links to the advertiser's Web site. The advertiser pays for a predetermined number of clicks at a price that is often set by being the highest bidder in an auction. The advertisement host (e.g., a search engine) removes the ad from the display list when this click budget is exhausted. The advertisement host might also remove the ad from the display if the *clicks-to-impressions* (CTI) ratio or *click-through rate* (CTR) falls below some predetermined limit (because it is failing to generate sufficient revenues.)

Click Fraud Classification

Fraud can exist in all three types of pricing models, but click fraud is probably the most problematic at this time because the PPC model has become so widely used in online advertising. Many types of online advertising fraud are motivated by two basic objectives. One is associated with an attempt to either hurt a competitor or to force the competitor to decrease its advertising. Another is to profit from hosting advertising messages. The first type could be classified as *competitive fraud* and the second as *affiliate fraud* or *network fraud* (cf., Claburn, 2005; Lee 2005; Stricchiola, 2004).

Competitive Fraud

The objective of competitive fraud is often to hurt a competitor or to get a competitor to quit advertising. For example, one competitor can repeatedly click on another competitor's PPC ad with the intent to inflate the competitor's advertising cost rather than to obtain information about the advertised product. The objective of deliberately imposing this cost on the competitor could be to:

- drain the competitor's advertising budget in an effort to decrease the competitor's profitability.
- cause the competitor to see less value in bidding up the price to be at the top of the search engine list. This thereby lowers the prices for other competitors to bid for top listing.
- cause the competitor to quit advertising or to quit doing as much advertising because it either cannot budget for the volume of clicks or sees PPC advertising as providing a poor return on investment. If the competitor bows out of the top spot, it is now open for the remaining competitors at lower prices.

Click Monkey, for example, advertises that it can be hired to "Google bomb your competition" for pennies on an advertisement's bid price as a cost-effective way to lower high-bid PPC rates (Click Monkey, n.d.).

An interesting example of apparent competitor fraud is the alleged actions both by and against Blue Star Jets. Charter Auction, a charter jet broker, at one time spent $20,000 per month on search ads and $20 per click for some search terms. Charter Auction and another charter-jet broker, Air Royale International, believed that they were the victims of click fraud and identified an IP address (Internet address) assigned to Blue Star Jets that had repeatedly clicked on ads thousands of times. But Blue Star Jets itself was hit with click-through theft by a competitor who presumably believed that it was justified in retaliating against Blue Star Jets. Tag Aviation found that competitor Blue Star Jets had purchased clicks based on the search phrase for its own name, "Tag Aviation," thereby stealing customers who might have intended to go to Tag Aviation. Tag Aviation staff were told to retaliate by clicking on these Blue Star ads in order to deplete Blue Star's click budget for these ad keywords (McKelvey, 2005).

Note that we do not necessarily have to click on the competitor's ads to drive up its costs. We could also quit using particular keywords ourselves, causing the competitor to get all the hits (non-fraudulent, legitimate ones). If the competitor has a high bid price on these keywords, its advertising costs might increase if it is getting all of the hits. If it cannot temporarily afford this increase, it might be coerced into decreasing its advertising, leaving the market open for the rest of us (cf., Crowell, 2005).

It is also possible to hurt a competitor through a *click restraint* action rather than doing a click-through. When the clicks-to-impressions ratio falls below a certain threshold, the search engine or other advertising host might automatically drop the ad from the display list to be replaced by an ad that gets a higher click response (which therefore generates higher revenues). A click-through is a *debiting click* when it is used to consume a click from the PPC prepaid budget of clicks (cf. Stricchiola, 2004). But in this case, the fraudster opens a Web page that causes an ad to be displayed, but then refrains from clicking on it; this decreases the click-to-impression ratio and therefore could cause the ad to be dropped or lowered on the list (cf., McKelvey, 2005).

Affiliate/Network Fraud

The objective in affiliate or network fraud is to obtain a financial commission on PPC advertising that is being hosted. Mentioned earlier, Auctions Expert allegedly recruited as many as 50 people to click on ads that it hosted (Vise, 2005). Vidyasagar (2004) suggests that a small industry is developing in India in which housewives can earn up to $0.25 per click to browse online advertising. With *paid-to-read* (PTR) programs, list subscribers are paid to click on links that are e-mailed to them (e.g., StopClickFraud, n.d.); the unscrupulous affiliate thereby lowers the risk of detection by generating clicks that appear to be legitimate in originating with real people at real computers in a wide geography. Click Monkey (n.d.) outright advertises its *click farm* services, advertising rates for as little as one dollar per thousand clicks. The higher rates, however, would have to be paid to those who would spend 60 or 90 seconds on an ad—long enough to give the appearance of a legitimately interested party. It is also possible to automate hits with spoofs of varying IP addresses (i.e., the software pretends to be making clicks from a variety of geographic locations instead of from a single computer), as when Michael Bradley claimed that his Google Clique software could be used to generate false clicks for Google affiliates (Nariane, 2004).

An advertising affiliate can also commit *impression fraud* and *content fraud*. In impression fraud, the advertisers pays for visitors who merely arrive at a page with an ad (an ad impression), not for a click-through of that ad. Impression fraud can be committed by the same methods used in click-through fraud (cf., Feldblum, 2005; Internet Retailer, 2005; Lee, 2005). In committing content fraud, the PPC advertising affiliate (host) indexes pages using keywords that are unrelated to the actual content of the page and the advertisement. In this way, the fraudster can increase the number of hits to that page (impressions), but the visitors who reach that page arrived with the expectation of different content; the impressions are wasted on an audience that has no interest and had expected something different (cf., Feldblum, 2005).

Click Fraud Detection Hints

An advertiser should normally look at measures and ratios in order to evaluate the cost effectiveness of an advertising campaign. Importantly, some of these could be useful in tracking the onset of fraud activities.

Click-Through Rate

The click-through rate (CTR) of an ad or sponsored link is the number of visitors who clicked on the link vs. the number of visitors who were exposed to the ad, or click-throughs vs. impressions, expressed as a percentage. A higher CTR could suggest that the ad or link is effectively placed in the context of the page that displays it. A sudden increase in CTR, however, could also suggest the onset of click fraud activities.

Bounce Rate

Some Web site visitors will enter and then back out (leave) without viewing any other pages on the site. The *bounce rate* or *ratio* is the number of visitors who leave without linking from anything on the page vs. the total number of visitors (or *pageviews*), expressed as a percentage (cf., IndexTools.com, n.d.; Think Metrics, n.d.). A sudden increase in bounce rate could suggest the onset of click fraud activities.

Customer Conversion Rate

C*onversion* has to do with visitors who become revenue-generating customers. The customer conversion rate (CCR) is the percentage of Web site visitors who engage in an ultimate *target action*, such as making a purchase (cf., Gold, 2005; Pelland, 2005; ThinkMetrics, n.d.). A sudden decrease in conversion rate, or an increase in *non-converting traffic*, could suggest the onset of click fraud activities.

FUTURE TRENDS

If the value of online advertising decreases due to fraudulent activity, providers of online advertising services will ultimately have a financial motivation to take action to protect the interests of advertisers. As customers of these services, advertisers will gravitate to competing service providers who provide the best assurance that they are providing good value for the investment in advertising. How these services might best protect advertisers is beyond the scope of this article; this emerging issue currently does not appear to have any easy answers either in practice or in the courts.

CONCLUSION

While this article has not provided any answers regarding how advertising hosts can protect against fraud, it has hopefully helped to make advertisers aware of important emerging issues associated with online advertising. Although fraud is currently a cost of business that cannot be easily stopped, the advertiser can be wary of signs that suggest fraud and can take measures that compare different media or service providers to track the cost effectiveness of an advertising campaign. Advertising waste exists and is accepted as a cost factor in traditional advertising media; that fraud cannot easily be controlled in online advertising might ultimately (and unfortunately) force us to accept it as a mere nuisance factor of waste in contrasting the cost efficiency of various media.

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KEY TERMS

Advertising Waste: Advertising that reaches an audience that is outside of its target market or intended audience.

Bounce Rate: A ratio of the number of Web page visitors who enter and then back out (leave) without linking from anything on the page (e.g., viewing other pages on the site) vs. the total number of visitors (total *pageviews*), expressed as a percentage.

Click Fraud: Clicking on an online advertisement link for the premeditated purpose of causing a PPC advertiser to pay for the click without the intent to take any other actions (such as buy a product).

Click-Through: When a Web page visitor clicks on a link, such as an advertisement, for more information.

Click-through Rate (CTR): A ratio of the number of Web page visitors who clicked on an ad link vs. the number of visitors who were exposed to the ad, expressed as a percentage.

Customer Conversion Rate (CCR): The percentage of Web site visitors who engage in an ultimate target action such as making a purchase.

Pay-Per-Click Advertising (PPC): A pricing model in which the advertiser pays for each click-through made on an advertising link. Also known as cost-per-click (CPC).

Sponsored Link: A link that is returned on a search engine search for which an advertiser has paid a fee in exchange for prominent ranking.

Category: Concepts, Trends, and Challenges

Ontology Development Tools for Ontology-Based Knowledge Management

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INTRODUCTION

Ontologies play a key role in realizing the full power of e-technology. Ontologies allow for machine-understandable semantics of data, and facilitate the search, exchange, and integration of knowledge for B2B (business-to-business) and B2C (business-to-consumer) e-commerce. Ontology is defined as the specification of shared knowledge (Waterson & Preece, 1999). By using semantic data, the usability of e-technology can be facilitated. There are several languages like XML (extensible markup language), RDF (resource description framework), RDFS (RDF schema), DAML+OIL (DARPA Markup Language+Web Ontology Language), and OWL. Many tools have been developed for implementing metadata of ontologies using these languages. However, current tools have problems with interoperation and collaboration. The primary goal of this survey is to introduce and understand several tools through their use. Therefore, we can develop a new generation of tools that not only support more capabilities, but also solve the problems of current tools.

BACKGROUND

Ontology tools can be applied to all stages of the ontology life cycle including the creation, population, implementation, and maintenance of ontologies (Polikoff, 2003). An ontology can be used to support various types of knowledge management including knowledge retrieval, storage, and sharing (Pundt & Bishr, 1999). In one of the most popular definitions, an ontology is the specification of shared knowledge (Waterson & Preece, 1999). For a knowledge-management system, an ontology can be regarded as the classification of knowledge. Ontologies are different from traditional keyword-based search engines in that they are metadata, able to provide the search engine with the functionality of semantic matching. Ontologies are able to search more efficiently than traditional methods. Typically, an ontology consists of hierarchical descriptions of important concepts in a domain and the descriptions of the properties of each concept.

Traditionally, ontologies are built by both highly trained knowledge engineers and domain specialists who may not be familiar with computer software. Ontology construction is a time-consuming and laborious task. Ontology tools also require users to be trained in knowledge representation and predicate logic.

XML is not suited to describe machine-understandable documents and interrelationships of resources in an ontology (Gunther, 1998). Therefore, the World Wide Web Consortium (W3C) has recommended the use of RDF, RDFS, DAML+OIL, and OWL. Since then, many tools have been developed for implementing the metadata of ontologies by using these languages.

MAIN THRUST OF THE ARTICLE

There are several ontology languages like XML, RDF(S), DAML+OIL, and OWL that are used to implement tools for implementing the metadata of ontologies.

Protégé 2000

Protégé (Noy, Sintek, Decker, Crubezy, Fergerson, & Musen, 2001) is developed by Stanford Medical Informatics. With Protégé, a user can construct domain ontologies, customize data entry forms, and enter data. Protégé has an extensible plug-in architecture, allowing users to add functionality by using plug-ins. Hence, Protégé can be easily extended to use knowledge-based embedded applications. Tables and diagrams are constructed using graphical widgets. However, new basic types cannot be added in Protégé.

Protégé 2000 assumes that knowledge-based systems are usually very expensive to build and maintain because knowledge-based system development is done by a team including both developers and domain experts who may be less familiar with computer software. Protégé 2000 guides developers and domain experts through the process of system development. Developers can reuse domain ontologies and problem-solving methods with Protégé 2000, shortening the time for development and program maintenance. One domain ontology that solves different problems can be used in several applications, and different ontologies can use the same problem-solving methods.

OilEd

OilEd (Bechhofer, Horrocks, Goble, & Stevens, 2001) is developed by the Information Management Group of the CS Department at the University of Manchester, United Kingdom. OilEd is an OIL editor that allows a user to create and edit OIL ontologies. OilEd is primarily intended to demonstrate the use of DAML+OIL, but it does not support a full ontology-development environment. OilEd does not support many activities such as the creation of large-scale ontologies, versioning, augmentation, and the migration and integration of ontologies that are involved in ontology construction. OilEd has no extensibility, but arbitrary class expressions, primitive and defined classes, and concrete-type expressions can be used.

Apollo

Apollo (Koss, 2002) is developed by the Knowledge Media Institute of Open University, United Kingdom. Apollo allows a user to model an ontology with basic primitives such as classes, instances, functions, relations, and so forth. The internal model is a frame system based on the Open Knowledge Base Connectivity (OKBC) protocol. The knowledge base of Apollo consists of hierarchically organized ontologies. Ontologies can be inherited from other ontologies and can be used as if they were their own ontologies. Every ontology has a default ontology, which includes all primitive classes. Each class can create a number of instances, and an instance inherits all slots of the class. Each slot consists of a set of facets. Apollo can be extended with plug-ins, but it does not support collaborative working.

RDFedt

RDFedt is developed by Jan Winkler of Germany. RDFedt allows a user to build complex and structured RDF and RSS (RDF site summary) documents. It provides an overview of complex data structures with element trees. Also, it allows a user to test data and to give comments and error messages with the help of additional functions.

RDFedt supports RDF, RDFS, and Dublin core elements. RSS 1.0 provides modules like aggregation, notation, content, cut, organization, change of page, threading, and so forth. RSS 0.91 supports declaration and levels of styles in XML, sets of imported elements, and the automatic generation of an RDF-based linked list from an HTML (hypertext markup language) document.

RDFedt is a textual language editor. It is not a Java program, is not platform independent, and works only on Windows.

OntoLingua

OntoLingua (Fikes, Farquhar, & Rice, 1997) is developed by the Knowledge Systems Lab of Stanford University. It provides a user-distributed collaborative environment, a suite of ontology-authoring tools, and a library of modular, reusable ontologies. It also supports a World Wide Web (WWW) interface and translation into different formats. OntoLingua is an ontology library and server that can be accessed with a traditional Web browser. By assembling and extending the ontologies obtained from the library and tools in OntoLingua, authorization can be provided. Using Chimaera, the taxonomy is reorganized and name conflicts in the knowledge base are resolved. Multiple users can use OntoLingua via write-only locking and user access-level assignment.

OntoEdit

OntoEdit (Sure, Angele, & Staab, 2003) is developed by Ontoprise of Germany. There are freeware and professional versions. Our survey focused on freeware. OntoEdit offers export interfaces to all major ontology-representation languages and has a flexible plug-in framework. This feature allows a user to customize the tool in a user-friendly fashion. Several functions are modularized, so it can be easily extended.

An ontology requirements-specification document describing what an ontology should support is needed for ontology development. According to the ontology requirements-specification document, an ontology engineer determines relevant concepts and their hierarchical structure in the ontology. OntoEdit can be used in this phase using two plug-ins, OntoKick and Mind2Onto5, for metaontology description with the automatic calculation of statistic information.

WebODE

WebODE (Arpirez, Corcho, Fernandez-Lopez, & Gomez-Perez, 2001; Corcho, Fernandez-Lopez, Gomez-Perez, & Vicente, 2002) is developed by the Technical School of Computer Science in Madrid, Spain. It was made to use and test the methontology methodology. The motivation of WebODE is to support an integrated ontological engineering workbench, which has three activity groups: ontology-development, -management, and -population activities; ontology middleware services; and ontology-based application development. WebODE supports varied ontology-related services and most of the activities involved in the ontology-development process. It is not an isolation tool for ontology development. The WebODE architecture consists of three tiers. The first tier provides the user interface, the second tier provides the business logic, and the third tier consists of the data.

KAON

KAON (KArlsruhe ONtology) (Volz, Oberle, Staab, & Motik, 2003) is developed by the FZI Research Center and the AIFB Institute of the University of Karlsruhe, Germany. KAON is designed to manage business applications. KAON has two user-level applications: OiModeler and KAON PORTAL. All other modules except for these two applications are for software development. OiModeler is an ontology editor for ontology creation and maintenance. We can navigate and search ontologies with a Web browser using KAON PORTAL. KAON supports scalable and efficient reasoning with ontologies; RDFS extension with symmetric, transitive, and inverse relations; and metamodeling using axiom patterns.

ICOM

ICOM is developed by Free University of Bozen-Bolzano, Italy. The purpose of the development of ICOM is to provide a freeware conceptual modeling tool that can be used for knowledge representation in database and ontology design. It is useful in the conceptual modeling of databases and the design of various ontologies. It supports interontology mapping with the GUI (graphical user interface). ICOM is created with Java 1.2 and can be run on Linux and Windows machines. The CORBA (Commoon Object Request Broker Architecture) protocol with the FaCT (Fast Classification of Terminologies) description logic server is used for ICOM communication.

DOE

DOE (Differential Ontology Editor; Isaac, Troncy, & Malais, 2003) is developed by the National Audiovisual Institute in France. It follows a methodology proposed by Bruno Bachimont. DOE is not developed for full ontology development, so many activities in traditional ontology construction are not supported. DOE allows a user to attach a lexical definition to concepts and relations and justify their hierarchy.

DOE has problems importing Dublin core metadata. In DOE, interoperability can be applied using both RDFS and OWL, and concepts cannot be defined intentionally with constraints. Individuals cannot be imported during the running of WebODE.

WebOnto

WebOnto (Domingue, Motta, & Corcho Garcia, 1999), developed by the Knowledge Media Institute of the Open University in England, supports the collaborative browsing, creation, and editing of ontologies, represented in the knowledge-modeling language OCML (Operational Conceptual Modelling Language) without suffering from the interface problems. WebOnto attempts to be easy to use and yet scalable to large ontologies. The main features of WebOnto are the management of ontologies using a graphical interface, the automatic generation of instance-editing forms from class definitions, the inspection of elements taking into account the inheritance of properties, and consistency checking and support for collaborative work using broadcasting and receiving and making annotations. WebOnto consists of a Java-based central server and clients.

Medius Visual Ontology Modeler

Medius Visual Ontology Modeler (VOM) is a UML-based ontology-modeling tool that enables ontology development and management for use in collaborative applications and interoperability, and is available as an add-on to the Rational Rose Enterprise Edition. It is developed by Sandpiper Software. It has a set of ontology-authoring wizards that create and maintain the required UML model elements for the user, substantially reducing construction errors and inconsistencies. That is to say, it supports limited consistency checking.

LinKFactory Workbench

LinKFactory Workbench (Deray & Verheyden, 2003) is designed for very large medical ontologies. The LinKFactory client-server structure is an information system constructed using a three-tier architecture. First, LinKFactory Workbench is a client application on the user side to manage the LinKBase ontology database. Second, LinKFactory is the server interface that receives and answers user requests, holds the business logic, and requests data using the application-server tier. Third, the data layer accesses the underlying database. This database contains all information (user information, ontology contents, and maintenance information).

Table 1. Comparison table

	Import format	Export format	GUI	Consistency check	Multi-user	Web support	Merging
Protégé 2000	XML, RDF(S), XML schema	XML, RDF(S), XML schema, FLogic, CLIPS, Java, HTML	Via plug-ins like GraphViz and Jambalaya	Via plug-ins like PAL and FaCT	Limited (multi-user capability added to it in 2.0 version)	Via Protégé-OWL plug-in	Via Anchor-PROMPT plug-in
OilEd	RDF(S), OIL, DAML+OIL	RDF(S), OIL, DAML+OIL, SHIQ, dotty, HTML	No	Via FaCT	No	Very limited name spaces	No
Apollo	OCML, CLOS	OCML, CLOS	No	Yes	No	No	No
RDFedt	RDF(S), OIL, DAML, SHOE	RDF(S), OIL, DAML, SHOE	No	Only checks writing mistakes	No	Via RSS	N/A
OntoLingua	IDL, KIF	KIF, CLIPS, IDL, OKBC syntax, Prolog syntax	No	Via Chimaera	Via write-only locking, user access levels	Yes	N/A
OntoEdit (free version)	XML, RDF(S), Flogic, DAML+OIL	XML, RDF(S), Flogic, DAML+OIL	Yes	Yes	No	Yes	N/A
WebODE	RDF(S), UML, DAML+OIL, OWL	RDF(S), UML, DAML+OIL, OWL, Prolog, X-CARIN, Java/Jess	Form-based graphical user interface	Yes	By synchronization, authentication, and access restriction	Yes	Via ODEmerge
KAON	RDF(S)	RDF(S)	No	Yes	By concurrent access control	Via KAON PORTAL	No
ICOM	XML , UML	XML, UML	Yes	Via FaCT	No	No	With inter-ontology mapping
DOE	XSLT, RDF(S), OIL, DAML+OIL, OWL, CGXML	XSLT, RDF(S), OIL, DAML+OIL, OWL, CGXML	No	Via type inheritance and detection of cycles in hierarchies	No	Load ontology via URL	No
WebOnto	OCML	OCML, GXL, RDF(S), OIL	Yes	Yes	With global write-only locking	Web based	N/A
Medius VOM	XML schema, RDF, DAML+OIL	XML schema, RDF, DAML+OIL	UML diagrams via Rose	With a set of ontology-authoring wizards	Network based	Via read-only browser support from Rose	Limited (only native Rose model)
LinKFactory	XML, RDF(S), DAML+OIL, OWL	XML, RDF(S), DAML+OIL, OWL, HTML	No	Yes	Yes	Yes	Yes
K-Infinity	RDF	RDF	With graph editor	Yes	Network based	No	N/A

K-Infinity

K-Infinity is a tool developed by Intelligent Views, a German company, for the creation, maintenance, and use of a knowledge network. It is a knowledge editor with broad support for object-oriented knowledge modeling. Knowledge Builder is K-Infinity's main component. Using Knowledge Builder, knowledge engineers and lexicographers can create, delete, rename, and edit both objects and relations, as well as relate objects to each other according to defined relations. This can be done in two different workspaces: (a) the graph editor that enables the user to see a graphical view of the network of objects and the relations of them, and (b) the concept editor that is a supplemental data viewer to the graph editor.

In addition to tools for editing the knowledge, K-Infinity provides the K-Organizer, which provides administration, navigation, search, and query formulation.

Table 1. Comparison table (continued)

	Collaborative working	Ontology library	Inference engine	Exception handling	Ontology storage	Extensibility	Availability
Protégé 2000	No	Yes	With PAL	No	File & DBMS (JDBC)	Via plug-ins	Free
OilEd	No	Yes	With FaCT	No	File	No	Free
Apollo	No	Yes	No	No	Files	Via plug-ins	Free
RDFedt	No	No	No	Yes	Files	No	Free
OntoLingua	Yes	Yes	No	No	Files	No	Free
OntoEdit	No	No	No	No	File	Via plug-ins	Free
WebODE	Yes	No	Prolog	No	DBMS (JDBC)	Via plug-ins	Free
KAON	No	Yes	Yes	No	DBMS	No	Free
ICOM	No	No	Yes	No	DBMS	Yes	Free
DOE	No	No	Yes	No	File	No	Free
WebOnto	Yes	Yes	Yes	No	File	No	Free Web access
Medius VOM	Yes	Yes (IEEE SUO)	Yes	N/A	N/A	Yes	Commercial
LinKFactory	Yes	Yes	Yes	No	DBMS	Yes	Commercial
K-Infinity	Yes	Yes	Yes	N/A	DBMS	No	Commercial

FUTURE TRENDS

There are still some research challenges. Ontology tools have to support more expressive power and scalability with a large knowledge base, and reasoning in querying and matching. Also, they need to support the use of high-level language, modularity, visualization, and so forth.

There are also research and applications about dynamic Web pages consisting of database reports. Database reports are indispensable for every e-commerce transaction (Tarassenko & Bukharova, 2001).

Research on ontology-integration tasks in B2B e-commerce is also undergoing. The infrastructure of business documentation from the integration perspective and the identification of the integration subtasks were suggested (Monostori, Váncza, & Ali, 2003)

There is research on a generic e-business model ontology for the development of tools for e-business management and IS requirements engineering. Based on an extensive literature review, the e-business model Ontology describes the logic for a business system (Osterwalder, Parent, & Pigneur, 2004).

CONCLUSION

So far, we have described 14 ontology tools. All of these tools are ontology-development tools. To compare each tool's features, we have chosen the tools with similar purpose. Of course, there are many other tools that have different purposes. For example, Chimaera, FCA-merge, and PROMPT are ontology-merge and -integration tools. AeroDAML, COHSE, MnM, and OntoAnnotate are ontology-annotation tools. Sesame, Inkling, rdfDB, Redland, jena, and cerebra are ontology-storing and -querying tools.

Several important aspects when we analyze tools exist. Most of the tools are moving toward Java platforms and extensible architectures as well. Interoperability and storage in databases are still weak points of ontology tools.

Polikoff (2003) used Protégé 2000, OilEd, and OntoEdit to test the interoperability of ontology tools. For example, plain RDFS from OilEd could be used in OilEd and Protégé 2000, but it was not working well in OntoEdit. Plain RDFS from Protégé 2000 could be used in Protégé 2000 and OilEd version 19990303, but it could not be used in OntoEdit. Also, standard Oil RDFS from Protégé 2000 and OWL from OilEd could not be used in all tools (OilEd, Protégé 2000, and OntoEdit). DAML+OIL from OilEd could be used in OilEd and OntoEdit with minor problems, but it could not be used in Protégé 2000. Interoperability with other ontology-development tools, -merging tools, and databases, as well as translations to and from some ontology languages, is an important factor in order to integrate ontologies in applications. However, there are few comparative studies about the quality of all translators, the possibility of exchanging ontologies between different tools, and the loss of knowledge in the translation processes.

In case of storage, only a few of the surveyed tools use databases for storing ontologies: LinKFactory, OntoEdit Professional Version, Protégé 2000, and WebODE. Also, only a few have backup-management functionality.

Although a lot of similar ontology tools exist for ontology creation, they do not interoperate well and do not cover all the activities of the ontology life cycle. The lack of interoperability between all these tools creates important problems, for example, when we integrate an ontology into the ontology library of a different tool, or when two ontologies built using different tools or languages are integrated using merging tools.

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KEY TERMS

B2B (Business-to-Business): Business that provides some kind of services or sells some product to other businesses.

E-Technology: Technology including hardware and software, and their development using Internet, multimedia, mobile, wireless, and security technologies, and so forth.

Knowledge Management: Systematic process of finding, organizing, and presenting information according to a specific area of interest.

Metadata: Data about data, or machine-understandable information for the Web that describes other data.

Ontology: The specification of shared knowledge (Waterson & Preece, 1999) and the relationships of the collected concepts.

Ontology-Management System: System for querying, storing, creating, modifying, loading, accessing, and manipulating ontologies.

Semantic Web: Extension of the current Web with well-defined meaning, facilitating machines and people to work in cooperation.

Ontology for E-Government Public Services

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INTRODUCTION

In the past few years, information and communication technologies are increasingly used for provision of public services, improvement of managerial effectiveness and promotion of democracy, a development that is commonly termed as e-government (Gil-Garcia, 2004). Transactional services are an indispensable tool for delivering public services and can additionally be used for democracy promotion (e.g., via questionnaires and polls), thus, playing a central role in e-government. Transactional services development and promotion has also been in the focus of specific projects and initiatives (e.g., European Commission, 2004) or supporting frameworks (e.g., UK online, http://www.govtalk.gov.uk/schemasstandards/egif.asp).

E-government services have now been developed to cover the basic services that should be delivered to citizens and enterprises (Cap Gemini Ernst & Young, 2004). Administrations realise however, that besides making new e-services available or enhancing existing ones, a number of issues regarding e-services has to be addressed, including:

1. **E-Service Composition:** In many cases, different public services need to be combined to fully service the needs of a service consumer (citizen or enterprise) in a particular point in time. This issue is often termed "handling of life events" (Wimmer & Tambouris, 2002).
2. **E-Service Cataloguing:** Mechanisms enabling service consumers to locate the available e-services should be provided (Gant & Gant, 2002). These mechanisms should cater for the needs of all service consumers, such as incorporation of multiple taxonomies for e-services (e.g., by delivering organisation, life events, by service category, etc.), provision of search facilities, retrieval of relevant legislative information, etc.
3. **Change Management:** Legislation regarding governmental services is often revised, necessitating changes to the content or procedures of services (Vassilakis, 2003). E-services are more prone to changes since the regulatory framework of e-service provision can also be subject to modifications (e.g., stronger encryption or stricter authentication requirements). Whenever changes occur, the affected services (or service portions) must be located and undergo maintenance activities. *Cascading effects* may also appear, (e.g., if service A depends on service B and service B is modified, harmonisation actions may be needed for service A).
4. **Administrative Responsibility:** The administrative responsibility must be clearly reflected in all phases of e-services lifecycle (Cassese & Savino, 2005), since it determines both the authoritative source to define (or revise) requirements and procedures and the canonical bureau for operating the e-service, resolving issues, etc. In some cases, operation of services can be delegated by the administratively responsible authority to other agencies, (e.g., the ministry of internal affairs is administratively responsible for the service "issuance of birth certificates", but municipalities or citizen service centres can be endorsed to also deliver this service.

The issues previously identified reveal the need for *semantically rich* means for representing the various aspects of e-services. Indeed, through these descriptions a number of *concepts* (i.e., types of entities such as service, document, service consumer, legislation, etc.) are identified, which are connected through various *relationships* (e.g., a service "issues" a document, a regulation "governs" a service and so forth). Such a representation, together with the appropriate tools, would facilitate the task of locating specific concepts, and then exploit the relationships to trace other concepts linked to them. For instance, if a piece of legislation is linked to a number of e-services through links of type "governs", these links can be used to pinpoint the services that should undergo maintenance activities when this piece of legislation is modified.

In this article, the usage of ontologies for meeting the requirements previously listed is examined. An ontology for e-government services is presented, covering various aspects of services, including administrative responsibility, meta-data, involved documents, and legislation. Both the development and usage phase of the ontology are covered and directions for further exploitation of the potential offered by the ontological representation are given.

BACKGROUND

According to W3C, "an ontology defines the terms used to describe and represent an area of knowledge" (W3C, 2004), defining *classes* (or *concepts*), which are general things in the domain of interest, *relationships* that may exist among things and *properties* (or *attributes*) those things may have. Ontologies can also be viewed as descriptions (like a formal specification of a program) of the concepts and relationships that can exist for an agent or a community of agents (Gruber, 1993).

The representational capabilities of ontologies can be complemented with reasoning capabilities through specific rule languages and rule evaluation engines, (e.g., SWRL [Horrocks, et al. 2004], the KAON2 reasoning engine [Motik, Sattler, & Studer, 2004]), providing thus a framework that completely supports the requirements presented above. Reasoning aims at extracting information not directly represented, mainly through the application of rules on the given facts. For example, the organisations through which a document is issued can be determined by first identifying the services that produce the specific document and then retrieving the organisations that offer these services. This can be represented as a rule of the form "if (offers (Organisation, Service) AND issues (Service, Document) THEN issues (Organisation, Document))". Such a rule is evaluated by a reasoning engine against the existing ontology to produce the list of organisations issuing a specific document. Finally, the use of ontologies enables direct integration of public services into the semantic Web (Berners-Lee, Hendler, & Lassila, 2001), multiplying the benefits of this approach. For this purpose, special languages have been designed, including DAML and OIL, whereas RDF can be also used for defining assertions (Davies, Fensel, & Harmelen, 2003).

The issue of service composition is typically tackled using pre-determined execution scenarios, where human experts model the execution order, flow control, and data dependencies of constituent services (Bunting, et al., 2003; Wimmer & Tambouris, 2002). More flexible frameworks allow the dynamic modification of certain model elements (Casati, et al., 2000), while commercial systems enable the graphical modelling of composite services and provide engines for their execution (Iona, 2005; Oracle, 2004).

In the area of e-service cataloguing, the predominant approach is the use of portals, (e.g., FirstGov of US (http://www.firstgov.gov) and DirectGov of UK (http://www.direct.gov.uk/). Portal maintenance is however a costly task, since the need for flexibility and support of multiple views in a change-prone environment, necessitates frequent updates and extensive consistency checks.

The relationship between e-services and legal documents or administrative information is usually handled in an ad-hoc manner. In the best case, legislation databases will be used for maintaining the "point-in-time" versions of the legislation (Teratext Solutions, 2004), but no direct linkage to relevant e-services is established. Similarly, administrative information for e-services is stored in an unstructured form within the legislation and/or the public authorities' regulatory framework.

Recently, the usage of ontologies for modelling e-services has been examined. In Bougouettaya, et al., (2001) ontologies are used as a basic model for organising and discovering e-services. An important aspect of this work is the *ontology distribution*, which facilitates a semi-autonomous maintenance of the ontology data, with each administration maintaining a specific ontology portion. In (Tambouris et al., 2004), the usage of ontologies in application development is examined. Finally, in Adams et al., (2002) an ontology is formulated to promote knowledge management in the context of e-service development.

PUBLIC SERVICE ONTOLOGY: KEY REQUIREMENTS, MODELLING, AND USE

For a public services ontology to be useful, a number of requirements have to be met. Firstly, the ontology should be *complete*, (i.e., it should cover all relevant aspects of services). Secondly, it should facilitate *incremental development* by incorporating certain concepts and relationships at an initial phase and then defining new ones, or creating instances as needed. Due to the decentralised responsibility scheme for public services, it is desirable to build an ontology scheme that can be jointly developed by multiple authoritative sources. Each source would maintain its own portion of the ontology, and the combination of all portions would form the global perspective. The ontology should allow the extraction of different *views* or *taxonomies* (Adams et al., 2002) enabling public service stakeholders to navigate within the ontology concepts as best suited to their interests, or the task at hand. The *semantics* of the concepts and relationships within the ontology should be clearly defined; semantic ambiguity and ad-hoc concept and relationship types would encumber user navigation within the ontology and hinder reasoning through rules.

The Ontology Template

In order to guarantee that the ontology only contains approved concept and relationship types, the editing process is supported by an *ontology template*, which defines all the allowable concepts and relationships that can be used by the ontology editor. For relationship types, the ontology template also designates which concept types can be linked using any particular relationship. For example, the "offers" relationship type can link concepts of types "service" and "organisation" but cannot two concepts of types "service" and "legislation". Table 1 lists some of the main ontology template concepts, while Figure 1 illustrates these concepts, along with associated selected specialisations (sub-concepts), as modelled using the KAON tool (http://kaon.semanticweb.org/).

In Figure 1, only *isa*-type relationships (specialisations) are displayed, for clarity purposes. The input for this ontology was gathered from e-government public service stakeholders (including managers, domain experts, help desk workers and IT staff) in three European countries (UK, Greece, and Spain). Cognitive maps (Axelrod, 1976) were the basic tool for guiding the input collection process.

Ontology Population

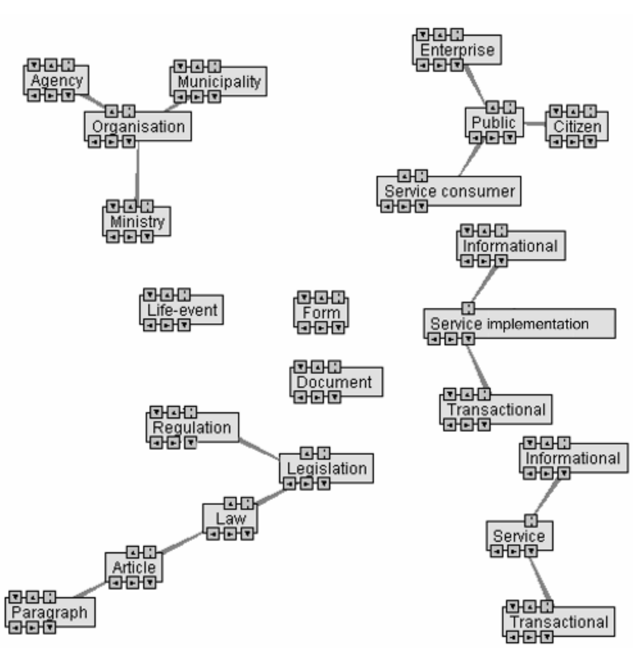
The ontology template is the basis for enabling the ontology development process, since it defines the semantics available to ontology editors. A second necessary step is the definition of *administrative responsibilities*, associating editing rights on portions of the ontology to different public authorities. Under this scheme, first-level administration entities (such as ministries) are created as *instances* of the relevant "organisation" sub-concept and are granted the privilege to create sub-concepts or instances of concepts in the ontology. For example, the Ministry of Finance may create the "Taxation Office" concept as a sub-concept of "Agency" and instantiate it multiple times to populate the ontology with information about tax offices. Additionally, the Ministry of Finance can directly instantiate a concept of the ontology template (e.g., "regulation") to provide data for a new piece of legislation. The organisation creating a specific sub-concept or instance is its *owner* and automatically assumes full permissions on it. Other organisations may view all sub-concepts and relationships between them in the "global" view, however they cannot modify them. Establishment of relationships between concepts may be subject to restrictions, depending on the relationship semantics. For example, the "offers" relationship linking an organisation to a service can only be established by the organisation that is administratively responsible for the service. Such a linkage states that the organisation has the right to offer this service and enables it to create an instance of the "service implementation" concept, which describes the characteristics of the specific service offering. Conversely, no restrictions are placed for the establishment of the "involves" relationship between a life-event and a service, since life-events may include services offered by any organisation, regardless of the organisation defining the life-event.

Both concept and relationship instances host various data items describing the information items they represent, constituting thus *meta-data*. The allowable data items per concept and relationship type are recorded

Table 1. Concepts in the ontology template

Concept	*Description*
Service	A means offered to the public for conducting business with the government.
Service consumer	A citizen or enterprise that is a potential user of a service.
Organisation	A governmental division that is responsible for defining and/or offering services to service consumers.
Service implementation	A concrete form of a service offered by an organisation and made available to service consumers.
Legislation	Any type of official document or practice that regulates the operation of services.
Form	An instrument through which a service consumer requests a service, typically by provision of field values and submission.
Document	An official certificate issued by services.
Life-event	An incident for a service consumer that necessitates the use of a number of services.

Figure 1.Part of the e-services ontology



within the ontology template. For example, a "service implementation" concept instance contains data slots regarding the method for invoking the service (Web form, Web service, RMI, etc), the address at which the service is accessible (e.g., URI for Web form, WSDL file location for Web services and so forth), the expected turnaround time for an invocation etc.

Service Composition Using the Ontology

Two of the relationship types defined in the ontology template, namely the "issues" and "uses", are of particular interest for the purposes of service composition. A relationship of type "issues" between an instance of the "service" concept and an instance of the "document" concept, asserts that the specific service may be used to obtain the designated document. A relationship of type "requires" between an instance of the "document" concept and an instance of the "service" concept declares that the service uses as input a document of the indicated category. For example, a "requires" link pointing from the "Marriage License Issuance" service to the "Birth Certificate" document illustrates that service consumers must present a "Birth Certificate" document as input to the "Marriage License Issuance" service. These relationship types can be exploited by *dynamic service composition engines* to formulate on-the-fly *service composition paths*. When a service S is requested, the service composition engine extracts all relationships of type "requires" emanating from it to identify the required input documents and, by subsequently following the "issues" relationships, the services producing these documents are pinpointed. This procedure is iteratively executed until no further dependencies exist. Note that if multiple services can issue the same document, or if multiple implementations for a single service exist, the service composition path will contain alternative routes leading to the desired result. The service composition path enactment mechanism may select the most prominent routes, employing optimisation criteria (e.g., current system load or expected turnaround time of services, as indicated by the metadata in the ontology).

Service Cataloguing through the Ontology and Ruels

The ontology can be exploited by service cataloguing mechanisms (e.g., portals), to present service consumers with flexible means for locating services. Since service catalogues are generally organised as taxonomies, the first step towards building a catalogue is to locate the taxonomy root entry. This can be any top-level concept (e.g., "Organisation", "Life-event" or "Document"). Afterwards, sub-concepts and instances are extracted to formulate lower-level taxonomy branches, and relationships are used to identify services that will become the taxonomy intermediate-level or leaf nodes. For example, if the "Life-event" node is used as root entry, its instances ("Birth of a child", "Building a house" etc.) are extracted and afterwards the "involves" relationships between the life-event instances and the respective service instances are traversed to populate taxonomy branches with pertinent services. Through this approach, the ontology may be used to create multiple service classification schemes, by selecting alternate root entry concepts and/or traversing different relationship types. The rules for service catalogue creation (i.e., the definition of concept and relationship types that will be used, the order of processing etc.) can be stored alongside the ontology, or be incorporated within each service cataloguing mechanism. Finally, querying mechanisms may be provided to enable service consumers to locate elements of the ontology whose contents match a set of criteria (e.g., the name of a service or a document), as an alternative to browsing.

FUTURE TRENDS

Ontologies are considered nowadays a key element for semantic interoperability, and information exchange between computers and humans in high complexity environments, providing an effective means for representing information in high levels of abstraction. For a more efficient use of ontologies, it would be beneficial if the immediate possessors of the knowledge could directly maintain the relevant ontology portions, without ontology experts' intermediation. To this end, ontology elucidation frameworks should be designed and appropriate tools must be developed and made available to domain experts.

Temporal characteristics are also of particular importance, especially in highly volatile environments such as the one of public services. The ontology framework must be thus extended to cater for the creation and querying of concept and relationship versions, maintaining simultaneously temporal consistency rules for concepts, relationships and instances (e.g., only one version should be active at any point in time).

CONCLUSION

In this article we have presented an ontology for e-government public services. The ontology covers multiple aspects of services, including administrative responsibility, involved documents, legislation, and metadata, formulating a semantically rich network of interrelated concepts. This network can be jointly developed by public administrations, subject to administrative authorisation, and directly supports essential tasks of service provision, such as service composition, change management and service cataloguing. This ontology may be complemented with active mechanisms, including rule processing engines, workflow enactment modules, etc., to deliver value-added services (e.g., invocation, coordination, and data exchange between the constituent services within a service composition path). Future work will focus on the definition and management of temporal characteristics, the creation of an integrated platform that will fully manage the ontology and encompass mechanisms for provision of value added services. Integration with third-party information systems, such as legal databases for extracting legislation information, will be also considered.

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KEY TERMS

Change Management: The procedure that controls the evolution of public services to keep them consistent with their governing legislation, user needs, technological developments etc.

E-Service Catalogues: Mechanisms enabling service consumers to locate the available e-services. Most often, these mechanisms are hierarchical classifications of the services under some categorisation axis (offering organisation, target group, etc).

Life-Event: An incident for a service consumer that necessitates the use of a number of services.

Ontology: An ontology defines the terms used to describe and represent an area of knowledge, defining classes (or concepts—general things in the domain of interest), the relationships that may exist among things and the properties (or attributes) those things may have. A set of concepts interrelated by binary typed roles. The concepts may be organised in specialisation/generalisation hierarchies. Ontologies may be used for information exchange between computers and humans in environments of high complexity.

Ontology Distribution: A mode of semi-autonomous maintenance of ontology data, according to with each public authority maintains specific portions of an ontology.

Public Service: A means offered to the public for conducting business with the government. The service may be directly targeted to be used by humans (e.g., Web forms and the associated back-end programs) or be oriented towards invocation by information systems (e.g., a Web service).

Reasoning: The extraction of information not directly available, mainly through the application of rules on the given facts. This procedure is driven by the reasoning engine.

Service Composition: The combination of simple services to achieve a value-added result and fully service the needs of a service consumer (citizen or enterprise) in a particular point in time

Ontology-Based Query Formation and Information Retrieval

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BACKGROUND

M-commerce is largely unrealized to date because there still does not exist a single killer application that can attract wireless users to use wireless services. According to a recent survey by the Gartner, Inc. (Wong, 2005), besides the importance of coverage of wireless network and pricing issues, the wireless Internet and data services is the next crucial factor that attracts users to wireless service. As such, there is a need to improve the data services over the wireless network. One of these services is the information retrieval service.

This article discusses the usage of ontology to create an efficient environment for m-commerce users to form queries. The establishment of a method that combines keyword searches with using ontology to perform query formation tasks further allows a more flexible m-commerce environment for users. Also, with the use of genetic algorithm, it is hoped that query effectiveness can be achieved, at the same time saving computational time.

Definition of Ontology

In artificial intelligence, ontology is defined as a design of a conceptualization to be reused across multiple applications (Bailin, 2004; Braga, Werner, & Mattosso, 2000; Fensel, 2000; Hendler, 2001; Riza & Oguz, 2002). A conceptualization is a set of concepts, relations, objects and constraints that define a semantic model of some domain of interest. In other words, ontology is like the structure that describes or encodes the conceptualization in any relational aspect (Ambrosio, De Santos, De Lucena, & De Silva, 2004; Karp, 2000; McGuinness, 1998; Sugumaran & Storey, 2003).

Chandrashekaran and Josephson (1999) described ontologies as the conceptualization that underlies knowledge, without which there will not be a vocabulary for representing knowledge. Besides modeling knowledge, the ontology is also a structure that can be made publicly available, thereby enabling knowledge sharing.

According to Howarth (2004), in agent technology, ontology is especially useful, as agents are able to learn the behavioral patterns of constraints and resources of business networks. These intelligent agents are then able to store their knowledge into an ontological structure which, besides storage, enables the observation of the interaction of the resources. Ontology, therefore integrates intelligence into the nodes of the network, providing a context in which intelligent decisions are made.

Literature Review

Unlike in e-commerce, query information using keywords alone in m-commerce is unrealistic, as mobile devices are too small and keypads are not suitable for typing. Moreover, it may be difficult for the user when vocabulary of subject is unfamiliar. Thus, relevance feedback is still the main technique for query modification.

Relevance feedback technique has been investigated for more than 20 years in various information retrieval models, such as the probabilistic model and vector space model (Boughanem, Chrisment, & Tamine, 1999; Salton, 1989). It is based on randomly changing the set of query terms as well as the weights associated with these terms according to the document retrieved and judged during the initial search.

In genetic algorithm, much research (Boughanem et al., 1999; Guan & Zhu, 2004; Kraft, Petry, Buckles, & Sadasivan, 1994; Kouichi, Taketa, & Nunokawa, 1999; Yang & Korfhage, 1994) has been done on how it (GA) can be used in information retrieval. One popular approach is query restructuring, which is used to improve the efficiency and effectiveness of the queries formed. GA actually extends the concepts of relevance feedback. The difference is that genetic algorithm uses more than one query and compares the fitness among these queries. The fittest query will survive in the end. Thus, this article focuses on extending the concepts of using genetic algorithms in query restructuring.

Fitness Functions

There are a number of measures of query fitness used in previous works, namely precision and recall retrieved (Kraft et al., 1994; Salton & McGill, 1983), average search length (Losee, 1991), and average maximum parse length (Losee, 1991).

Precision is the percentage of documents retrieved that are relevant, whereas *recall* measures the percentage of the relevant documents retrieved (Kraft et al., 1994; Salton & McGill, 1983). These two terms tend to be inversely proportional so that one is traded for one another in most situations. *Average search length* is the average number of documents or text fragments examined in moving down a ranked list of documents until arriving at the average position of a relevant document (Losee, 1988, 1996). Evaluating the performance of a filtering or retrieval process with average search length provides a single number measure of performance. *Average maximum parse length* is the average (over a set of sentences) of the largest number of terms in a parse for each sentence. There are also measures that combine both average search length and average maximum parse length.

Typically, present methods had only dealt with the relevance of the document retrieved. This is reasonable but inefficient because it is rather difficult to indicate the relevance of a document when the number of documents could be very large. This chapter measures the relevance of queries instead of documents retrieved. Based on this, efficiency will be improved significantly as the number of queries will be much smaller than the number of documents retrieved, which is ideal for mobile devices. The objective of this article is threefold: (a) to research the use of ontology to assist the users in shaping up their product enquiries; (b) to study the use of genetic algorithms and agents in query optimization, and (c) to develop information retrieval services for the m-commerce arena. This article proposes a methodology for efficient query formation for product databases and for effective information retrieval systems, which includes the evaluation of retrieved documents to enhance the quality of results that are obtained from product searches.

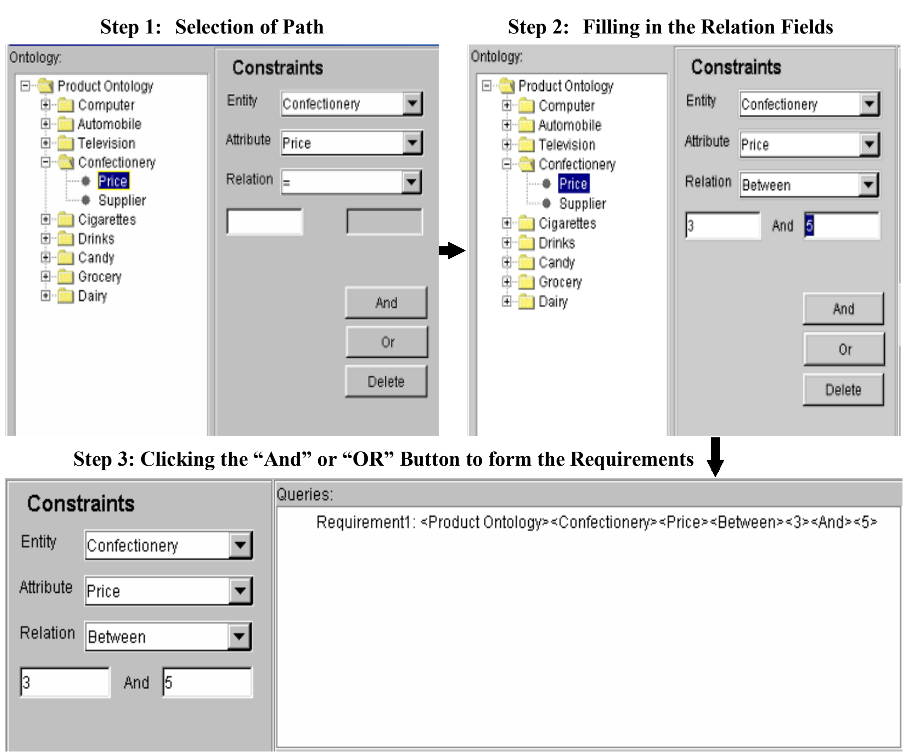
DESCRIPTION OF ONTOLOGY-BASED QUERY REFINEMENT APPROACH

Prototype Design and Implementation

Query Formation Using Ontology

Query formation will be done with the aid of tree ontology. Following the tree path will help form the requirements of a query and thus allow easy forming of a query. An illustration of the query formation process is shown in Figure 1. As can be seen from this illustration, using ontology helps the user to save several steps by forming a query using the ontology path that is selected. Thus, it can be claimed that forming queries using ontology are actually more efficient than using keywords.

Figure 1. Illustration of using ontology to form queries



Combining Keywords and Ontology

The design of parallel combination is rather straightforward. Ontology does not cover everything. Thus, besides having ontology for the user to click on when forming a query, there should be some fields present for the user to fill in. When these fields are being filled in, they can either replace the use of ontology either partially or completely. For a serial combination, keywords are used to look for ontology terms in the ontology. This is necessary because when the ontology is too large, search for an ontology term by manual clicking becomes difficult. Thus, there would be a field that allows the user to highlight the terms in the ontology itself as shown in Figure 2. From this illustration, it can be seen that using keywords to search ontology terms in the ontology creates an efficient environment and context for the user.

Information Retrieval

Using the query formed by the query formation application, an application searches the databases to retrieve information. Intuitively, this application would first do a normal search before allowing the user to proceed with a genetic algorithm search. This is because a genetic algorithm search would definitely take a much longer time than a normal search because of its expensive iterations. The retrieval results are presented to the user and if he is not satisfied, he can then choose to proceed with a genetic algorithm search.

Genetic Algorithm

If the user requests for the use of a genetic algorithm, the system will request for some input from the user to perform genetic algorithm computation. The system then creates a population of queries from the original query. Basically, genetic algorithm will mutate the queries according to the synonyms of the terms in the ontology.

The Fitness Function

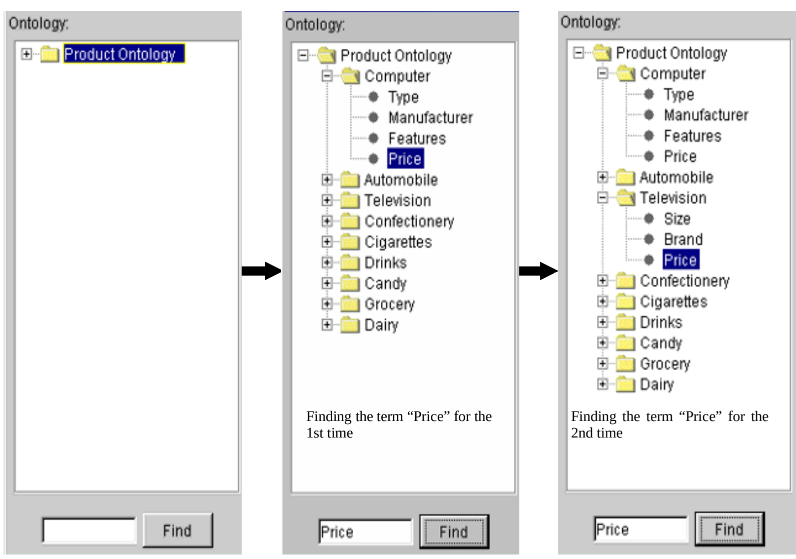
The main concern of using genetic algorithm is the design of the fitness function. In this application, three major elements are used to define the fitness function, namely, the fitness of the number of documents retrieved (f_d), the fitness of the average quality of the query results (f_q) and the overall correlation for the query (f_r). The fitness of each chromosome is calculated as follows:

$$\textit{Fitness} = |f_r \cdot (f_d + f_q)|$$

| . | indicates that the fitness function is normalized to form a population distribution function.

The calculation of the value of f_d is not straightforward. Let i be the ideal number of documents specified by the user. If the user does not know the value of i, the default value will be 20. Using the value of i as the mean value, two "band pass filters"-like functions, namely the triangular and Gaussian functions, are used to create a more flexible mapping from number of documents retrieved (d) to f_d. The triangular function gives a constant

Figure 2. Illustration of the sequence of events for finding ontology terms



drop in "gain" (decrease in fitness) from the "center frequency" (the mean). This function is good when the user wants to give an equal amount of demerits for every document that is away from his expected or ideal number. The Gaussian function is a more robust or high-ordered "band pass" such that its" bandwidth" could be specified by the value of the standard deviation. Thus, this function is useful when the user wants to give heavy demerits to queries that do not fall near his expected or ideal number.

Only requirements that are specified by numerical constraints will have the value f_q. Here, it is required that the numerical values are summed up and averaged. Then, they are normalized. The signs "<" and ">" formed during the query indicate the direction towards which the quality is favored.

Another interesting portion that contributes to the fitness function is the correlation of the synonyms (f_r) with the ontology terms. A value from 0 to 1 is assigned to each relation between the ontology terms and their synonyms. When a requirement is <Television> <Price><<><2000>, the value or f_r will be the product of all the discrete correlations. Also, the user should be able to edit the correlation values to his preference. When there are many requirements in the query, these requirements will be linked with an "OR" or "AND" term.

Mutation and Crossover

The concept of mutation is to replace some terms with synonyms when parsing the results. Basically, the mutants are the terms that are included in each query. These terms are mutated randomly according to the synonyms so that new populations will be formed. Crossover will only be just interchanging the different genes between two different chromosomes. A 1-point crossover will be performed. This is also done randomly.

Feedback and Selection of Survival

The survivors are selected according to their overall fitness in the roulette-wheel selection manner. However, before this is done, the system will prompt for feedback from the user. The feedback will show the user some quality of each query. From this quality metric, the user may choose to kill queries that do not meet his requirements. Figure 3 shows a screenshot of a feedback presented to the user. If the user is satisfied with the results, he can choose to end the genetic algorithm by clicking on the "Stop" button. In this way, he can look at the retrieved results immediately.

Prototype Testing and Evaluation of Genetic Algorithm

Effectiveness of the Genetic Algorithm

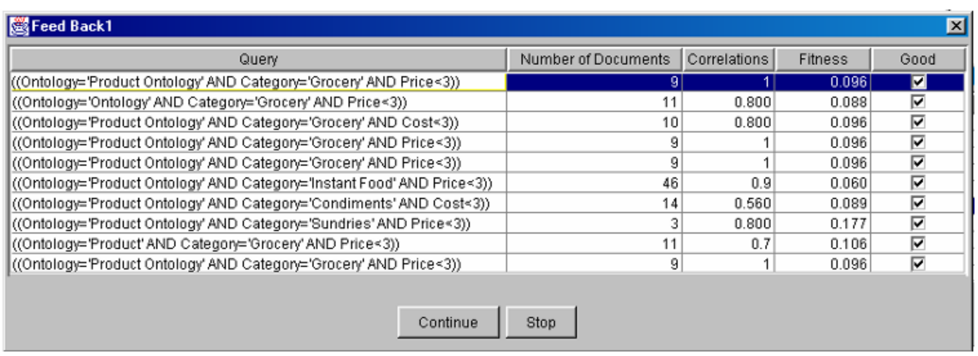
It is believed that the effectiveness of the chosen genetic algorithm is mainly determined by its supremacy in query effectiveness amplification. This is because its evolution power allows more retrieval results. The system was tested with a product list database. The effectiveness was measured by testing a series of queries with and without using genetic algorithm. For example, a query, "<Product Ontology><Grocery><Price><<> <3>", can retrieve only 9 items when a normal search was performed but can retrieve 98 items when genetic algorithm was performed. Table 1 shows the other results obtained by other queries.

By comparing the results shown in Table 1, it is obvious that using genetic algorithm does, in fact, retrieve more items than using a normal search.

Effect of the Fitness Function

The fitness function in a genetic algorithm determines how well it can optimize a query. The OntoQuery system tested out various fitness functions to improve the power of the genetic algorithm. The usage of triangle or Gaussian functions to evaluate the fitness for the number of documents retrieved suggested some ways to counter the "too

Figure 3. Screenshot of a feedback frame



Query	Number of Documents	Correlations	Fitness	Good
((Ontology='Product Ontology' AND Category='Grocery' AND Price<3))	9	1	0.096	☑
((Ontology='Ontology' AND Category='Grocery' AND Price<3))	11	0.800	0.088	☑
((Ontology='Product Ontology' AND Category='Grocery' AND Cost<3))	10	0.800	0.096	☑
((Ontology='Product Ontology' AND Category='Grocery' AND Price<3))	9	1	0.096	☑
((Ontology='Product Ontology' AND Category='Grocery' AND Price<3))	9	1	0.096	☑
((Ontology='Product Ontology' AND Category='Instant Food' AND Price<3))	46	0.9	0.060	☑
((Ontology='Product Ontology' AND Category='Condiments' AND Cost<3))	14	0.560	0.089	☑
((Ontology='Product Ontology' AND Category='Sundries' AND Price<3))	3	0.800	0.177	☑
((Ontology='Product' AND Category='Grocery' AND Price<3))	11	0.7	0.106	☑
((Ontology='Product Ontology' AND Category='Grocery' AND Price<3))	9	1	0.096	☑

Table 1. Results showing effectiveness of GA

Query Formed	Without GA	With GA
<Product Ontology><Drinks><Price><<><2>	25	95
<Product Ontology><Diary><Price><<><3>	3	92
<Product Ontology><Candy><Price><<><3>	13	178
<Product Ontology><Confectionery><Price><<><3>	20	248
<Product Ontology><Confectionery><Supplier> <Contains><Ho>	1	52

many or too few retrieved documents" dilemma in typical search engines.

Efficiency of the Genetic Algorithm

Although using genetic algorithm allows a more flexible and effective platform in retrieving information, there is no doubt that it trades off efficiency due to its expensive iterations. Thus, the only study that can be made here is about its improvement over relevance feedback. In relevance feedback, query expansion is achieved by modifying a query. Similarly, genetic algorithm extends the relevance feedback techniques with an additional rule, the survival of the fittest.

In this research, the efficiency of the system is measured as follows:

$$\varepsilon\,(\text{Efficiency}) \approx \frac{E}{t} \approx \frac{D}{I}$$

where E denotes the effectiveness of the system,
t denotes the time taken for the system,
D denotes the number of relevant documents retrieved, and
I denotes the number of iterations.

Efficiency is formulated as above because it is believed that the number of documents retrieved is linearly proportional to the effectiveness of the system. Also, the number of iterations is directly related to the time taken to retrieve the results.

IMPACT OF ONTOLOGY-BASED QUERY REFINEMENT APPROACH

Both keyword-based and ontology-based approaches have their advantages and disadvantages. Ontology provides the structure, context and visual aid while keyword provides a direct search mechanism. Both approaches are relevant for mobile commerce because they save time in browsing and searching, which is very much required by mobile users who are always on the move. Thus, by combining keyword queries with ontology, it is possible to achieve a better and more effective query formation. Before ontology terms are accessed to form the queries, there will be a keyword search to find the required ontology term. For example, ps2 can be hidden in the node "mouse" when presented in the ontology. The user will not be able to know where ps2 can be found intuitively without eyeballing the ontology. With the help of keyword search, the term *ps2* can be found easily.

In forming queries, there can be a high chance that the vocabulary used by the user to describe a query does not exactly match the vocabulary used by a query system (Preece et al., 1999). This will result in getting insufficient information. Therefore, restructuring dealing with domain ontology relationships might be useful. These relationships involve semantic links such as hyponyms and synonyms (Braga et al., 2000). Using synonyms is an adequate option to restructure queries because it correctly broadens the scope of search, even to the extent of different languages.

When too little information is retrieved, the use of synonym or hyponym might be necessary in order to relax the constraints of the query. This approach, however, has a major disadvantage. By relaxing the constraints of a query using synonym or hyponym to increase the number of documents retrieved, one could actually deface the meaning of the original query such that it could drift away from the user's intention. This concern can be alleviated by having user feedback along the process. Also, we have considered to relax constraints step-by-step. This option can better eliminate the chances of constructing far-fetched queries from the use of genetic algorithm.

CONCLUSION AND FUTURE WORK

This article investigated the OntoQuery system within an m-commerce agent framework against current query formation and information retrieval systems from extant work that were not intended for m-commerce. The prototype implementation results showed that querying formation using an ontology approach is efficient as it provides a friendly environment to the user using mobile devices. In addition, by combining the keyword and ontology approaches, a more efficient and effective way of forming queries could be achieved. Thus, the objective to propose efficient query formation for product databases is successful.

It was found that genetic algorithm is able to optimize queries effectively. Also, using genetic approaches, we have proposed and tested out various fitness functions for searching product databases. Moreover, adding feedback to the system helps it to cater to the needs of the user more closely.

Considering typical e-commerce or m-commerce users using mobile devices for product enquiry tend to have some time constraints and they need quick response before making decisions, our work suggests a feasible approach. With the use of ontology, product enquiry can be formed easily and quickly. With the help from genetic algorithms and agents and the technique of query optimization such as query restructuring, futile enquiries can be turned into productive. And finally, the use of genetic algorithms help improve the quality of product information retrieved.

We consider the following for future work. With the usage of synonyms, it is rather tedious for the user to add synonyms to his ontology terms. There is a need to automate the learning of synonyms from other agents. The synonym table of each agent may start off as one with only a few synonyms. Because the synonym table is also an ontology, learning synonyms can be achieved by ontology exchange. During the interaction among agents, the agents will exchange their synonyms for a particular query or even during product ontology exchange.

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KEY TERMS

Agent: A software agent is a piece of autonomous, or semi-autonomous proactive and reactive, computer software. Many individual communicative software agents may form a multiagent system.

Genetic Algorithm: A genetic algorithm (GA) is a heuristic used to find approximate solutions to difficult-to-solve problems through application of the principles of evolutionary biology to computer science.

Information Retrieval: Information retrieval (IR) is the art and science of searching for information in documents, searching for documents themselves, searching for metadata which describes documents, or searching within databases, whether relational stand alone databases or hypertext networked databases such as the Internet or intranets, for text, sound, images or data.

M-Commerce: M-commerce or mobile commerce stands for electronic commerce made through mobile devices.

Ontology: In computer science, ontology is the product of an attempt to formulate an exhaustive and rigorous conceptual schema about a domain.

Relevance Feedback: Relevance is a score assigned to a search result, representing how well the result matches the search query. In many cases, a result's relevance determines the order in which the result is presented to the user.

Category: Concepts, Trends, and Challenges

Open Content Distribution Management in Virtual Organizations

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INTRODUCTION

Future scenarios of **organization**s envision companies that are organized around a central **knowledge** base in the form of a **network**. It is assumed that each company contributes its own expertise and intellectual capital to the network's knowledge base. This article discusses the use of **open content** distribution management systems (OCDMSs) in knowledge-intensive fields, such as content production and software development, in order to ensure seamless and open collaboration between the firms in the organization.

OCDMSs offer participants several advantages. For instance, such systems can be seen as a way of enhancing the competitiveness of small and micro-sized knowledge-based firms by ensuring that each firm receives fair compensation for the content it develops. OCDMSs are revolutionary in the sense that they allow participants to contribute content to a common resource pool and add all the required **metadata** to the content. A common information pool where information is shared with well-defined rules lowers transaction costs between participating organizations. This article looks at one open content distribution management system that was developed in a university-industry research project and is being further developed by a company that is a spin-off company from the project.

BACKGROUND

Virtual Organizations

Developments in information technology as well as new organizational concepts have led to the emergence of new types of organizations. Miles, Miles, and Snow (2004), Miles and Snow (1995), and Miles, Snow, and Miles (2000) have discussed network organizations that rely on collaboration between independent units. The term virtual organization has become ever more commonplace in organizational literature. Walters (2004) discusses the business model of the virtual or holonic organization and refers to McHugh, Merli, and Wheeler (1995) in listing the following properties of a virtual organization.

- The organization consists of businesses of equal standing; that is, there is no hierarchy between the individual businesses in a virtual organization.
- Information can be accessed and exchanged freely throughout the organization and across its boundaries; that is, the organization is open.
- The organization is evolutionary and is involved in constant interaction with its environment.

One interesting form of virtual organizing is the virtual web, defined by Franke (1999) as "the base of virtual corporations" (p. 211). According to Franke, a virtual web belongs to the typology of dynamic networks, as defined by Miles and Snow (1986), which has the following characteristics.

1. **Vertical Disaggregation:** Different organizations in the network perform separate functions that have been performed by functional units in a traditional organization.
2. **Brokers:** Brokers bring together the necessary functions available in the organization and play a leading role in building business units and subcontracting for needed services. Brokers can operate at different levels of a dynamic network and, thereby, have varying degrees of responsibility.
3. **Market Mechanisms:** These hold the network together and regulate its functioning. Competition is promoted amongst the members of the network and also with external companies, and this regulates the internal prices of the services available in the network.
4. **Full-Disclosure Information Systems:** Companies wishing to become a part of the network, even for a fixed-term project, are expected to connect their information systems to the network's continuously updated information system via broadband access in return for a general payment structure for the value they add to the network. The purpose of this,

according to Miles and Snow (1986), is to facilitate the rapid and mutual assessment of contributions and to speed up the trust-building process.

According to Franke (1999), virtual corporations are involved in temporary partnerships established by brokers in a virtual web in order to bring together the necessary combination of skills and resources. In order for a virtual web to successfully generate virtual corporations, the web must offer an environment that encourages the member companies to participate in virtual corporations without compromising confidentiality and intellectual property rights, while, at the same time, preserving the dynamic and flexible properties of the virtual corporation.

Virtual Communities

Lee, Vodel, and Limayem (2003) have analysed various definitions of virtual communities and have identified four elements that they found common to most definitions. First, a virtual community should exist in cyberspace; that is, the members of a virtual community use computer-mediated spaces in order to interact. Second, the activities of a virtual community are supported by computer-based technologies, such as e-mail, message boards, and chat. Third, the main focus and content of virtual communities are participant driven, and the content of such communities is formed through the communication between the members of the community. The fourth and final element that Lee et al. found to be common to all virtual community definitions was the formation of a sustained relationship as a result of the interaction between the members of the community. Koh and Kim (2003-2004, 2004) have also observed cyberspace to be a usual feature for identifying virtual communities. However, they also found the interaction of many virtual communities to take place off line as well as online, especially in the case of communities that have originated off line. Koh and Kim's definition of a virtual community is "a group of people with common interests or goals, interacting for knowledge (or information) sharing predominantly in cyberspace" (p. 157). Etzioni and Etzioni (1999) point out the discrepancies in the definitions given for computer-mediated communities (CMCs) by different authors; some authors may refer to tightly knit communities while others to groups of acquaintances. The authors have found communities to have two common features: networks of relationships that may overlap rather than single links between the members, and a common set of values and norms to which the members of the community adhere and are committed and a common shared history.

One of the most productive virtual organization models is the free and **open source** software (later FOSS) movement (see DiBona, Ockman, & Stone, 1999). It uses licenses that allow the use and modification of FOSS program components. Open-source licenses grant rights that are otherwise exclusive to the copyright holder. FOSS licensing enables the flexible but controlled use of software resources. FOSS is a multibillion-dollar business that has shown how less restrictive content sharing can lead to considerable benefits for the whole software industry and society at large.

The uncontrolled sharing of information goods leads to exploitation that does not benefit content providers or society in the long run. According to Kwok, Yang, Tam, and Wong (2004), digital and peer-to-peer (P2P) technologies have made it easier to produce and distribute illegal copies of copyrighted material. Thus, a virtual web that is supported by a common broadband information system, to which all the participants are linked, poses risks in terms of content and copyright management. Digital rights management (DRM) is one of the concepts for managing the rights of information products. Benkler (2002) points out how computers have changed copyrights into "privately created and enforced exclusion—created by contracts and enforced by technology" (p. 81). In most cases, DRM systems limit access to information through the use of technical protection measures. This does not serve the purposes of virtual organizations. While DRM might be an overly restrictive tool, some control is needed. This can be obtained by using digital rights expression (DRE).

DIGITAL RIGHTS EXPRESSION

In the digital environment, it is possible to attach a license to a work. Most new music, image, and text formats have a field reserved for metadata. The attaching of metadata that describes the copyright status of a work is called digital rights expression. DRE uses semantic web methods to let users know of the permission that they have. Unlike DRM systems, DRE does not use technical means to restrict users from violating these terms.

One of the most commonly used ways of expressing digital rights is W3C's (World Wide Web Consortium's) resource description framework (RDF). It provides a foundation for the processing and exchange of machine-understandable information on the Web. RDF can be used for cataloguing (to describe content that is in a digital format on a Web page, in a digital library, or on a P2P network), for resource discovery (for example, to let a search engine search for works that have certain licenses), and by intelligent software agents (to facilitate knowledge sharing and exchange) in content rating. The W3C glossary (http://www.w3.org/2003/glossary/) defines metadata as "Data about data on the Web, including but not limited to authorship, classification, endorsement, policy, distribution terms, IPR, and so on." Most file formats support metadata. Metadata can be easily attached and read from Mp3, PDF (portable document format), mpeg4, and HTML (hypertext markup language) formats. Machine-understandable metadata can be used to efficiently define rights in the information management system of a virtual organization. Metadata can hold pricing and author information as well as licensing terms.

Open content can be briefly defined as being creative works that are in a format that explicitly allows their copying and distribution. Open content must also have a license that allows copying and distribution, or must belong to the public domain. By automating the licensing procedure, transaction costs can be further lowered. While the licenses are expensive to write, they can be used over and over again with minor modifications. These modifications can be made automatically through the use of a licensing engine. In this way, licensing can be fixed to an organization's work flow. Creative Commons (http://www.creativecommons.org), a nonprofit organization, has produced a set of open content licenses and a Web interface that allow content producers to tailor copyright licenses that suit their needs. They also provide licenses in RDF format. More than 4 million works have been licensed with Creative Commons licenses.

Open content files carrying legal metadata serve virtual organizations by lowering transaction costs. Members of an organization do not have to search for the holders of the rights and negotiate license agreements, and they have the content at their disposal. Open but controlled sharing also has a positive impact on marketing (Nadel, 2004). Benkler (2002) notes how organizations should adapt different information policies and levels of exclusivity depending on their business models. Open content systems benefit creative networks that depend on cooperation.

For the rights holder, the system enables easy licensing, a distribution channel, and the possibility for price discrimination. The price can be set dynamically for different projects. For example, the Magnatune record company (http://www.magnatune.com) uses dynamic pricing for their records that are available online. Magnatune music is available for free for noncommercial use, but commercial licenses must be bought from the Magnatune Web site. The price is preset and is fixed by the licensee, who has to enter the details of the commercial activity. Magnatune's system calculates the prices of licenses, which depend on the size of the budget and the rights to be licensed. The system also generates a license that is valid after the license payment has been made.

AN EXAMPLE OF AN OPEN CONTENT INFORMATION SYSTEM

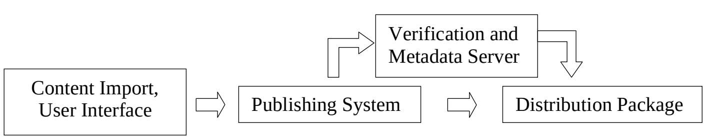
Virtual organizations and communities that have grown on the Internet and out of networks of content-production companies need systems for managing content contributed by their members for common use. This article discusses one such system, the Digital Content Distribution Management System (DiMaS). DiMaS is a prototype of a system designed for use within a community of content producers and was developed in cooperation with the Digital Economy Core (DE Core) and Mobile Content Communities (MC^2) research projects at the Helsinki Institute of Information Technology (HIIT).3 The following description is based on two papers by Reti and Sarvas (2004a, 2004b) that outline the functions of the system.

DiMaS enables multimedia producers to publish their works along with content metadata. The content-import user interface is the front end of the system and contains the user registration, user-information database, log-in, user manual, and content-import functionalities. At the point of registration, the user must accept the system's rules of conduct. After registration, the content provider can upload content to a server. Users enter content-related metadata using a chain of Web forms that appear in a particular succession and between which the user can move freely backward and forward. During the upload procedure, the content provider can add metadata, preview files, and feedback questions for the primary content payload. Once entered, the content file, metadata, and preview image are stored in the system until the user publishes them using a specific control button in the user interface.

The structure of the DiMaS system is shown in Figure 1.

After being uploaded, the content is forwarded to the publishing system. The publishing system forms a distribution package using the inserted content file, pre-

Figure 1. The structure of DiMaS



view file, user interface, and metadata. The publishing system can be in a closed or open environment. Publishing can be performed in uncontrolled peer-to-peer networks, such as Gnutella or KaZaa. DiMaS also enables content encryption. In this way, the content can be distributed on public P2P networks and stored on uncontrolled servers. If the content is access controlled, it is not open content.

When consumers, or other end users, find content that they want, they can download and open it, for instance, on their PDAs (personal digital assistants). When opening the content, a user application that resembles a DVD (digital videodisc) menu appears and the system can update the content metadata, for example, the description of the content stored on the metadata server. This makes it possible for the content provider to change the pricing or licensing terms after the content has been uploaded and even after it has been distributed to end users. This feature can be used to set the price of the product according to the product's life cycle. Novel works may carry a higher price tag than vintage material. The system can also notify the user when a new version of a work is available. Users can browse through the copyright license or contract in the price section of the application. The only technology required by the end user in order to run the distribution package is the Java Standard Edition Runtime Environment (http://java.sun.com).

In open content mode, an entire virtual organization can browse the content freely. The metadata inform users on how the content can be modified or exported out of the virtual organization for commercial use. DiMaS also has a feedback option. The system can collect user feedback after content browsing and store this information along with the metadata. Feedback enables content rating, which helps to distinguish premium content from large information masses.

DiMaS is an MIT-licensed open-source product and can be customised to meet the needs of specific content-production communities. The goal of DiMaS is to be executable without specific client software and independent of the type of content to be distributed. The DiMaS prototype supports Windows Media Player files and, as mentioned above, requires that the user have the Java Standard Edition Runtime Environment installed on his or her system. As yet, DiMaS has not been used in any real-life organizations since it is still in the prototype stage.

CONCLUSION AND FUTURE TRENDS

This article has discussed the problems related to the management of digital rights in virtual communities and the meaning of open content systems. It also presents the prototype of one system for content distribution: DiMaS. DiMaS allows content producers to attach metadata to their works, share works on a publishing platform, and modify the metadata attached to content after the content has been published. DiMaS enables version handling as well as the dynamic pricing of copyright licenses. Because the system packs the metadata into a distribution package, it does not have to rely on any proprietary file format. This also means that the system can be used to distribute all kinds of content without introducing new file formats or players.

Semantic webs and metadata will be a part of knowledge management in future organizations. The management of the vast knowledge bases of networks will require systems that can handle different types of files and can hold all various types of information. Already, file sharing and P2P technologies have made it important for organizations to have in place tools for the management of content with different rights, and there is a clear market for technologies that allow different users different levels of access to common content pools.

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KEY TERMS

Digital Rights Expression (DRE): The attachment of metadata to a work in order to describe the copyright status of that work

Digital Rights Management (DRM): The limitation of the access of users to information in a repository through the use of technical protection measures.

Metadata: Metadata are data about data. In information repositories, metadata are used for labeling the content of such repositories with appropriate descriptions.

Resource Description Framework (RDF): RDF provides the foundation for the processing and exchange of machine-understandable information on the Web. RDF can be used for cataloguing, for resource discovery, and by intelligent software agents in content rating.

Virtual Community: Virtual communities are communities of users that have the following characteristics.

1. They exist in cyberspace and the communication between the members of the community is computer mediated.
2. They use communication technologies, such as e-mail, message boards, blogging, and online chatting, for communication.
3. They develop largely through the activeness and interests of their participants. The content of virtual communities is formed through the communication between the members of such communities.
4. They lead their members to form sustained relationships as a result of their interaction.

Virtual Organization: An organization in which business partners and teams work together across geographical or organizational boundaries through the use of information technology. It is also a strategy for revolutionizing customer interaction, asset configuration, and knowledge leveraging.

Virtual Web: A form of virtual organization that belongs to the typology of dynamic networks and has the following properties.

1. The member organizations of the network perform separate functions that are performed by functional units in traditional organizations.
2. Brokers in a virtual web combine resources to build business units and subcontract to bring together the necessary functions available in the organization. They play a leading role in building business units and subcontracting for needed services.
3. Internal and external market mechanisms hold the network together and regulate its performance.
4. The information system is open, and there is free access to the web's joint knowledge base. Companies belonging to the network have integrated their information systems into the network's continuously updated information system via broadband access in return for a general payment structure for the value they add to the network.

ENDNOTES

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3 More information on the DE Core and MC[2] projects is available at http://www.hiit.fi/de/core/ and http://pong.hiit.fi, respectively.

Category: Applications of E-Technologies

Open Source Community Portals for E-Government

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BACKGROUND

The value of the Internet as a flexible tool for the posting and exchange of information is expressed in the potential it has for governance, commerce, and social interaction. The Internet is symbolic of the *digital revolution* of the 20th century that changed the packaging and dissemination of electronic information. In politics, the potential of the Internet is perceived to be in *e-government.* In the book *The Internet Galaxy,* Castells (2001) indicates how the Internet is expected to be an instrument to further democracy. The Internet has a significant role to play in government or politics; it provides a two-way medium of communication between government and society in flexible personalized and mass forms of communication.

Through the Internet, information can be easily accessed by both citizens and their leaders as a means of effective communication. All kinds of information, public records, service forms and requests, and a wide range of non-classified information can be disseminated on the Web. The interactive nature of the Internet technology allows for on-demand accessing of information in the form of citizen request, the voicing of opinion, and in some cases, asking government representatives for information or answers to issues of concern. The typical use of Internet portals by governments has been in the form of information access points where governments post information without a concerted attempt at interacting with the potential users of the resource. Such approach to e-governance is cast in the traditional mode of top-bottom political activity that focuses on what government leaders or their administrative systems want to give to their constituents, with little concern or regard to issues of interest to their constituents.

Chadwick (2003) makes a distinction between what he calls e-government and *e-democracy.* According to him:

Public administration scholars, public policy analysts, and public management specialists focus on e-government, whereas political communication specialists, social movement scholars, and democratic theorists sharpen their analytical tools on e-democracy. (p. 444)

Chadwick points to the need to have e-democracy, which is found with civil society, and e-government that operates at the local and national levels of political administrations to converge. The discourse of how these two aspects of *electronic politicking* can converge using *open source content management systems* (CMSs) is the focus in this discussion. E-democracy and e-government allude to the fact that electronic politicking has two distinct aspects:

1. **Managerial:** This feature is typical of e-government because it involves government bringing people closer to government by providing an information system that is convenient and prompt in the dissemination and retrieval of information.
2. **Policy Making:** This element is characteristic of the e-democracy in the sense that it entails deliberation of public policy and in some cases advocacy.

Musgrave (2005) identifies these two aspects of e-government as community and civic portals. Castells (2001) indicates that e-government has its origin in the convergence of three different components of online political activities:

…the pre-Internet grassroots movements in search of new opportunities for self-organizing and consciousness-raising; the hacker movement in its most politically oriented expressions; and municipal governments trying to strengthen their legitimacy by creating new channels of citizen participation. (p. 144)

Drupal, Xoops, and *Mambo* are open source CMSs that facilitate the convergence of all the elements of online political activities, and the dissemination of information that usually gets lumped together as e-government. We compare Drupal, Xoops, and Mambo and outline how they can be used as integrated e-government portals. The three CMSs are among the most popular open source CMSs used for creating online communities and systems for the discussion of issues and dissemination of information.

DESCRIPTION OF E-GOVERNMENT APPLICATIONS/SYSTEMS

Open source is software that is developed by software engineers who give users the right to alter the software code in order to develop and improve the software for use and distribution. This approach to software development and distribution has created unprecedented opportunities for the exchange of information between businesses, society, and government. The open source movement is a deliberate attempt to keep access to software code and information open. The movement originated from an initiative by Richard Stallman of the Massachusetts Institute of Technology's Artificial Intelligence Laboratory in 1984. It was an attempt to counter the decision by American Telephone and Telegraph (AT&T) to claim proprietary rights to the UNIX operating system. His efforts were supplemented in 1991 by Linus Torvalds, a student at the University of Helsinki, who developed the Linux system and posted it on the Web for distribution and further development. By 2001, "over 60 percent of World Wide Web servers in the world were running on Apache, which is an open source server program developed by a cooperative network of UNIX programmers" (Castells, 2001, p. 14).

All open source software and applications are developed through cooperative networks of programmers. Drupal, Xoops, and Mambo open source content management systems are also developed by programmer networks that have fashioned them to be useful for the launching of online portals. Open source portals have the ability to be customized and localized in every language. Donnelly and Merrick (2003) identified this type of customization as *communitization*, of which there are two types—protected and public. *Protected communitization* enables "a design to be customized by an acknowledged community representative who adapts a design for a group of people based on their own expert knowledge of the characteristics, abilities and environment of the community they represent." *Public communitization* is the "active adaptation by anyone allowed within the community, in the same way that communities allow participation in forums and chat rooms" (p. 10).

A 2001 Pew Internet study on online communities in the United States indicated that people used the Internet "to intensify their connection to their local community … arrange neighborhood gatherings, and petition local politicians" (p. 2). According to the Pew Internet Research Study, people who joined online communities reported that online communities lowered the barriers that prevented them from democratic participation. Flew (2002) also determined that community portals "reinvigorated [a] sense of community-building and citizen participation in public life" (p. 77).

Interactive online technology has redefined and changed the way society communicates: "The Internet provides virtual third places (different from home and work) that allow people to hang out and engage in activities with others" (Preece, Maloney-Krichmar, & Abras, 2003, p. 5). Preece et al. (2003) described how technologies such as *e-mail, chat rooms, blogs,* and *wikis* have changed the nature of online interactions and facilitated the exchange of ideas and dissemination of information. Such activities have empowered people and promoted development. The type of software used for these online communities is very crucial in the usability of the portal. Drupal, Xoops, and Mambo are CMSs that have the potential to integrate different online interactive features into a portal through the configuration of modules that are developed by programmer cooperatives and are posted online for use.

Drupal, Xoops, and Mambo

The *scalability* of open source CMSs makes them suitable for customization and use in launching sustainable e-government systems. We examined the features of Drupal, Xoops, and Mambo by downloading and installing these software on a Sony VAIO PCV-RS620G desktop computer with a Windows XP operating system.

To be functional, most CMSs use a combination of a Web server, database, programming language, and operating system. Apache Web server is the most widely used Web server. Open source CMSs use either MySQL or PostgreSQL database systems. The programming languages that are often used are PHP, Perl, or Python, and the operating systems used are either GNU or LINUX. The combination of these components is sometimes called a LAMP platform. This enables open source CMSs to run on other operating systems (OSs) such as Windows, Mac OS, and Solaris.

In studying Drupal, Xoops, and Mambo, we documented the following steps that are worth noting for the deployment of an open source CMS portal. We did not do an online installation, but rather installed it on a standalone desktop computer. Since the computer used was not a server, we downloaded Easy PHP 1.7, which consisted of Apache Web server and MySQL open source database with a Web interface. EasyPHP provides a Web interface for MySQL called PHPMyAdmin, which means there is no need to know MySQL coding or programming in order to populate the database you create for the portal. We unzipped the downloaded CMS files and used the Web interface of EasyPHP to install the CMSs onto the computer. The Web interface walks you through the various installation steps, including the creation of the database. After the installations, the rest of the development of the portal depends on identifying modules or components as add-ons for the customization of the portal.

The approach to attaching modules or components on Drupal, Xoops, and Mambo are similar with minor variations. Module attachment in Xoops requires unzipping the files and saving them into a specific modules folder. Mambo eliminates unzipping files, because it has an inbuilt function that unzips the module or component, and installs it in the appropriate places. Drupal requires that modules and module tables be installed through the Web interface of the database, PHPMyAdmin. These processes, although different, are user friendly and make it possible to install modules and components without knowledge of MySQL. The installation and customization of a portal using any of these three open source CMSs can be completed without knowledge of any programming language.

Drupal, Mambo, and Xoops have localization and multi-language support. In order to monitor content posted on sites, Drupal has a review and approval process. With Xoops and Mambo this process is optional depending on the module installed.

Table 1 is a comprehensive comparison of the three products. The aim of this comparison is to show these products can be used for e-government depending on the rationale for setting up the CMS and the needs of the users.

Table 1. A comparison of Drupal, Mambo, and Xoops

Content Management System	**Drupal 4.6.0**	**Mambo 4.5.2**	**Xoops 2.0.9.2**
System Requirements			
License	GNU GPL	GNU GPL	GNU GPL
Server	Apache	Apache	Apache
Database	MySQL, PostgreSQL	MySQL	MySQL
Programming Language	PHP	PHP	PHP 4.1.0 or later
Security			
Content Approval	Yes	Limited	Yes
E-Mail Verification	Yes	Yes	
Problem Notification	No	No	Limited
Applications/Add-On/Modules/Components			
Blog	Yes	Yes	Yes or Add On
Chat	Yes or Add On	Yes or Add On	Yes or Add On
Contact Management	Yes or Add On	Yes or Add On	Yes, Being Developed
Discussion/Forum	Yes or Add On	Yes or Add On	Yes or Add On
Document Management	Yes or Add On	Yes or Add On	Yes or Add On
Events Calendar	Add On	Add On	Add On
FAQ Management	Yes	Yes	Yes

Table 1. A comparison of Drupal, Mambo, and Xoops (continued)

File Distribution	Yes or Add On	Yes or Add On	Yes or Add On
Interface Localization	Yes	Yes	Yes
Link Management	Add On	Add On	Add On
Multi-Lingual Content Integration	Yes or Add On	Yes or Add On	Yes or Add On
Polls	Yes	Yes	Yes
Search Engine	Yes	Yes	Yes
Syndicated Content (RSS)	Yes	Yes	Yes
User Contributions	Yes	Yes	Yes
Wiki	Yes or Add On	Yes or Add On	Yes or Add On

IMPACT OF E-GOVERNMENT APPLICATIONS

Many e-government initiatives are driven by open source technology. Governments in countries like Brazil, India, and the United Kingdom have recognized the importance of open source applications in creating online spaces where people can interact with their government.

A United Nations press release illustrated how open source software applications are being used to create e-municipalities in Bulgaria, Bosnia and Herzegovina, Croatia, Macedonia, Romania, Serbia, and Montenegro (United Nations Development Program, 2004). Other e-government portals are The Knowledge Village Portal developed by Karakulam Panchayat in India, the E-shringla project (Kumar, 2002), and the Maleny community portal in Australia (MENA, 2004).

The effectiveness and success of e-government platforms requires enthusiasm and expertise in the delivery of information online. The challenge is not with the technology, but politics and how e-government sites are set up. Most e-government platforms are not given the necessary design detail and attention. Many of them are poorly designed and maintained. They are usually set up by content managers who have limited skills in the design and maintenance of online portals.

In some cases, e-government portals are experimental projects that are left to dysfunction after an initial enthusiasm and elaborate work on the site. Over time they are not given the attention, detailed preparation, and delivery of service. Some sites end up becoming passive or less active compared to when they were established. What appears to be affecting most e-government initiatives are the issues of continuity and longevity. Tied in with these issues is the fact that political or administrative personalities that are really interested in e-government portals are usually not tech savvy. Even though, they may posses the drive and the material resources to run an e-government portal, and politicians and administrators may lack the barest minimum of technical skills to do so. Table 2 catalogs the strengths and challenges of e-government.

Increasingly, open source CMSs have emerged to address the issue of skill as a determinant for the running and maintenance of e-government portals. They offer a cost-effective technology package for the setting up and running of portals. Drupal, Xoops, and Mambo offer an opportunity to the content manager with little or no knowledge of Web authoring to process and publish materials after a portal has been configured and launched. They use the WYSIWYG authoring interface to allow portal administrators and users to process and post materials on a portal.

Despite these opportunities, there are still issues related to government and politics that are beyond the digital technology of open source software and CMSs. Technology cannot redeem political and government difficulties. And as Castells (2001) rightly points out:

> *In the world of widespread crisis of political legitimacy, and citizens' disaffection vis-à-vis their representatives, the interactive, multi-directional channel of communication provided by the Internet, finds few active takers on both sides of the link.* (p. 156)

Table 2. Issues related to e-government

Strengths	Challenges
Promotes participation of citizens in political decision making. Helps create a dynamic network of citizens who are well informed Facilitates bottom-up approach to decision making Helps create transparency in government Twenty-four-hour on-demand source of information Helps improve government performance	Involves a lot of planning and design work greater than e-government advocates are aware Investment needs for an efficient e-government portal could be expensive Could become static, one-way government hand-down of information and instruction, instead of a two-way free flow of information The focus could easily be on the technology development instead of provision of service

Nevertheless, the flexibility in online communication that Drupal, Xoops, and Mambo offer provides a lateral system of communication that is relatively inexpensive, but possesses the potential to facilitate the management and legislative functions of government. With a team of highly motivated public managers schooled in the ideas of creative public entrepreneurship of new public management as espoused by Osborne and Gaebler (1992), Drupal, Xoops, and Mambo can be used to deploy e-government systems that will make any government a learning government. Governments become responsive and effective through a system that allows government "to respond to the needs of its citizens, who are in turn able to influence public policies by rapid, aggregative feedback mechanisms such as e-mail and interactive Web site" (Chadwick, 2003, p. 447).

Web portals offer extraordinary potential for the expression of citizen rights, as well as for public management, because they are capable of broadening the sources of communication between citizens, public managers, and politicians.

Given that Drupal, Xoops, and Mambo are not the only open source CMSs available, and given that many public managers who would like to launch a portal get overwhelmed by what technology to use, THE Open source movement has a Web site, Open Source CMS (http://www.opensourcecms.com), which allows potential users to explore various CMSs. This site provides administrator access to anyone willing to evaluate a CMS without having to download and install it.

CONCLUSION

Increasingly, open source CMSs used for community portals have great potential for e-government. They are easy to install and relatively inexpensive compared to their proprietary alternatives. They offer a great opportunity for governments that want to encourage citizen participation in government affairs, but do not posses technology expertise in online publishing. The add-on modules and components enable public mangers in government to promote transparency and increase accessibility to government services.

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KEY TERMS

Blog: Short for Weblog. Usually a personal journal on the Web, it could be of opinions, social issues, or reflections. People that blog are often identified as bloggers.

Chat Rooms: Online spaces where virtual users can "converse" in real time about issues of specific interest. Users can engage in both public and private chats with other users.

Community Portal: A Web site tailored for the needs of a community.

E-Democracy: The use of electronic media such as the Internet to enhance democracy.

E-Governance: The delivery of government services in an electronic medium. It also includes the online interactions between government and citizens.

E-Mail: A form of communication in which electronic mail is transmitted via communication networks.

Open Source: Software that is developed by software engineers who give users the right to alter the software code in order to develop and improve the software for use and distribution.

Wiki: Web pages that are editable by users of a site. A form of online collaboration or community development project.

Category: Applications of E-Technologies

Open Source LMS for Management and E-Business Applications

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BACKGROUND

Advances in computer technology have led to the increase in the use of information technology in business (Barron, 2002). Computer-mediated communication in the form of the Internet offers unprecedented avenues for the exchange of information and the delivery of instructional materials globally and locally (NHDP, 2003; Robey, Boudreau, & Rose, 2000). Through the Internet and related technologies, people are able to acquire skills and knowledge, adapt learning experiences to their own needs, and assimilate information faster (Azad, Erdem, & Saleem, 1999; NHDP).

An organization that is making use of such e-technologies for the advancement of e-business is the Advance Information Technology Institute's Kofi Annan Center of Excellence for Communications and Information Technology (AITI-KACE), established in 2003 in Ghana. The center is a collaborative initiative between Ghana and India, and is aimed at bridging the gap between education and industry. This initiative was in response to Ghana's recognition of the social and economic benefits of information and communications technologies. The center is considered part of a national initiative to educate Ghanaians and unleash their creative potential in the use of digital communication technologies for business and education. It is a major skills-development and training institution whose graduates can transition into industry immediately as employees or employers. Ghana's main challenge is that computer education at all levels is inadequate, and businesses are struggling to incorporate computer applications in their operations. Despite the relative advances made in the adoption of e-technologies in businesses and education, the greatest challenge lies in the fact that a greater part of the adult population does not have adequate knowledge and skills in computer software applications or hardware in order to explore their use in everyday activities or at their workplaces. It is therefore expected that by enrolling in the programs at AITI -KACE, a participant[1] can either be employable or have skills to venture out into self-employment. AITI - KACE targets adults—at least those who have completed high school.

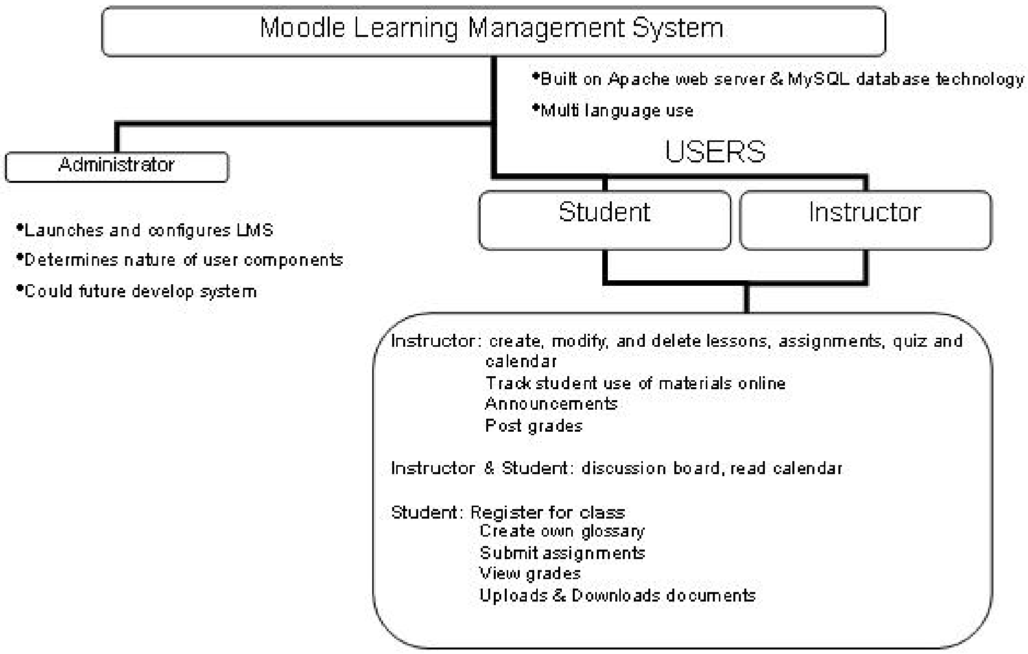
DESCRIPTION OF E-BUSINESS APPLICATIONS

The main technology used by AITI-KACE to deliver instruction and learning materials, and promote e-business solutions is an open-source learning-management systems (LMS). Free and open-source software (F/OSS) is software with an unrestrictive license whose source code is made available for modification, customization, and distribution by others. Martin Dougiamas (n.d.) began the development of the Moodle LMS in the 1990s. However, it was not until August 20, 2002, that version 1.0 was released. Moodle assists in the planning, delivery, and management of e-learning, and is aimed at remedying the fragmented nature of e-learning by creating an integrative system.

LMSs were developed to enable instructors not only to deliver materials in an online environment, but also to track user activities and progress across various learning activities (Barron, 2002). LMSs are characterized by the following customizable elements: a course-development component that enables an instructor to develop a course, a roster component that enables the instructor to enroll users in a course, the assignment-management component that enables the instructor to assign lessons and activities for the users, the courseware-launching component that provides the interface for users to have access to course content and activities, and the data-collection component that enables the instructor to collect and manage information, as shown in Figure 1.

The F/OSS that have been operational at AITI-KACE are Open USS, Eledge, and Moodle. Open USS is an open-source administration system aimed at institutes of higher learning. Eledge is a learning- and course-management system developed by the University of Utah. AITI-KACE

Figure 1. The basic setup of the Moodle LMS



has since discontinued the use of Eledge, but has combined the examination section of Open USS with Moodle as the main system for delivering and managing its online program. The AITI-KACE e-learning-management system is a virtual campus with instructional material on e-technology applications in business such as those required for diplomas in advanced computing (DACs), business computing, Web technologies, and Microsoft .Net technologies; and certificates in C programming, Web programming, and database technologies.

The installation of Moodle requires three other open-source software: Easy PHP, Apache, and MySQL. Easy PHP is a software application written in the dynamic PHP language that combines an Apache Web server and a MySQL database to create flexible Web development tools. Apache is an open-source Web server. Web servers use the hypertext transfer protocol (http) to enable a computer user to connect to the Internet. MySQL is an open-source database that organizes information through tables, and enables interactions between the user and the Web through the creation of dynamic Web pages. The system was implemented by the AITI-KACE management to ensure efficiency and the effective delivery of the services at the center. It was aimed at providing an alternative and flexible approach to the development of ICT skills of the participants enrolled at the center. It also serves as a practical demonstration of the use of ICT in the management and delivery of services in business.

Moodle is a learner-centered application grounded in the social constructionist pedagogy (Dougiamas, n.d.). Social constructionists assume that knowledge is acquired through interaction with an environment. Learners acquire knowledge through active construction and discovery, and by explaining their understanding of concepts to others. Learner-oriented LMSs such as Moodle are suitable for the adult learner because it facilitates the design and delivery of custom-fit materials. Adult learners are considered to be motivated by their perceived benefit of a learning exercise, especially if it may have a positive impact on their profession (Holton & Swanson, 1998). In this regard, the use of Moodle offers AITI-KACE an opportunity for self-directed learning, consistent with Campbell's (2000) notion of an education environment where learners take responsibility for their own learning in a flexible instructional environment that allows for the designing and use of nonlinear instructional material suitable for adults. Such an environment provides the opportunity for adult learners to apply previously gained knowledge and experience, and to also relate their future goals to the learning process.

IMPACT OF E-TECHNOLOGY APPLICATIONS

AITI-KACE is a novelty and is in principle an initiative long over due. It has created more awareness about the value of e-technologies in the development of the economy of a nation like Ghana. The center is involved in the development of expertise in the field of ICT. The use of Moodle in the facilitation and promotion of ICT applications in business at AITI-KACE is a pioneering effort in the teaching of ICT in Ghana that combines traditional teaching and learning methods with the online delivery of teaching and learning materials.

The Moodle LMS is used to provide an online version of all instructional and learning material used at AITI-KACE. It provides an online teaching and learning environment alternative to the daily on-site teaching activities at the center. It provides students access to learning and instructional materials on demand and at their convenience. According to the Moodle administrator at AITI-KACE, it is a more flexible approach to the delivery of services compared to on-site delivery. From the perspective of the system administrator, the on-site delivery of services has spatial limitation in terms of where, when, and how students can access, use, and submit materials.

The center's e-applications administrator has configured Moodle such that all of AITI-KACE's 12 lecturers have automatic accounts based on the courses they teach. Each course has a maximum class size of 25 participants. At the moment, the center, which started in 2003, has 145 students (F. Ankamah, personal communication, February 4, 2005) and has turned out 635 graduates (Ghana News Agency, 2005).

Administratively, the use of Moodle is considered a success because it is cost effective (the Moodle LMS software is free, and all the setup and content management are done at the center) and works well for the center. The greatest challenge in running the Moodle application at the center lies with its use by the lecturers and participants of the center. Currently, 21% of participants and 8% of lecturers use the Moodle LMS. According to the system administrator, the percentage of usage is attributable to the Ghanaian learning culture, to which the Internet-based delivery of educational instructions and the performance of learning activities are new. The participants, especially, are not familiar with online virtual campuses, and would rather prefer traditional on-site teaching and learning activities, and hard-copy delivery and submission of learning materials.

To ensure that the Moodle LMS e-application does not fail, the AITI-KACE administration adopted and implemented an e-documentation policy by declaring the center's learning environment paperless. However, there are drawbacks in the implementation of the paperless e-documentation policy for the following reasons. First, it has been observed that even though participants appreciate the online delivery and submission of instruction and learning material, most of them do not have access to the Internet at home. Second, not all of the lecturers have used the Moodle LMS as an alternative to the delivery of instructional and learning materials to the center's participants, and that is a major concern. Finally, building up a team to manage the Moodle LMS has been a challenge.

The center had a system administration team of three, which has now been reduced to one because the other two who trained on the job quit their positions. The current team of one is fully stretched with regard to the maintenance and further development of the system; this is quite a challenge. The Moodle LMS is a stand-alone Web application at the center, and the administrator is working toward integrating it with its post-nuke-based Web site. The other challenges are how to improve participant access and lecturers' usage of Moodle as an alternative medium for delivering their work (E. Ofori, personal communication, February 4, 2005).

The center estimates that about 80% of its graduates are able to apply their acquired skills at their jobs or start-up businesses. The majority of the center's participants enroll with sponsorships from their employers. The center does not know what the remaining 20% do with the skills they acquired after their respective programs. Tracking and knowing what this significant minority does with its skills is another challenge.

CONCLUSION

The establishment of the Moodle LMS at AITI-KACE offers alternative, electronic means for delivering learning and instructional material at an information and communications technology innovation center. The use of the Moodle LMS is considered successful because it allowed the administrators of the center to adopt and implement a paperless learning environment while promoting e-business application in Ghana. The center's activities for which the Moodle LMS was used to implement support the principles of social constructionist pedagogy, which is favorable to adult learning.

The use of the Moodle LMS at AITI-KACE indicates, first, that F/OSS have the potential to support the integration of e-technologies in institutions and in regions like Africa as suggested by Castells and Ince (2003). Particularly, the use of business models based on open-source software has been very successful in developing countries (Weerawarana & Weenatunga, 2004), and AITI-KACE is on the right track. Second, the use of the Moodle

LMS by the lecturers and participants illustrates that the deployment of e-applications for the delivery of services in an institution requires taking into consideration the cultural influences on the users. Third, the delivery of e-business services requires that end-user access to the Internet in their homes or off campus is essential, especially when the service is Web based.

Twenty percent of the graduates of AITI-KACE are not known to have either taken up employment or set up new businesses. This calls for a tracking system and an evaluation of the mechanism used in accessing the needs of participants when they enroll at the center. The center should seek ways to improve its mechanism for identifying and tracking the needs of participants after they have completed. This will enable it to cater to those needs that are not easily discernable, and assess the full impact of the activities of the center. Perhaps an approach to supplement existing procedures is to expose participants to developed prototypes of information and communications technology applications as a first step toward developing their own models for implementation.

The center should consider having an office or setup for innovations in teaching and learning that will explore other electronic means of packaging their electronic materials. For instance, the center could package their materials into portable files on compact discs or other downloadable forms to be used by participants who do not have personal Internet access in their homes. Finally, the center should consider making its business incubation component more prominent.

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KEY TERMS

Apache: An open-source Web server. Web servers use http to enable a computer user to connect to the Internet.

Easy PHP: Software application written in the dynamic PHP language that combines an Apache Web server and a MySQL database to create flexible Web development tools.

E-Business Models: Strategies that enable businesses to take advantage of the latest technologies to generate profits and customer satisfaction.

E-Innovations: Innovations encouraging users of new communications technologies to develop dependable and viable business plans or systems that can be used for an economic (business) or social (health care, education, etc.) enterprise.

E-Learning: Effective and continuous learning process that occurs through the delivery of interactive multimedia educational materials that have no spatial limitation.

E-Models: The designing of prototypes of electronic businesses or systems that illustrate how digital technology can be used in any enterprise.

F/OSS: Software with an unrestrictive license whose source code is made available for modification, customization, and distribution by others.

MySQL: Open-source database that organizes information through tables and enables interactions between the user and the Web through the creation of dynamic Web pages.

Virtual Campus or Learning-Management System: Web-based, customizable e-learning environment that integrates a variety of educational tools with interfaces to accommodate the technology competencies of the user and his or her learning needs.

ENDNOTE

[1] The center refers to those enrolled in its programs as participants and not students.

Overall Satisfaction Prediction

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INTRODUCTION

Strides in information technology and improvements in networking technology have set the pace for rapid growth in new applications of electronic commerce in a variety of settings. Business to business (B2B), business to customer (B2C), customer to business (C2B), and customer to customer (C2C) have become prevalent business channels and have reshaped the ways that business transactions are conducted in the marketplace. According to Internet Data Corporation (IDC), the number of Internet users worldwide will exeed 1 billion Internet users by 2007 (IDC, 2004). Given recent trends and forecasting, it is clear that no business enterprise can afford to ignore the tremendous potential of these emerging technologies in terms of the rate of creating, processing, and distributing the volume of business.

The proliferation of the Web potential for business, together with its profuse customer information, have offered an alternative sales channel for a growing number of firms and have prompted extensive research on the effect of negative critical incidents on customer satisfaction with Internet shopping. The increase in business-to-customer (B2C) channels has made several firms look for new strategies to understand online shopping behavior in order to attract, retain and satisfy customers' needs (Ranganathan & Ganapathy, 2002). In fact, many researchers have considered that customer satisfaction leading to higher levels of customer retention would depend on the success of critical factors, such as quality design (Huizingh, 2000; Liu & Arnett, 2000; Stefani & Xenos, 2001), security concerns (Belanger, Hiller, & Smith, 2002; La & Kandampully, 2002), and other factors for electronic commerce (Loiacono, Watson, & Goodhue, 2002; Yang, Cai, Zhou, & Zhou, 2005). However, Waterhouse and Morgan (1994) reported an interesting finding that just one factor of dissatisfaction and defection would be enough to cause customers to become disenchanted with Internet shopping. Thus, the call for the managers to find and discriminate the dissatisfaction or defection in the velocity and dynamic nature of the Internet environment becomes loud.

According to Fang, Shih, and Liu (2004), the slow response affected overall satisfaction indirectly by quality attributes satisfaction (QASAT) seems to be more important to customers who have less purchase frequency or purchase amount than high one. Furthermore, online bookstores with incomplete content and have untrustworthy transaction would affect overall satisfaction indirectly to customers with high loyalty by QASAT. The main purpose of this study was threefold. First, it designed a set of quality attributes satisfaction, in term of the negative critical incidents concept, to measure individual satisfaction, an online shopping bookstore served as empirical cases. Second, from predictive model standpoint, a method, call multiple discriminant analysis (MDS), was used to analyze customers' satisfaction based on QASAT and estimated data. Finally, it adopted holdout samples to confirm the ability of generalization with a predictive model.

BACKGROUND

In the past decade, perhaps, the most dramatic evolution, a new agenda, in business is the dawn of the Internet. A hallmark of the new economy is the ability of company to increasingly recognize that in the postindustrial era, a company success is determined mainly by economic value from its new application of electronic commerce in a variety of settings.

Based on the book chapter in e-commerce and m-commerce technologies (Fang et al., 2004), research on web quality attributes for measuring Internet shopping falls into four broad categories: quality e-store, information content, security concerns, and consumers' experience. These four categories were specified to construct a set of critical incidents for encounter satisfaction. The four factors consisted of 34 items from previous literature described as follows:

1. **Quality E-Store (10 items):** Fast Web-page download, store size, promotions, ease of use and so on (Huizingh, 2000; Liu & Arnett, 2000).

2. **Information Content (8 items):** Availability of information to compare across alternatives, completeness of information provided about a firm, product, and service, and so on (Huizingh, 2000; La & Kandampully, 2002; Ranganathan & Ganapathy, 2002).
3. **Security Concerns (5 items):** Availability of secure modes for transmitting information, provisions made for alternatives, overall concern about security of transactions over the Internet, gathering of personal information, and so on (Belanger et al., 2002; La & Kandampully, 2002; Ranganathan & Ganapathy, 2002).
4. **Consumer Experience (11 items):** Increased customization, convenience in purchasing, responsiveness in product delivery, and so on (Elliot & Fowell, 2000; Iwaarden, van der Wiele, Ball, & Millen, 2004).

There are a number of custom satisfaction measurements currently in place. However, the assessment from negative critical incidents is spare. For the content validity purpose, these items were initially assessed using a Delphi method (Green, 2000). Furthermore, three e-commerce scholars were asked to evaluate the items and make changes to eliminate repetitive items. After two evaluation rounds, there remained 22 critical incidents of Web quality attributes for further study.

Two questions were used to measure overall satisfaction. One question is, "What is the degree of satisfaction for online bookstores?" The other question is, "Will you recommend using online bookstores to a friend?"

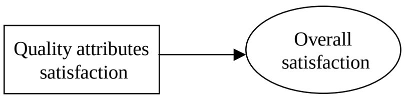
To detect customer's satisfaction in online shopping, a model was proposed and applied to the empirical case—online bookstores (shown in Figure 1). This model used dimension of quality attributes satisfaction to discriminate and forecast overall satisfaction by multiple discriminant analysis.

METHODOLOGY OF THE MANUSCRIPT

Research Procedure

First, to produce more precise and interpretable factors for the dimension of quality attributes satisfaction, the principal component analysis (PCA) was used to examine related items. Moreover, to provide meaningful interpretation of the relative importance among the various factors, a multivariate analysis-discriminant analysis was chosen as the appropriate statistical technique. This technique derives a profile based on a linear combination of variables that will best discriminate between the a priori defined groups. In this study, a degree of overall satisfaction was divided into two groups, based on the cutting

Figure 1. Proposed model



score (a score of more than 4 indicates customer who has higher overall satisfaction; a score of less than 3 represents customer has lower overall satisfaction).

Finally, for the cross validity purpose, a holdout sample was used for validation of the discriminant function. In this study, 70% of the cases were assigned to the analysis sample for purposes of training the discriminant function first; then, it was validated by assessing its performance on the remaining cases in the holdout sample.

Measurement

A questionnaire was designed to measure satisfaction of service quality, overall satisfaction, demographic variables, and experience of online purchasing. The questionnaire was based on the previous studies (Fang et al., 2004). A measurement of quality attributes satisfaction and overall satisfaction, such as "What is the degree of satisfaction for online bookstores?" included a 5-point Likert scale from 5 (*strongly agree*) to 1 (*strongly disagree*). A measurement of the second question of overall satisfaction, "Will you recommend using online bookstores to a friend?" included a 5-point Likert scale from 5 (*strongly willing*) to 1 (*strongly unwilling*). In addition, two demographic variables (gender and income) and three variables with experience of online purchasing (number of online bookstore visits per month, frequency of purchasing per month, average amount of money spent in online bookstores per month) are all measured by a nominal scale from respondents to obtain more information for explaining the analytical results.

Data Collection

According to Fang et al. (2004), 15 critical incidents were for measuring the constructs of QASAT. An online survey was performed for collecting the data. Participation in this study was completely voluntary, but respondents of at least one online purchase were considered qualified for analysis. In this online survey, our system would check incomplete data and ask the respondents to fill out the questionnaire on time.

This paper used 210 respondents to predict their overall satisfaction based on quality attributes. Table 1 presents the characteristics of respondents. The sample included 88 (42%) males and 122 (58%) females, all of whom had made purchases online, with 75% having had

Table 1. Profile of respondents (N = 210)

	Frequency	(%)		Frequency	(%)
Gender			No. of books purchasing a month		
Male	88	42	1-2	158	75.2
Female	122	58	3-4	43	20.5
Income			5-6	6	2.9
<=20,000	134	61.9	7-8	2	1.0
20,001~40,000	45	21.4	>8	1	0.4
40,001~60,000	27	12.9	Average spending a month		
60,001~80,000	4	1.9	<=500	88	41.9
80,001~100,000	4	1.9	501-1,000	85	40.5
No. of bookstores a month			1,001-	16	7.6
1-2	75	35.7	1,501-	13	6.2
3-4	48	22.9	>2,000	8	3.8
5-6	31	14.8			
7-8	17	8.1			
>8	39	18.6			

Table 2. Principal component analysis with varimax rotation—quality attributes

Quality attributes	Variable (Coded)	Factor1	Factor2	Factor3	Factor4
Acceptable service charge	Sat4	0.65	0.16	-0.08	0.17
Diversity shipping	Sat5	0.82	0.14	0.11	-0.03
Diversity ordering	Sat6	0.78	0.10	0.19	0.10
Diversity receiving	Sat7	0.81	0.10	0.05	0.14
Speedy product delivery	Sat8	0.24	0.56	0.35	0.12
Simple transaction process	Sat9	0.46	0.42	0.14	0.28
Variety of communicates	Sat10	0.21	0.70	0.12	0.20
Quick response	Sat11	0.09	0.83	0.15	0.14
Convenience to exchange product	Sat12	0.10	0.77	0.11	0.13
Book preview service	Sat13	0.10	0.41	0.50	-0.09
Infrequent books	Sat18	0.05	0.01	0.82	-0.01
Complete introduction of books	Sat19	0.08	0.23	0.81	0.21
Accurate book reviews	Sat20	0.08	0.24	0.66	0.32
Security of transactions	Sat21	0.25	0.17	0.22	0.81
Privacy of personal details	Sat22	0.12	0.23	0.06	0.85

at least one or two experiences in online book purchasing per month, spending varying amounts.

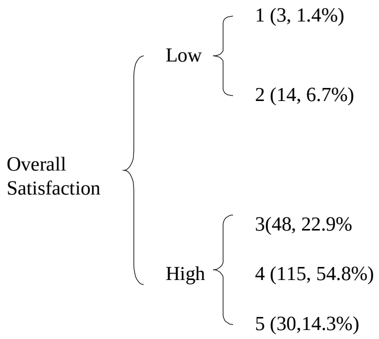
Analytical Results

Factor Analysis—Quality Attributes Satisfaction (QASAT)

Hair, Anderson, Tatham, and Black (1992) suggested that item loadings > 0.3 are considered significant, > 0.4 are more import, and > 0.5 are considered very significant. There are no accepted "absolute" standards for the cut-offs; the choice is based on judgment, purpose of the study, and prior studies. Because our goal is to examine a set of the most significant criteria incidents to assess overall satisfaction, a cut-off point of 0.7 for item loadings and eigenvalue ≥ 1 was used, factor analysis revealed five factors were obtained from quality attributes satisfaction (see Table 2).

Because three item scales (sat8, sat9 and sat13) did not load on any factors, they were removed. Sat4 and sat20 factor loading less than 0.7 were removed, respective. Finally, 10 measured variables onto the four latent factors of positive emotions were constructed. Furthermore, quality e-store, customer experience, and information content were renamed into ease of use, quick response, complete information, and trustworthy.

It was found that ease of use consisted of three items and dealt with such attributes as diversity shipping, *Figure. 2. Two groups among overall satisfaction*



diversity ordering, and diversity receiving. "Quick response" reflects concerns related to finding specific details about supporting multiple channels of communication with organizations and response quickly. "Complete information" consisted of two items: support of infrequent books and complete introduction of books. "Trustworthy" contains two items: security of transactions and privacy of personal details. The standardized Cronbach's alpha coefficients with 0.81, 0.79, 0.7, and 0.78 for ease of use, quick response, complete information and trustworthy were all exceeding the generally accepted guideline 0.7 and above (Hair, Anderson, Tatham, & Black, 1995).

Results of Multiple Discriminant Analysis

As mentioned previously, two groups based on cutting score of customers' overall satisfaction are listed in Figure 2. Overall satisfaction was measured using a 5-point Likert scale ranging from 1 (*lowest overall satisfaction*) to 5 (*highest overall satisfaction*). Because nearly half of samples are below scale 3 (37.2%), a cutting score of 3 was used in this article. The high group (individuals with scores over 3) indicated customers with high overall satisfaction, and a low group (individuals with scores under 3) represents low overall satisfaction.

The result of the discriminant analysis (see Table 3) indicated the overall model for overall satisfaction (Wilks' Lambda = 0.583, F = 10, $p < 0.01$) was significant. The canonical correlation was found to be 0.645, indicating that these dimensions explain 41.7% of the variance (by squaring it) in overall satisfaction. The subsequent analysis of variance (ANOVA) procedures revealed groups are significant different all variables (acceptable level equals 0.001), except sat12 (Convenience to exchange product) and sat18 (Infrequent books).

Furthermore, in case of multicollinearity, discriminant loadings is a better parameter for evaluation of variables (Hair, Anderson, Tatham, & Grablowsky, 1979). The discriminant loadings reflected the variance shared by the QASAT to demonstrating the contribution of each variable to the discriminant function. Generally, discriminant loadings of absolute value was greater than 0.3 to be considered significant (Hair, Anderson, Tatham, and Grablowsky, 1979).

The results indicate that not all the factors were significantly discriminate overall satisfaction, such as convenience to change products and has infrequent books. The quality attribute of diversity receiving (sat7) was the most significant variable to discriminant between two groups of overall satisfaction. Moreover, discriminant function for overall satisfaction is very good at 86% compared with a chance accuracy of 57.2% (calculated as $p^2 + (1 - p)^2$), where p is the proportion of sample in the low overall satisfaction group.

To validate predictive accuracy of the discriminant function, holdout sample was used to address the valid-

Table 3. Summary of two-groups discriminant analysis results

Factors (predictors)	Discriminant Loadings	F-value	Significance	Mean (overall satisfaction) High	Low
Sat5	0.39	15.48	0.0001*	4.08	3.46
Sat6	0.47	23.41	0.0001*	4.11	3.32
Sat7	0.64	41.92	0.0001*	4.51	3.46
Sat10	0.58	35.40	0.0001*	3.63	2.64
Sat11	0.54	30.68	0.0001*	3.65	2.7
Sat12	0.23	5.30	0.0227	3.22	2.82
Sat18	0.22	5.27	0.0232	3.56	3.12
Sat19	0.53	28.90	0.0001*	3.77	2.82
Sat21	0.58	34.99	0.0001*	3.80	2.94
Sat22	0.34	11.86	0.0008*	3.59	3.06
Wilk's Lambda = 0.583 F = 9.72 (df = 10), $p < 0.0001$					

*: Significant level = 0.001

Table 4. Classification matrix

	Analysis sample				Holdout sample		
	Low	High	Total		Low	High	Total
Low	38	12	50	Low	12	3	15
High	12	85	97	High	4	44	48
Accuracy = 84%				Accuracy = 89%			

ity. We split roughly 70% (147 cases) of total sample for training the discriminant function, then validated by assessing performance on the remaining 63 cases in the holdout sample. Hair, Anderson, Tatham, and Grablowsky (1979) suggest that the classification accuracy reflected in the overall hit ratio should be at least 25% higher than the proportional chance criterion (e.g., should be 71.5% or more) before one can have confidence in the predictive validity of the discriminant function. Because the overall hit ratio of holdout sample (89%) exceeds 71.5%, the discriminant model is valid. The classification accuracy for analysis sample and holdout sample, respectively, was summarized in Table 4.

FUTURE TRENDS

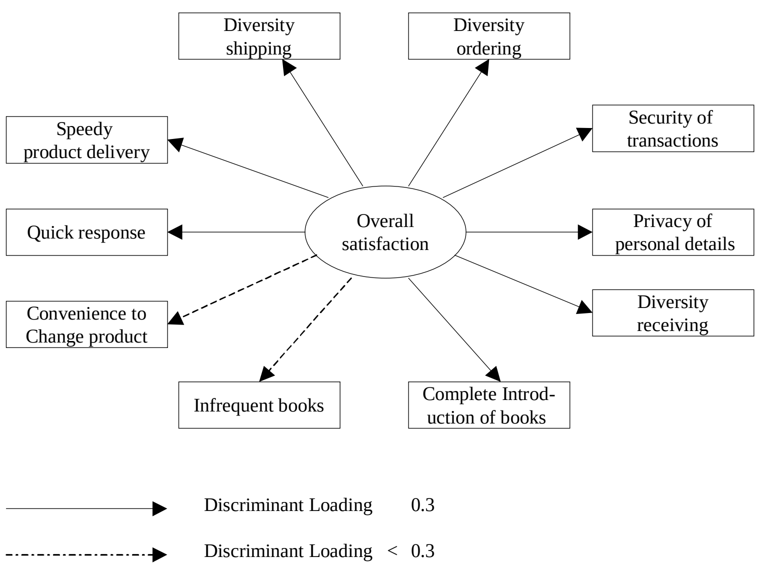
Like all research, this study has its limitations. One such limitation is that the predictive model was designed for applying to online bookstores. Accordingly, whether the predictive model is appropriate to other range of sites needs to be verified in future study. Furthermore, that we only use quality attributes to predict customers' overall satisfaction. Therefore, more dimensions or factors will be involved in the future to enhance the power of model explanation.

CONCLUSION

At the end of the 20th century and the beginning of the 21st, Internet has emerged as an important and increasing interest research area in a variety of academic setting. This phenomena stem from both its proliferation of the Web potential for business, together with its profuse customer information.

Armed with the aforementioned points, 10 measured variables onto the four factors of positive emotions were constructed in this study. Two-hundred ten online users from a Web-based survey who have made at least one online shopping experience was included the following analysis. Using the discriminant analysis, a good predictive accuracy (86%) was achieved and a good validity results (86%) was produced adopted on predictive model. Finally, based on Hair et al., (1995), discriminant loadings suggestion (values greater than 0.3), the proposed model was revised into Figure 3. Therefore, once customers have a feeling with the slow response, slow product delivery, cannot offer diversity shipping, or diversity ordering, diversity receiving, security problems, privacy concerns, or incomplete content, will be influenced by these nega-

Figure 3. Revised model



tive emotions, and affect overall satisfaction indirectly. Therefore, that we also verified that if customers are first time to visit online bookstores, these factors are not effect on overall satisfaction in this study.

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KEY TERMS

Electronic Commerce: A way of doing business transactions over the Internet. Electronic commerce has three different categories: those are business to business or B2B, business to consumer, or B2C, and consumer to consumer, or C2C.

Business-to-Business (B2B): It takes the form of automated processes between trading partners.

Business-to-Consumer (B2C): In this method, products or services are sold from a firm to a consumer.

Consumer Experience: Such as increased customization, convenience in purchasing, responsiveness in product delivery, and so on.

Customer-to-Customer (C2C): In this method that participants bid for products and services over the Internet, such as online auction.

Delphi Method: The objective of most Delphi applications is the reliable and creative exploration of ideas or the production of suitable information for decision making.

Information Content: Such as availability of information to compare across alternatives, completeness of information provided about a firm, product and service, and so on.

Multiple Discriminant Analysis: Discriminant analysis is one of the available technologies for identifying the variables that discriminant "best" between groups. Furthermore, that we can use the identified variables to develop a rule to classify future observations into one of the groups.

Quality E-Store: Such as fast Web page download, store size, promotions, ease of use, and so on.

Security Concerns: Such as availability of secure modes for transmitting information, provisions made for alternatives, overall concern about security of transactions over the Internet, gathering of personal information, and so on.

Password Security Issues on an E-Commerce Site

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INTRODUCTION

With the exponential growth of the Internet and e-commerce, the need for secure transactions has become a necessity for both consumer and business. Even though there have been advances in security technology, one aspect remains constant: passwords still play a central role in system security. The difficulty with passwords is that all too often they are the easiest security mechanism to defeat.

Kevin Mitnick, notably the most recognized computer hacker, made the following statement concerning humans and their passwords:

…the human side of computer security is easily exploited and constantly overlooked. Companies spend millions of dollars on firewalls, encryption and secure access devices, and it's money wasted, because none of these measures addresses the weakest link in the security chain. (Poulsen, 2000)

Without secure passwords, e-commerce sites invite online criminals to attempt fraudulent schemes that mimic the goods and services that legitimate e-commerce merchants offer. With increasing numbers of users on an increasing array of e-commerce sites, often requiring the use of passwords, users often choose to reuse the same simplistic password, and do so on multiple sites (Campbell, Calvert, & Boswell, 2003).

For most computerized systems, passwords are the first line of defense against hackers or intruders (Horowitz, 2001). There have been numerous published articles that have created guidelines on how to create better or safer passwords with the following recommendations:

1. passwords should be memorized and not written down;
2. passwords should be an eight- or nine-character word or phrase, and end users should randomly add
3. passwords should contain a mixture of letters (both upper- and lowercase), numbers, and punctuation characters; and
4. passwords should never be words that can be commonly found in a dictionary.

But if an individual adheres to security experts' suggestions about password authentication, it usually involves a trade-off. If a password is easy to create and remember, it is most likely that it is easy for others to guess or a hacker to crack.

Eventually, any password can be cracked. Password crackers use a variety of methods and tools that can include guessing, dictionary lists, or brute force attacks. Dictionary lists are created by using an automated program that includes a text file of words that are common in a dictionary. The program repeatedly attempts to log on to the target system, using a different word from the text file on each attempt. A brute force attack is a variation of the dictionary attacks, but it is designed to determine passwords that may not be included in the text file. In a brute force attack, the attacker uses an automated program that generates hashes or encrypted values for all possible passwords and compares them to the values in the password file (Conklin, White, Cothren, Williams, & Davis, 2004).

Unfortunately, many of the deficiencies of password authentication systems arise from the limitations of human cognitive ability (Pond, Podd, Bunnell, & Henderson, 2000). The requirements to remember long and complicated passwords are contrary to a well-known property of human memory. First, the capacity of human memory in its capacity to remember a sequence of items is temporally limited, with a short-term capacity of around seven items plus or minus two (Kanaley, 2001). Second, when humans remember a sequence of items, those items cannot be drawn from an arbitrary and unfamiliar range, but must be familiar "chunks" such as words or familiar symbols. Third, the human memory thrives on redundancy. In fact, studies have shown that individuals' short-term memory will retain a password for approximately 30 seconds, thereby requiring individuals to attempt to memorize their passwords immediately (Atkinson & Shiffrin, 1968).

BACKGROUND

Password security research has dramatically increased over the past 20 years (Ives & Walsh, 2004). Even though there has been an increased awareness surrounding the topic of password protection, password vulnerabilities remain significant. Most of today's e-commerce sites allow access to both data and the networked system by granting permissions based on password approval. The increased usage of passwords and logins has revealed several interesting issues associated with users' difficulty in developing and remembering passwords (Jones, 2002).

In order to combat the issue of having to remember so many different passwords, some users have resorted to selecting familiar terms such as a pet or family name, their own name, their phone number, or other common terms that could be found in a dictionary. British psychologist Helen Petrie, PhD, a professor of human/computer interaction at City University in London, analyzed the passwords of 1,200 British office workers who participated in a survey funded by CentralNic, an Internet domain-name company in 2001. She found that most individuals' choices of passwords fell into one of four distinct password "genres" or categories (see Table 1).

The first group, which she labeled as "family," comprised nearly half of the respondents. These individuals selected their own name or nickname; the name of a child, partner, or pet; birth date; or a significant number such as a phone or social security number. Further, Petrie found that these individuals chose passwords that symbolized people or events with emotional value or ties.

One-third of the respondents were "fans," using the names of athletes, singers, movie stars, fictional characters, or sports teams. Petrie also found that these individuals were generally young and wanted to align themselves with the lifestyle represented by or surrounded around a celebrity status such as Madonna and Homer Simpson.

Eleven percent of responses were "fantasists." Petrie found that their passwords comprised sexual terms or topics. Some of the examples included in this category were terms such as "sexy," "stud," and "goddess." The final 10% of participants were identified as "cryptics." These users were seemingly the most security-conscious, but it should also be noted that they were also the smallest of all of the four categories. These individuals selected unintelligible passwords that included a random string of letters, numbers, and symbols.

IMPACT

To assess the security level of the passwords selected by consumers at the online bookstore, the researchers reviewed current best practices for online password security (Ohio State, 2004; University of New Mexico, 2004; Department of Defense, 1985; Security Stats, 2004) and aggregated the guidelines into an instrument that was used to rate the security level of each password. The data set contained 520 customer profiles collected from an e-business site from the summer of 2003 until the summer of 2004, with the majority of the respondents being from the western United States. Also, it should be noted that the e-commerce site did not require a signed consent from the user, as the information was obtained via the owner of the site, nor was a password recommended or created by the system.

Using the five-point human rating system gathered from a review of the literature, a panel of three individuals familiar with the current literature related to password security developed the categories presented in Appendix A. To provide a greater degree of granularity for analysis, a series of dichotomous yes or no questions was developed that was both positive and negative. From these questions, a standardized scoring system was developed (see Appendix B). The scoring system included eight

Table 1. Petrie's category definition

Category #	***Name***	***Definition***
1	Family	Name or nickname; name of a child, partner, or pet; birthday
2	Fan	Names of athletes, singers, movie stars, fictional characters, or sports teams
3	Fantasists	Interest in sex is evident in passwords such as "sexy," "stud," and "goddess"
4	Cryptic	Unintelligible passwords or a random string of letters, numbers, and symbols, such as Jxa+157

Table 2. Descriptive statistics

Category	N	%
1—Family	101	19.3%
2—Fan	11	2.1%
3—Fantasists	2	.4%
4—Cryptic	201	38.5%
5—Faith	30	5.7%
6—Place	7	1.3%
7—Other	143	27.4%
8—Numbers	25	4.8%
Total	520	100%

questions concerning positive recommendations of what people should be doing according to best practices, and an additional eight concerning negative "what not to do" practices. Next, the researchers developed an aggregate score for the positive and negative section by assigning a 1 or a 0 to the password for each question and then summing the scores. An overall score was assigned by subtracting the overall negative score from the overall positive score.

The review of Table 2 suggests that users are using good password practices that include numbers, symbols, and upper- and lower-case letters. This result differs from the study conducted by Petrie (2001), in that Cryptics were the smallest group of users in her study, but the largest in this study. The second largest group in this study was "Other," where consumers selected common English words such as "checkers," "onions," "cake," and so forth.

As noted earlier, Petrie's study identified four distinct categories in the order of family, fan, fantasists, and cryptics, while this study identified eight separate categories. It should be noted that in this study the classification of groups became more refined. Our additional categories are Other, Faith, Place, and Numbers, which appear to be more descriptive of consumers' passwords (see Table 3). It could be argued that the categories of "other," "faith," "place," and "numbers" should be included in, for instance, the "family" category in that it may represent words that relate to individuals' choices of favorite food, religious choices, favorite places, or places that have emotional ties and numbers that are meaningful to them personally. It appears that individuals, and males in particular, are becoming more careful in their password selection.

The results in Table 4 are an indicator of password strength and present the results of an ANOVA procedure with comparison of means. The procedure identified significant differences in the means of the rating for password categories. Additionally, the analysis identified groups that have statistical homogenous means.

For the dichotomous scale, the mean rating for cryptics is statistically higher than the mean rating of the categories of numbers, faith, other, and fan. For the five-point human categorization scale, the procedure identified three different groups: Group 1 comprises the cryptic category, Group 2 comprises the numbers category, and Group 3 comprises the fan, faith, and other categories. For both scales, Cryptics are more secure in creating their passwords, followed by the Numbers category.

Table 3. Current study category definition

Category #	Name	Definition
5	Other	Common English dictionary terms that did not include religious terms or places
6	Faith	Terms associated with religion or religious activities
7	Place	Names associated with towns or cities
8	Numbers	A string of all numbers

Table 4. Results of linear model procedure for the comparison of means

Variable	F-Statistics (p-value)	Category 1 Fan	Category 4 Cryptic	Category 5 Faith	Category 7 Other	Category 8 Numbers
Dichotomous positive/negative scale (-8 to 8)	111.51* (0.0001)	0.44 ^{A}	2.78 ^{C}	1.00 ^{B}	0.91 ^{B}	1.88 ^{D}
Five-point human categorization	78.68* (0.0001)	2.34 ^{E}	3.36 ^{G}	2.37 ^{E}	2.52 ^{E}	2.92 ^{H}
Sample size (n)	--	101	201	30	143	25

Means with the same letter indicate that they are not significantly different in each row
*H_o: $\mu_1 = \mu_4 = \mu_5 = \mu_7 = \mu_8$ vs. H_1: At least one of them is not equal

In the scoring system we had eight questions concerning the positive recommendation of what people should be doing according to best practices, and an additional eight concerning negative "what not to do" guidelines. The researchers then developed an aggregate score for the positive and negative section by assigning a 1 or a 0 to the password for each question and summing the scores for each section. An overall score was assigned by subtracting the overall negative score from the overall positive score. Since we have eight positive questions and eight negative questions, this gives us a theoretical range of between -8 and +8 for the overall score.

FUTURE TRENDS

Certainly, the future of passwords is debatable as more and more identify thefts are occurring. Both individuals as well as e-commerce sites are feeling the wrath of hackers who have broken into their systems and stolen millions of dollars worth of information. In response to the increase of online fraud, many organizations are beginning to use other forms of verification in addition to passwords, such as two-factor authentication where the consumer uses his or her password in conjunction with an additional piece of information. Another level of security is the use of personal Web certificates, where an e-commerce site relies on these personal Web certificates and the authentication process of the corresponding public/private keys to verify that you are who you claim to be.

Authenticating consumers in the future on an e-commerce site may be based upon what someone has (a smart card, token, or ID card), what he or she knows (a password or PIN), what he or she is (a biometric like a fingerprint or voiceprint), or any combination of these (Ciampa, 2005). Normally, the more authentication factors in use, the more secure the authentication. Some methods of authentication, such as a simple user ID and password, are not considered particularly strong since they are susceptible to hacking with freely available tools. Therefore, it would seem evident that other methods of security would be adopted.

Advanced authentication measures such as smartcards, authentication tokens, biometrics, and software-based mechanisms are designed to counter the weaknesses of traditional passwords. While the authentication techniques vary, they are similar in that the passwords generated by advanced authentication devices cannot be reused by an attacker who has monitored a connection. Given the inherent problems with passwords on the Internet, it appears that the use of advanced authentication measures will be necessary.

CONCLUSION

Although humans may be creative, it appears that we are still very predictable in our choices. It is evident through our research that individuals are becoming more aware of the need to create passwords that are relatively secure. Our research subjects, though different from the prior study (Petrie, 2001), have apparently learned the necessity of secure password selection. Overall, this study indicates that there are some statistical differences between the categories, and that the category's password may give some clues about its security level. It is not known whether the knowledge gained concerning good password selection has been gained through education, direction from administrators, information regarding ID theft, nature of the demographic population, or possibly a post 9-11 paradigm shift, but individuals have apparently seen the need for more secure passwords that involve both length and complexity.

Extensions of this study are also needed. Currently, further research into the areas of gender and categories may lead system administrators and e-commerce sites to make specific recommendations and/or policies related to password creation based upon gender, and in the future, it could be studied as to how effective the aforementioned devices have been in securing computerized systems.

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KEY TERMS

Advanced Authentication Measures: Techniques beyond passwords that can be used to identify the end user to determine if they are who they say they are.

Authentication: Determines a user's identity, as well as determining what a user is authorized to access.

Categories: Levels of observed actions or choices made by an individual.

Password: A word or string of characters which serves as authentication of a person's identity (personal password), or which may be used to grant or deny access to private or shared data (access password).

Password Best Practices: Guidelines to create a safe password that is hard for someone else to guess.

Password Cracking Software: A purpose of password cracking software might be to gain unauthorized access to a system, or as a preventive measure by the system administrator to check for easily crackable passwords.

Password Security: Methods or ways to protect a person's password.

APPENDIX A: ORIGINAL FIVE-POINT HUMAN PASSWORD RATING SYSTEM

Level	Description	Criteria
1	Obvious name or number	1. Password contains all or part of a username, e-mail, name, etc. 2. Or is somehow related to known information, such as a spouse or a child's name. We may not have enough information to always assess this. 3. It is easily guessable by someone that knows a little about the individual, based on publicly available knowledge.
2	Common word or number	1. Password is a repeating number (i.e., 99999). 2. Or it is a common word recognizable as either a name or word likely to be found in a dictionary.
3	Words with number at start or end or non-repeating numbers	1. Example: John52 or 73horses, combining recognizable words or phrases with a number. 2. Or having a non-repeating number, such as 345820, that does not appear to be a social security number, phone number, or street address. 3. Or adding a compound word, such as lovejohn or tomuchfun. 4. Or unrecognizable alpha characters that did not form a common word or name (i.e., mtlyfll).
4	Unrecognizable alpha and number combinations	1. Has a mixture of unrecognizable alpha characters with numbers thrown in (i.e., jds932). 2. May include compound words with numbers lovejohn99.
5	Special characters	1. Numbers and letters mixed with the inclusion of special characters like #, %, and @, etc. 2. Spaces and dashes are included in this category.

APPENDIX B: DICHOTOMOUS PASSWORD SCORING SHEET

Question	**Yes**	**No**
Positive Questions		
1. Does the password have both upper- and lower-case letters?	1	0
2. Does the password have both upper- and lower-case letters throughout the password, not just the beginning?	1	0
3. Does the password have both letters and numbers?	1	0
4. Does the password have both letters and numbers throughout, not just at the beginning or end?	1	0
5. Does the password have any special characters?	1	0
6. Does the password have at least six characters?	1	0
7. Does the password have eight or more characters?	1	0
8. Does the password appear to be random?	1	0
Negative Questions		
9. Is the password the same as the username, e-mail, or name?	1	0
10. Does the password resemble the username, e-mail, or name?	1	0
11. Does the password appear to be the name of a person (real or in book)?	1	0
12. Does the password appear to be the name of a place (real or in book)?	1	0
13. Does the password appear to be a word that could be found in an English dictionary?	1	0
14. Does the password appear to be a word in a foreign dictionary?	1	0
15. Does the password appear to have a discernible pattern to it (i.e., 123321, 8888888, or aabbccbbaa)?	1	0
16. Does the password appear to be a date?	1	0

Category: Applications of E-Technologies

Payment Mechanism of Mobile Agent-Based Restaurant Ordering System

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INTRODUCTION

The Internet, especially the World Wide Web, is moving from a free, academic domain to a profitable commercial world. This underscores the importance of a digitally secure means of electronic payment for an electronic commerce application. The payment is usually an important part of an electronic commerce transaction, and it deals with the transfer of trust, either as cryptographically signed promises, or as digital cash, between the customer, the merchant, and the payment service provider.

Due to the explosive growth of e-commerce transactions, many electronic modes of payment are devised to address a diverse set of Internet user requirements (Guida, Stahl, Bunt et al., 2004; Tsiakis & Sthephanides, 2005; Garfinkel, 2003; Usher, 2003; Polk, Hastings, & Malpani, 2003; Evans & Yen, 2005; Marchesini, Smith, & Zhao, 2005; Lancaster, Yen, & Huang, 2003; Lekkas, 2003; Medvinsky & Neuman, 1995; Schoenmakers, 1997; Levi & Koc, 2001; Mahony, Peirce, & Tewari, 2001; DigiCash Press, 1994; Neuman & Tso, 1994; Vivtek, 2000).

The background of this article is that we have developed a mobile agent-based restaurant reservation and ordering system whereby users are able to search for restaurants that fulfill a list of user-entered parameters (e.g., type of cuisines, ambiance, specialties such as steaks, etc.) (Quah & Leow, 2003). The system is built on the IBM Aglet mobile agent platform. (A mobile agent is a small executable code/program that can migrate itself to remote hosts and execute predefined instructions—e.g., information retrieval, and return the processed information to its originating host system) (Lanage & Oshima, 1998). Due to the uniqueness of our system, we find the existing e-commerce payment methods inadequate to fit our system's need. As such, we studied several existing methods and adapted one into our system operation structure. The use of mobile agent to implement the payment system adds robustness and scalability to the system.

DESCRIPTION OF THE ELECTRONIC PAYMENT SYSTEM

To support electronic commerce, various Internet payment protocols have been proposed and adopted by a variety of organizations. In fact, the existence of different payment mechanisms are justified because there are different needs to be satisfied in terms of:

- Cryptographic needs (strong, symmetric, exportable, importable, etc.)
- Latency of the transaction (micropayment must be very fast)
- Minimal and maximal amount for the transaction itself
- Minimal and maximal amount for the cost of the transaction
- Repudiation, notarization needs
- Involvement of financial institution (i.e., online vs. off-line)

Some of the above requirements may call for contradictory system requirements, and as such, trade-offs have to be made. In a nutshell, an electronic payment system should meet the following requirements:

1. Sufficient security means based on the amount of money transferred in a transaction.
2. Similar running scenario as the traditional business whenever possible to ease the doubts of the public and encourage them to participate.
3. Minimum changes on the current financial system to avoid tremendous costs when electronic commerce is introduced.

The participants of an electronic commerce transaction must be able to exchange trade and payment information over a network. The implementation addresses the problem of online payment by credit card in which anyone with knowledge of the customer's credit card number can create an order for payment. It also tries to eliminate the requirement of a Certificate Authority (CA), and consequently a CA-based Public Key Infrastructure (PKI), in order to verify a public key-based digital signature.

Characteristics of the Mobile Agent-Based Restaurant Order Payment System

Secure Socket Layer- (SSL) (Rainbow Technologies, 2001; Freier, Karlton, & Kocher, 1996; Albrecht, 1998) based protocols used in credit card payment are convenient but have some authentication and non-repudiation problems. Secure Electronic Transaction standard (SET) (MasterCard, 1997) and other payment-card-based protocols, which require either intermediary agents or CA-based PKI, are secure, but not so convenient, particularly for financial institutions (FIs). The mechanism of our implementation tries to find a middle ground in the "security vs. convenience" trade-off.

In our payment mechanism implementation, both the customer and the merchant need to be registered off-line with a network payment service (or trusted party) with their credit card data and given a unique persona. This persona acts as a mapping between an identified user and that user's public key and credit card information stored in the trusted third-party system. The trusted third party then acts as an intermediary in collaborating with the customer's issuing bank and the merchant's acquiring bank in the settlement of the credit card bill.

The basic idea behind the mobile agent-based restaurant order payment system is to avoid the necessity of consumer certificates. It also provides a remedy to the inability of the traditional credit card payment system in authenticating the customer's identity. The trusted third party makes use of the stored public key to authenticate the identity of the customer and merchant. Only signed payment request from the customer and an order endorsed by the merchant can effect the payment. The merchant verifies the digital signature of the consumer in most of the electronic payment protocols. In our payment scheme, the trusted third party is the authority who verifies the consumer's digital signature.

The payment system serves like a credit card system without the online authorization with the issuing bank. This payment method does not require changing the existing credit card settlement infrastructure tremendously to adopt this scheme. Another important characteristic of the system is that messages transmitted among the consumer, merchant, and trusted third party are not encrypted. Justifications for this challenging characteristic are as follows:

1. The persona is not valid unless there is an accompanying digital signature issued by its owner. Any third party cannot take advantage of knowing the persona, since it cannot produce a digital signature. Thus, personas need not be encrypted.
2. The strong public private key authentication is sufficient to prevent the majority of consumer and merchant frauds. Using the persona concept and strong authentication make encryption a luxury in this payment system.

Mobile Agent-Based Payment Protocol

A payment protocol based on mobile agents is devised to structure the interactions and information exchange among agents to complete a payment transaction. The payment structure integrates the use of public key cryptography into the mobile agent framework for enhancing security in electronic payment.

The payment protocol consists of the following steps, as shown in Figure 1:

- CC—Consumer
- TTP—Trusted third party
- Mer—Merchant
- SigCC—Consumer's signature of payment data and order information
- SigMer—Merchant's signature of order information

1. Having decided the food to order, the consumer clicks on the "Pay" button at the Aglet Service center. The ASC launches the consumer aglet that carries the payment request which most importantly contains the merchant's persona and the payment amount.
2. At the merchant site, the consumer aglet passes the payment request to the merchant aglet. The merchant aglet carries the consumer's payment request with its own signature of the order and dispatches to the TTP site.

   Consumer payment request:
   > Consumer persona, [payment data, H(Order)], SigCC

   Merchant signature of the order:
   > Merchant persona, [H(Order)], SigMer

3. At the TTP site, the merchant aglet passes the consumer's payment request and merchant's signature of the order to the TTP aglet. The TTP aglet verifies the consumer's signature on the payment request and the merchant's signature on the order.

Figure 1. Payment protocol

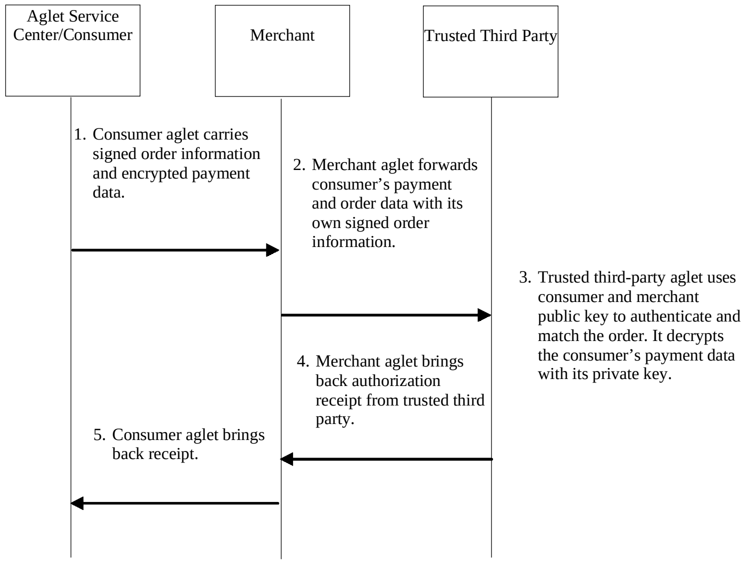
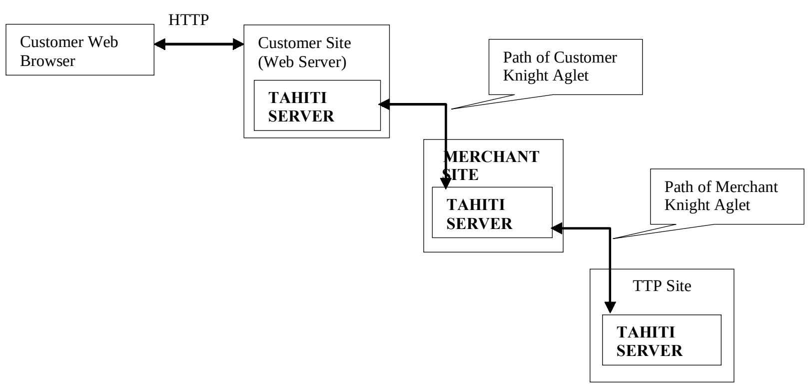


Figure 2. System setup



The TTP aglet verifies that both the customer and merchant agree on the order and authorizes the payment. The TTP aglet returns a receipt to the merchant aglet.

4. The merchant aglet returns to the merchant site with the receipt.
5. The merchant aglet forwards the receipt to the consumer aglet waiting at the merchant site. The consumer aglet returns to the consumer site with the receipt.

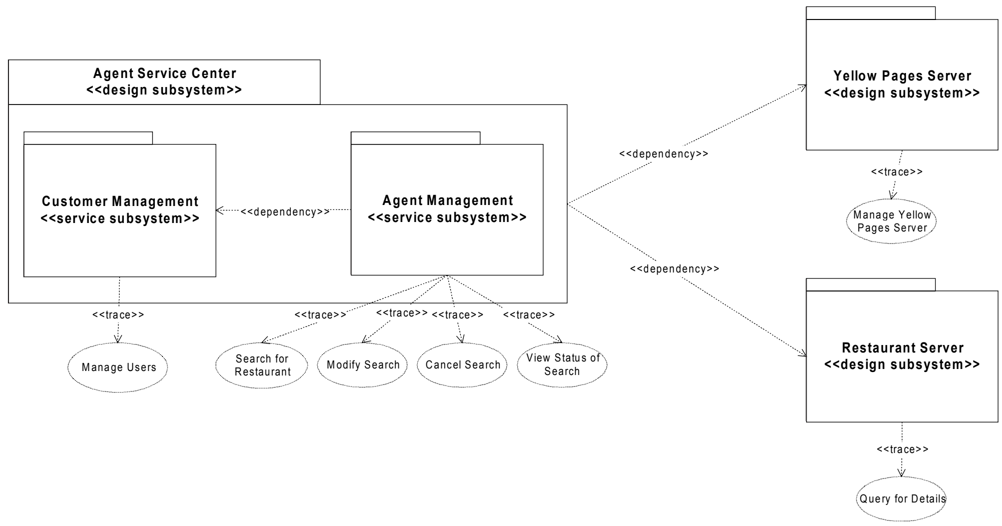
Figure 2 shows the setup of the payment system prototype in the aglet environment. Our system implements a master-slave mechanism of agents. The master agent is a stationary agent residing in the Tahiti Server. It spawns off one or more slave agents to accomplish a task. The slave agents are mobile agents, as they need to execute on a remote host. The mobile slave agent keeps information about its origin, the destination site on which it is going to run on, and the aglet information of the master who created it, as they need to inform their master on their return.

IMPACT AND USEFULNESS OF THE PAYMENT MECHANISM

Features of the payment system that is used in our mobile agent-based restaurant system include:

1. Anonymity, meaning the merchant would not know the customer's identity. Only the trusted third

Figure 3. Architecture framework for online restaurant system



party knows the identities to process the payment. But the trusted third party would not know the order detail. He can only verify that both the merchant and customer agreed with the order.

2. No credit card number is required to be sent over the network by using the trusted third-party approach. Instead, the customer's persona, sent with the signed payment request, acts as an identifier that is only recognized by the specific trusted third party. This unique persona will map to the credit card information preregistered by the customer with the trusted third party.
3. Non-repudiation using public private key authentication. In the proposed payment system, it can be later proven that the customer had agreed to pay for the food and the merchant had endorsed the order, as the trusted third party kept record of the signed payment request from the customer and signature of the order from the merchant. This addresses the problem of the credit card and token-based payment system where there is no proof that the cus4. Offline settlement via third-party avoid transaction latency resulted from online authorization via the banking infrastructure as in a typical credit card transaction. The transaction and its associated authorization are stored in a "batch," along with the rest of the transactions for the day. The trusted third party will submit the batch request to the processing network to process the transactions for which authorizations have been recorded.
5. Auditability, meaning the trusted third party has records of transaction signed by the customer and the merchant.
6. Widespread use and acceptance of credit card payment is a proposed scheme which can leverage on the existing credit card payment infrastructure. The credit card billing procedure that current customers are accustomed to can be utilized. As for merchants, there is no overhead since the trusted third party acts as a bridge for payment between the acquirers and merchants.
7. Achieve interoperability and reduce message exchange across network using Java mobile agent technology.

A potential weakness of the payment mechanism is the bottleneck at the trusted third party during peak traffic volume because all payment requests are sent to the trusted third party for signature verification. This, however, is a common problem for most online payment systems. One possible solution is to have a cluster of high-power servers at the verification site.

RESULTS

The mobile agent framework consists predominantly of Client, Agent Service Center (ASC), and the Restaurant Server Platform (see Figure 3).

The hotel guest will be able to access the online restaurant recommendation system through a Web browser in his hotel room. The search request(s) made by the guest will be registered with the ASC, which will then process each request and generate a list of online restaurants sites that will likely provide the pertinent information (i.e., food dishes) requested by the guest. The Yellow Page (YP) server that provides a database of such online sites helps to facilitate the compilation and generation of a list of such relevant online sites. This list of online sites will constitute the itinerary list that the mobile agent (MA) will have to visit. As mentioned, another main functionality of the ASC server would also be to generate a mobile agent that will begin traveling to the online restaurant sites to gather data on behalf of the user.

The mobile agent will abide by the generated itinerary list as it travels from one online restaurant server to another in order to complete its search for food and restaurant information. Upon arrival at each online site, the mobile agent will enquire the restaurant server to search for the food based on the user's search requirements. In addition, the restaurant server can retrieve its promotional information and push it to the ASC server, which in turn displays the promotional information to the users.

When the returned information is consolidated, the user (the customer) will be able to browse through the information and decide on his purchases.

CONCLUSION

A mobile agent system has been developed to perform restaurant food searches for customers from restaurants with Web presence. Details on promotional offers are also 'pushed' to the user. The security aspect of the system and integrity of the data are ensured by means of cryptography and digital signature schemes. The system provides a user-friendly environment for easy usage.

There are areas that we are currently exploring to further improve the system. Firstly, we are extending the aglets server functions to handle advance reservation requests from the user; this will require further mobile agent activity such that the mobile agent will interact with the restaurant reservation system to place a booking. This will also involve expanding payment options that must be provided for the user to pay for his meals. To push the technology further, we are exploring the possibility of allowing autonomous negotiation by the mobile agent. Basically, mobile agents representing the users and the restaurant servers will meet at some cyberspace negotiation room to transact their requests for their respective hosts that they are representing.

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KEY TERMS

Aglets: Platforms for mobile agents to operate on and on which to perform transactions.

Electronic Commerce: Business transactions over the Internet.

Encryption: Data coding schemes to protect information privacy.

Mobile Agent: Software code that can migrate host to host autonomously to perform operations.

Payment System: A mechanism for enabling payment for Internet transactions.

Trusted Third Party: A trust center that serves as an intermediary for Internet transactions.

Personalization and Customer Satisfaction in Mobile Commerce

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INTRODUCTION

The advancement of wireless technology facilitates both consumers' activities and business transactions. With the rapid proliferation and widespread use of mobile devices, including mobile phones, personal digital assistants (PDAs), and handheld computers, mobile commerce or m-commerce is widely considered to be a driving force for the next generation of electronic commerce (e-commerce). According to Jupiter Research, the m-commerce industry is expected to be US$22 billion globally by 2005. However, to date many promising technologies—especially m-commerce applications—have failed with the notable exceptions of i-Mode service and short messaging service (SMS).

Popular "i-Mode", produced by NTT DoCoMo of Japan, is a service that enables wireless Web browsing and e-mail from mobile phones. The "i-Mode service" has been the first successful commercial introduction of 3G (third-generation) mobile applications. It exceeded expectations and acquired over 30 million profitable users in a three-year period (Cohen, 2002).

One of the main goals of most operators might be building customer satisfaction and loyalty by providing one or more 'killer apps' to them. One way is to integrate customer relationship management (CRM) into the development of mobile services' applications. Some firms have tried to target these applications to their customers on an individualized basis. "Personalization" may be the way to achieve that. Specifically, personalization can be regarded as the use of technology and user/customer information to match multimedia content with individual needs with the goal of producing user satisfaction. Personalization can be presented by an IP services framework that allows operators and subscribers through self-service provisioning approaches to control the types of service and applications they want and are willing to buy.

The purpose of this article is to develop a deeper understanding of personalization, with an emphasis on those factors that lead to customer satisfaction and/or delight. Specifically, this article presents factors contributing to consequences derived from using personalized applications and services in m-commerce.

BACKGROUND

In their pilot study, Ho and Kwok (2003) applied the technology acceptance model (TAM) originated by Davis (1989) to their m-commerce study. They utilized four constructs to predict the service subscribers' intention to switch: number of generalized messages, perceived ease of use of general advertisements, perceived usefulness of personalized message, and privacy issues about personalized advertisements.

This article extends the thrust of Ho and Kwok's research to incorporate the effect of personalization on customers' satisfaction and delight that could contribute to CRM. Customers' satisfaction and delight are derived from expectancy theory, and they are discussed by Oliver (1981), Oliver, Rust, and Varki (1997), Spreng, Mackenzie, and Olshavsky (1996), and Verma (2003).

Expectancy: Satisfaction and Delight

Expectancy theory is used to frame the evaluation of mobile services users. Oliver (1981) defined expectation to include two components: the probability of occurrence (e.g., the likelihood that a personalized cell service will be available) and an evaluation of the occurrence (e.g., the degree to which the personalization level is desirable or undesirable). The disconfirmation/confirmation paradigm of satisfaction is based on expectancy theory. It can be an emotional response to the comparison of the performance received and the products' normative standards. When the performance and expectations are at variance with each other, there is a discrepancy. This discrepancy could be either *positive* (when performance exceeds the expectations), which often causes satisfied state, or it could be *negative,* when performance is worse off than expected (Oliver, 1981). In other words, the consumer would be satisfied if perceptions match expectations or if confirmations are reached. Consistent with Spreng et al. (1996), satisfaction arises when consumers compare their perceptions of the performance of a good and/or service to both their desires and expectations. As such, satisfaction is a subjective judgment and may imply mere fulfillment.

Delight is a positively valence state reflecting high levels of consumption-based affect. The feeling of delight is experienced when the customer is pleasantly surprised in response to an experienced disconfirmation. It is the feeling state containing high levels of joy and surprise (Westbrook & Oliver, 1991). Further, Oliver et al. (1997) proposed and confirmed that delight is a function of surprising consumption, arousal, and positive effect or a function of surprisingly unexpected pleasure. They empirically confirmed that delight is a "mixture" of positive effect and arousal or surprise. It is associated with the level of arousal intensity. Moreover, it is a reaction experienced by the customer when he or she receives a service and/or a good that does not simply evoke a feeling of satisfaction, but also provides an unexpected value or unanticipated additional pleasure. In other words, delight occurs when the outcome is unanticipated or surprising. It can be marked by pleasurable, unforgettable, and memorable feelings in a service encounter or a product purchase (Verma, 2003). It is thought to be the key to customer loyalty and loyalty-driven profit (Oliver et al., 1997) and is known as the highest level of expectation-disconfirmation paradigm.

Technology Acceptance Model (TAM)

From Davis' (1989) TAM model, ease of use (EOU), and perceived usefulness (PU) of a technology are factors that either directly or indirectly increase a person's intention to adopt an innovation. While *perceived usefulness* is the degree to which a person believes that using a particular technology/system would enhance the outcome performance, *perceived ease of use* is the extent to which a person believes that using a particular technology/system will be free of effort (Davis, 1989). TAM could be helpful in predicting the usage of personalized applications and services. Greer and Murtaza (2003) adapted the TAM model to study issues that impact the valuation of Web personalization as well as factors that determine customer use of Web personalization. Ho and Kwok (2003) adapted Davis' (1989) EOU and supported the effect of using a generalized message on changing a service provider. They also used "PU of personalized service" to test the importance of personalization in mobile commerce. They found support for both. Most importantly, the PU of personalized service was the most effective factor, together with ease of locating generalized message and the amount of generalized message that affected the decision to change to a new service (Ho & Kwok, 2003).

MAIN THRUST OF THE ARTICLE

Usually when there are too many generalized messages, customers lose their motivation to read, retrieve, or even locate a useful message. In addition, the amount of space available on the mobile screen limits the amount of options and information. Given this, personalization is considered to be the key factor for success/failure of mobile devices and services. Information and services must become increasingly tailored to individual user preferences and characteristics in order to accommodate limited space and scarce airtime. Personalization is viewed as including "recognition of a customer's uniqueness" (Surprenant & Solomon, 1987, p. 87), use of a customer's name, and response to customer needs (Goodwin & Smith, 1990).

Message Format

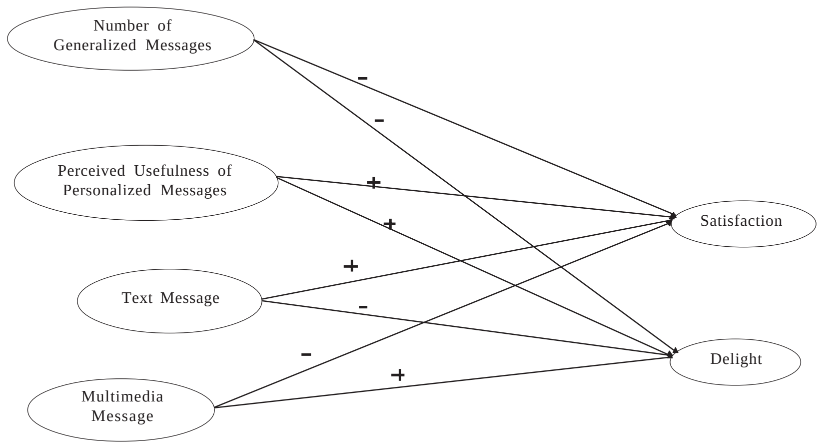
Carlson et al. (1998) characterized medium *richness* as the capacity to convey information. It is further defined as the ability to provide immediate feedback to customers' consumption of media. Rich information can be produced by giving immediate feedback, having a variety of available communication cues, understandable/common language, and foremost, personalization of the medium (Carlson et al., 1998).

Media richness theory postulates that media selection depends on the uncertainty of the task at hand (Kumar & Benbasat, 2002). Both media richness theory and the TAM model have illustrated their relationships with task orientation. Also, social presence theory postulates a particular communication task based on the degree of necessary social presence that links a selection of media (Kumar & Benbasat, 2002). Originally, it referred to the degree to which a medium allows a user to establish a personal connection with the other users. Social presence seems to be moving towards a task orientation at an individual level in the latter theoretical development, such as the para-social concept from Kumar and Benbasat (2002). Para-social is a combination product of social presence and media richness. This article focuses on the PU of personalized messages that employ a task orientation, while two different formats of messages (text and multimedia) were drawn from media richness theory.

Personalization

Personalization can be defined as the use of technology and user/customer information to customize multimedia

Figure 1. Research model



content so as to match with individual needs and ultimately produce user satisfaction (Zhang, 2003). Personalization is primarily regarded with sending the right message to the right person at the right time. The main goal behind personalization is to make any medium's usage easier and enhance any channel communication between customers and service providers.

Personalization translates individual profiles into unique presentations. The individual profiles can be built upon user preferences, the quality of his or her senses, user location/environment, contexts, users' network, and terminal capabilities. Morris-Lee's (2002) study on personalization of brochures indicated that personalization helped increase interest and involvement. The more personalized features are, the greater the possibility of increased costs (Greer & Murtaza, 2003). Hence, these increasing costs hopefully should produce greater customer satisfaction and retention, thus a greater return. This is a very important point because, for example, a 5% increase in customer retention costs can translate into a 25%-125% increase in company profitability (Reichheld et al., 2001). Also, personalization of service has been found to have a positive impact on customers' evaluations of service encounters (Surprenant & Solomon, 1987).

Figure 1 presents the research model of personalization in m-commerce. The model is developed based on the TAM (Davis, 1989) and expectancy theory (Oliver, 1981). Specifically, this research model extends Ho and Kwok's (2003) research framework. Further, our model integrates customer expectancy as an endogenous variable. The model includes six sets of variables: (1) number of generalized messages, (2) perceived usefulness, (3) text messages, (4) multimedia message, (5) satisfaction, and (6) delight.

FUTURE TRENDS

As predicted, text message predictor had a positive association with the dependent variable. Number of generalized messages was negatively related to satisfaction. Multimedia message was not a significant predictor of satisfaction and was deleted in the second model. On the other hand, the analyzes of "delight," "multimedia message" contributed the most importance to the equations and was positively related to delight. Text message and PU of personalized message had positive associations with delight, while the number of generalized messages had a negative contribution to the equation (Hsu, Bruner, & Kulviwat, 2005).

According to Santos et al. (2003), even though satisfaction and delight are two different constructs, each serves a dimension of confirmation (satisfaction) at one end and disconfirmation (delight) on the other end. Increasing literature has being drawn in the difference between consumer satisfaction and delight (Kumar & Olshavsky, 1997; Oliver et al., 1997). To compare satisfaction with delight, Oliver et al. (1997) see customer delight as being fundamentally different from customer satisfaction. Compared to satisfaction, delight seems more abstract and more extreme in terms of affection. While satisfaction may be induced by avoiding problems or may meet standard/minimum requirement, delight requires more than that. Oliver et al. (1997) empirically confirmed the distinction between the satisfaction and delight constructs, with delight being a higher level of satisfaction. In fact, customer delight is associated with a strong and positive emotional reaction to a product or service. Thus, both practitioners and scholars should manage customer delight as a separate goal from satisfaction.

Te'eni, Sagie, Schwartz, Zaidman, and Amichai-Hamburger (2001) used three dimensions to define media richness further; these are interactivity, adaptiveness, and channel capacity. Beyond just a different format from a text message, future researchers may look into a deeper understanding of multimedia messages that convey information for possible customers' delight in addition to satisfaction. Delightedness can be marked with pleasurable, unforgettable, and memorable where customer loyalty is rooted (Verma, 2003; Oliver et al., 1997). With the limitation of student population, future research may investigate some professional group that has reasons to use mobile commerce and/or some population that has more disposable income at hand. Another limitation that can also be addressed in the future is the sophistication of multimedia services and the maturity of users. In other words, future researchers may look into some markets that have rolled out the mMode of AT&T, Mobile Web of Verizon, and/or Sprint's PCS.

From mobile application point of view, "personalization" can be more sensitive to users' needs, for example, location-based application as in www.mobull.usf.edu. Local merchants ally to deliver a personalized text message—such as sales, promotion advertisement, coupons—from a Web site to a wireless device based on personal preferences that are set up by each individual. Location-based services utilize location information to provide specialized contents to mobile users (Varshney, 2003). Explicit user permissions should be obtained before "pushing" any advertising contents to particular users (Varshney, 2003). Push and pull advertisement, of course, relates to the issues of privacy and sharing of user information. Therefore, the "trust" matter may surface between a group of local merchants and individual consumers.

CONCLUSION

This article identifies the same situation as in Ho and Kwok (2003) that the amount of generalized message had a negative effect on customer satisfaction. Personalized message is more likely related to customer satisfaction and delight. The TAM model and expectancy theory were drawn as the foundation of this research model. Media richness explains the division between text message and multimedia message, whereas TAM contributes the perceived usefulness of personalized message.

Beyond personalization, this article attempts to merge the media richness theory with expectancy theory. Specifically, it explains the relationships between text/multimedia message and customer's satisfaction/delight. The article concludes that consumers would like to have a richer media to experience a "delightful" emotion. Consistent with the principle of media richness (Carlson et al., 1998): the more complex media format, the more information can be delivered in a message. If managers would like to increase effectiveness and/or efficiency of mobile services, text message alone would not be sufficient for market differentiation to gain competitive advantage. With personalization, multimedia formats can be a supplement tool to increase the interaction with consumers when launching advertising campaigns. The richer the media, the more effective it is in communication.

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KEY TERMS

Customer Delight: The feeling of delight is experienced when the customer is pleasantly surprised in response to an experienced disconfirmation.

Customer Satisfaction: Based on the consumption, consumer would be satisfied if perceptions match expectations or if confirmations are reached.

Expectance Theory: Oliver defined expectation to include two components: the probability of occurrence and an evaluation of the occurrence. The discrepancy of confirmation could be either positive or negative.

Media Richness: Media richness theory postulates that media selection depends on the uncertainty of the task at hand. The more complex media format, the more information can be delivered in a message.

Mobile or M-Commerce: Both consumers' activities and business transactions are facilitated by the advancement of wireless technology including cellular phones, wireless PDAs, or any hand-held units.

Personalization: Can be regarded as services of the use of technology and user/customer information to customize multimedia content aiming to match with individual needs and ultimately deliver customers' or users' satisfaction.

Technology Acceptance Model (TAM): From Davis' TAM model, ease of use (EOU) and perceived usefulness (PU) of a technology are factors that either directly or indirectly increase a person's intention to adopt an innovation.

Personalization Techniques and Their Application

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INTRODUCTION

Personalization is an approach to increase the usability of complex information systems and present the user with a comprehensible interface that is tailored to his or her needs and interests. In this article, we examine general techniques that are employed to achieve the personalization of Web sites. This is followed by a presentation of real-world examples. It will be shown how different levels of personalization can be achieved by employing the discussed techniques. This leads finally to a summary of the current state in personalization technologies and the issues connected with them. The article closes with some ideas on further research and development, and a conclusion.

In general, the concept of personalization refers to the ability of tailoring standardized items to the needs of individual people. It is originally derived from the ideas of Pine (1993) who proposed that companies should move from the paradigms of standardized products and homogeneous markets to customizable products that meet the requirements of many different customers. The principle of mass customization applies to a certain degree to most car manufacturers and some computer manufacturers, for example, Dell.

In the digital world of the World Wide Web, the degree of customization can be much higher than in the physical world. Currently, a number of online portals and e-commerce shops make use of personalization to provide a better user experience. Although Web sites may be the most popular examples of personalization, the concept is not limited to the Web. Every information system that deals with large amounts of data and/or has a heterogeneous group of users can benefit from it. Examples include e-learning environments, electronic books, computer-operated voice and telephony services, and tourist guides.

Personalization is also very useful for mobile devices like personal digital assistants (PDAs) or mobile phones (cf, Mulvenna, Anand, & Buchner, 2000). Technologies like mobile Internet access, WAP (Wireless Application Protocol), and future multimedia applications based on high-capacity wireless technologies require the designers of services for these devices to deal with limited input capabilities and small display sizes. For that reason, every method that assists the user in navigating and finding information easily adds real value to applications for such devices.

PERSONALIZATION TECHNIQUES

The core idea of personalization is to customize the presentation of information specifically to the user to make user interfaces more intuitive and easier to understand, and to reduce information overload.

The main areas of tailoring presentation to individual users are content and navigation. Content refers to the information being displayed, and navigation refers to the structure of the links that allow the user to move from one page to another. Personalized navigation can help the user to easily find what he or she is looking for or to discover new information. For example, a system discussed by Belkin (2000) assists users in refining search queries by giving recommendations on related or similar terms.

Adaptable vs. Adaptive

There are two approaches to achieve personalization: adaptable and adaptive methods. The former is a term for systems that can be customized by the user in an explicit manner; that is, the user can change the content, layout, appearance, and so forth to his or her needs. This data is called a user profile, and all personalized presentation is based on data the user provided for configuration purposes. It is important to note that the customized appearance does not change over time until the user decides to change his or her preferences.

In contrast, adaptive methods change the presentation implicitly by using secondary data. This data can be obtained from a variety of sources, for example, from the user's actions, from the behaviour of other users on that

Table 1. Application of adaptable and adaptive methods to content and navigation

	Content	Navigation
Adaptable	▪ explicit selection and ordering of content items by the user ▪ providing personal information to be listed in directories ▪ setting up stock portfolios	▪ building link lists (favourites, bookmarks) ▪ setting default links for generic navigational structures/menus to omit intermediate step(s)
Adaptive	▪ present the user new items which are related to the current items (recommendations) ▪ filter content based on current actions (remove items which are dissimilar)	▪ hiding unsuitable links based on the context ▪ annotate links to give meta-information about value of the linked content relating to the user's navigation history (e.g. "no new information", "insufficient previous knowledge" etc)

site, or based on the currently displayed content. Methods that use this data as input are discussed in detail below. The most distinctive characteristic of adaptive methods is that they are constantly monitoring the user's activities to adjust the arrangement and selection of relevant information.

Adaptive methods or machine-learning algorithms are huge steps toward automated customization. Current static interfaces suffer from the fact that the designer has to anticipate the needs, interests, and previous knowledge of the users in advance. As these preferences change over time, customization that requires human interaction for collecting and identifying preferences leads quickly to outdated user profiles.

Table 1 shows how adaptive and adaptable methods can be applied to customize content and navigation. The examples given are intended to be generic; more concrete examples are examined in the case studies below.

Degree of Personalization

Another important criterion for classification is the degree of personalization. Systems can have *transient* or *persistent personalization*, or be *nonpersonalized*. With transient personalization, the customization remains temporary and is largely based on a combination of the user's navigation and an item-to-item correlation. For example, if an item is selected, the system attaches similar items as recommendations to it whereby the content of the shopping cart is taken into consideration.

Persistent personalization systems maintain a permanent user account for every user to preserve his or her settings and preferences across separate sessions. Although this raises privacy issues and is the most difficult to implement, it offers the greatest benefit. These systems can make use of user-to-user correlation algorithms and thus provide higher accuracy.

Another technology that belongs to the broad area of personalization is *recommender systems* (Mulvenna et al., 2000). Whereas straight personalization tailors just the presentation of information, recommender systems support the user in discovering new information. As recommendation relies on user preferences and interests, it is often part of personalized systems. From another perspective, one can say that recommender systems provide a selection of the most suitable content for the user. The application of recommender systems to e-commerce is discussed by Schafer, Konstan, and Riedl (2001).

In the following sections, we look at two cases that highlight the adaptive and adaptable approaches to personalization.

APPLICATION AND IMPACT OF PERSONALIZATION: AMAZON.COM

Amazon.com is one of the pioneers of e-commerce. Originally set up as a bookstore, it has grown to a general retailer for a wide range of products. It also provides an auction platform and a marketplace where customers can sell used goods. The marketplace is seamlessly integrated into the main product catalogue, therefore customers can decide whether they want to buy a particular product as a new or a used one.

Goal

As the Amazon.com product catalogue contains more than 2 million products, users can easily get frustrated if they do not find what they are looking for. Thus, one of the main goals is to tailor the product catalogue as much as possible to the needs and interests of the user.

Aside from easy navigation, the site offers a seamlessly integrated recommendation system. It is intended to offer customers products that are either related to their interests or to the product that is currently displayed to exploit cross-selling potentials.

Personalization Techniques

Amazon.com is a highly developed online shopping site and incorporates a combination of numerous adaptive and adaptable methods. The generated user profile is stored in a database on the server; that is, the degree of personalization is persistent.

The prevalent recommendation method is based on the purchases of other customers. It appears as a list beginning with the phrase "Customers who bought this book also bought…" on each product detail page (Figure 1a). A second list contains up to five authors whose books were bought by customers who also bought the currently selected book. Both of these features are collaborative-filtering methods of implicit collected data. Another feature called purchase circles is also a collaborative-filtering mechanism that displays the top-10 products for a particular region, institution, or company.

Other recommendation methods are based on the activities of the customer. For example, there is always one product recommendation in a sidebar that is apparently directly derived from the list of recently viewed items (Figure 1c). Moreover, there is also a recommendation page for each of the main categories (books, software, etc.) that is completely based on the customer's purchase history.

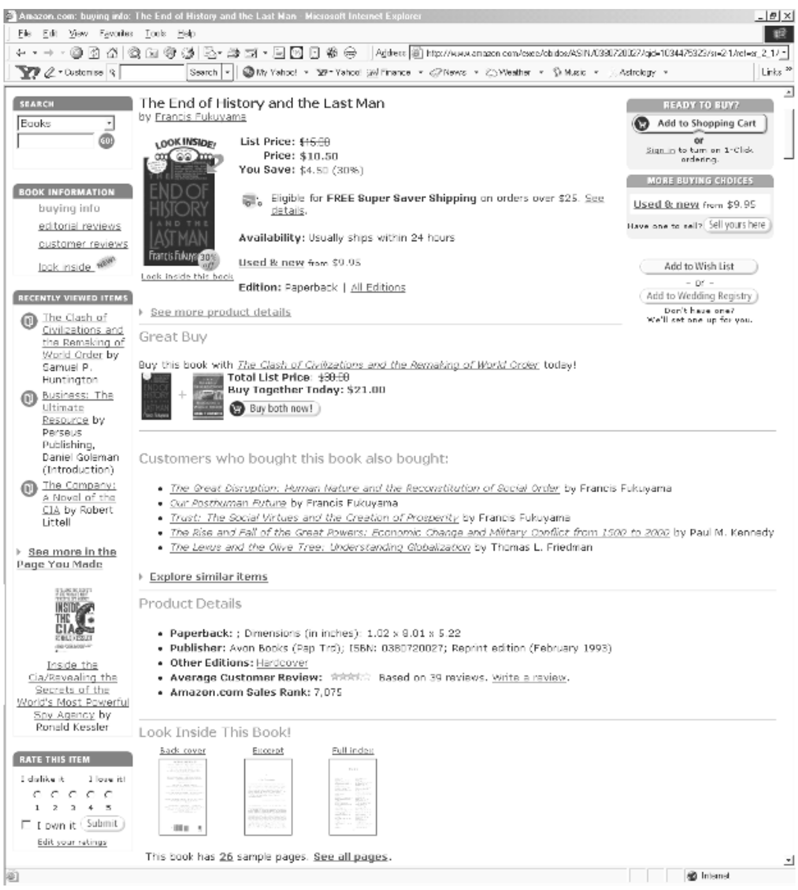
Amazon.com also encourages customers to rate their purchased products (Figure 1e). Ratings belong to the collaborative-filtering methods. However, in contrast to the list of products other customers bought, they require explicit interaction for the sake of personalization. The ratings can also be part of customer reviews and comments. Interestingly, it is even possible to rate the ratings; that is, customers can indicate whether they found the rating helpful or not (e.g., "3 of 5 people found the following review helpful"). This mechanism is used to display the most helpful comments first and let the least helpful comments move to secondary pages.

As mentioned before, one of the goals is to exploit cross-selling potentials. One of the recent additions to Amazon.com is the "Great Buy" feature. It offers the customer the current product together with another product in a bundle at a special price (Figure 1b). The two products must have a complementary relationship to be valuable to the customer.

Outcome and Lessons Learned

Amazon.com has clearly utilized a very broad range of different personalization methods. As this site has developed constantly in product variety, functionality, and comfort, it is nearly at the state of the art in this area. The

Figure 1. Amazon.com detail page for a book



goals stated above are nearly completely fulfilled. The site is easy to navigate, the products are easy to find, and the accuracy of the recommendations seems to be very high, which animates the customer to buy further products.

The "Great Buy" feature is certainly one of the best ways to take advantage of the cross-selling potential, whereas the list of products other customers bought is more useful for the discovery of new, interesting items and navigation. The latter seems to be less accurate compared to the earlier days of the site. This might have something to do with the enormous number of customer profiles that do not provide enough distinctive attributes to form useful clusters.

Ratings and reviews can be considered as a helpful feature; however, there are a number of relatively unqualified comments. To improve the situation, the rate-the-rating feature was introduced (far after the review function itself). While this highlights the more valuable reviews, there is still room for improvement.

APPLICATION AND IMPACT OF PERSONALIZATION: YAHOO!

Yahoo! was one of the first search portals on the Web and one of the first Web sites that applied personalization on a larger scale (Manber, Patel, & Robinson, 2000). In 1996, the My Yahoo! service was introduced. It allows setting up a personal version of Yahoo! for every user. Not only the content, but also the layout and the appearance of the page can be modified. Yahoo! is a completely adaptable system; therefore, all personalization is based on the data the user entered beforehand. The ZIP code is especially central as a lot of personalized features rely on it. The intelligence of the system lies in the ability to use this data in different situations to tailor the presentation specifically to the user.

Goal

The goal of Yahoo! is to bind its users by differentiating from other Web catalogues and search engines, and to provide a fully customizable and integrated portal. As the customer structure of Yahoo! is very heterogeneous, it is a good idea to offer personalization and let users construct an individual start page. Yahoo!'s service is free for its users; money is mainly earned with advertising and revenue provisions of shopping partners. Thus, the second goal is to make advertising as effective as possible. This can be achieved by selecting banner ads that are likely to be of interest for the user.

Personalization Techniques

Yahoo! offers an adaptable system that requires the user to explicitly provide information for personalization. The user profile is kept on a server between different visits, thus Yahoo! offers persistent personalization.

My Yahoo! enables registered users to build their own Yahoo! pages. The content is selected as so-called modules. Among the available modules are ones for weather, news, sports results, stock quotes, horoscopes, movie reviews, personal news filters, and many more. Further configuration can be done within these modules. In the example shown in Figure 2, the headline module (a) is set up to show world news from British news agencies and German Formula 1 news. The weather module (b) displays the current weather situation of selected cities only. Modules can be edited or deleted (c) directly on the page. Some of the modules offer an individual default setting that is based on the user profile. For example, when the sports-results module is added, it already contains the results of teams in the user's area.

Not only the content, but also the layout is customizable. The chosen modules can be distributed on multiple pages that in turn consist of two or three columns where modules can be ordered arbitrarily. There are also options like colour sets and themes to change the appearance of My Yahoo!.

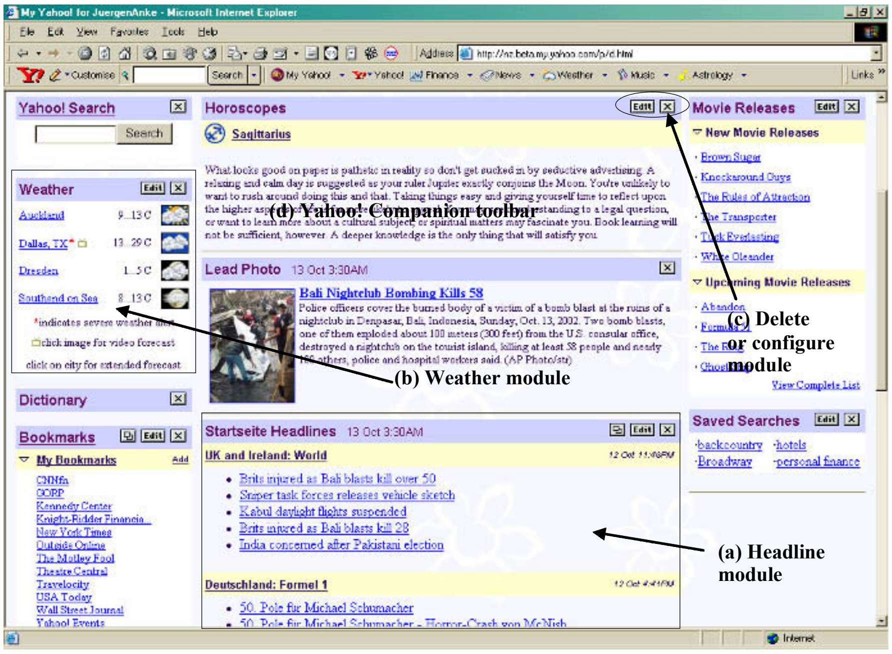
Outcome and Lessons Learned

The goal of flexible customization to provide an integrated portal can be considered to be fulfilled. Whether the effectiveness of advertising is increased by personalization cannot be decided with certainty since most of the literature does not mention it. However, as it is vital for Yahoo! to have effective advertising, it can be assumed that it incorporates a relatively advanced system for selecting banner advertisements on an adaptive basis.

Apart from these sophisticated personalization features, it is also essential to design high-quality default pages for people who do not want to customize at all. It turned out that only a small number of users actually customize Yahoo!; most of them take what is offered. The reasons for this may be either that the personalization tools are too complicated, or the users do not need complex personalization as the default page is satisfactory for them. Addressing all types of users also includes not requiring users to enter any personal data and not forcing them to use personalization features.

Yahoo! has decided not to use adaptive methods. They believe that these methods are still not good enough for such a complex site as a user's behaviour is not

Figure 2. A customized version of the My Yahoo! start page



sufficiently predictable. People must not be unsure of how the systems work; otherwise, it prevents them from experimenting as they fear breaking something. The people from Yahoo! reckon that any kind of personalization should encourage the users to experiment.

While it is beyond the scope of this article to look at the numerous other cases of personalization, it is worthwhile to mention the large-scale personalization project at ibm.com. Karat, Brodie, Karat, Vergo, and Alpert (2003) describe this in detail, and they provide an overview of the many different personalization techniques used and the reasons for selecting them for the project.

CONCLUSION

Current State of Development

A number of different approaches to personalization are currently used in various applications. Highly sophisticated e-commerce sites usually employ a combination of multiple methods and contain adaptive as well as adaptable elements in a coherent user interface. As the case study of Amazon.com has shown, organisations can add real value for the users by making it more convenient to tailor the presentation to individual needs.

Adaptive methods for personalization are very powerful means to manage information overload and simplify user interfaces. Despite their sophisticated algorithms, they can produce unpredictable and unwanted results. This is an area where further research is necessary as adaptable methods have the serious disadvantage of their configuration remaining static until the user changes it explicitly. This can be a tedious task for most users, which lowers the value even of the most flexible customization services. Hence, there are only a small number of users who actually want to customize their pages.

Directions for Future Research and Development

Improve Group-Based Personalization

The personalization based on a user's preferences is increasingly being extended by collaborative methods. Instead of recommending items based on the profile of a single user, the system should try to take advantage of other users' ratings and preferences as well. While this might in fact increase the accuracy of predictions, it raises the issue of proper user selection.

New Input Methods

Methods that allow formulating queries in a natural language rather than in special inhuman query syntax could make the interaction between the user and the system even more personalized and individualistic (Zadrozny, Budzikowska, Chai, Kambhatla, Levesque, & Nicolov, 2000).

Combination of Explicit and Implicit Data

Both adaptive and adaptable methods have their strengths and weaknesses, and may be more or less applicable for a particular situation. However, it seems to turn out that the combination of explicit and implicit user data provides the best results. On one hand, the effort of manual customization is minimized, and on the other hand, an adaptive method will not cause much unpredicted results when it is limited by explicit statements. Wells and Wolfers (2000) explain how customers who use online banking services need to make some basic statements about their financial goals and situations. After that, adaptive methods are used to offer financial products and services that are tailored to the customer and suitable for his or her particular needs. However, not all techniques applicable to a certain scenario will be successful in practice. Alpert, Karat, Karat, Brodie, and Vergo (2003) show in their study about users' attitudes toward adaptive systems that users have a strong desire to always be in full control of all interaction. It is therefore important to carefully analyze the potential acceptance barriers of a designed solution before finally deploying it.

Future Outlook

Personalization technologies have found their way out of experimental systems of researchers into commercial applications. They are a powerful means to handle information overload, to make complex information systems more usable for a heterogeneous group of people, and to help online businesses establish personal relations with their customers (one-to-one marketing). Although we have focused on applications of personalization to Web sites, they can be used in a wide range of human-computer interactions. Personalization techniques are the key to mass customization and provide people with a much more individual experience instead of standardized services.

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KEY TERMS

Adaptable Personalization Systems: Systems that can be customized by the user in an explicit manner; that is, the user can change the content, layout, appearance, and so forth to his or her needs.

Adaptive Personalization Systems: These change the presentation implicitly by using secondary data. This data can be obtained from a variety of sources, for example, from the user's actions, from the behaviour of other users on that site, or based on the currently displayed content.

Decision-Support Systems and Tools: In a wider sense, it can be defined as systems and tools that affect the way people make decisions.

Mass Customization: The customization of products and services for individual customers, but at a mass-production price.

Personalization: An approach to increase the usability of complex information systems and present the user with a comprehensible interface that is tailored to his or her needs and interests.

Recommender Systems: A special type of decision-support system that gives recommendations for further actions or related items.

Tailoring: In the context of personalization, it can be with respect to content or navigation. Content refers to the information being displayed, and navigation refers to the structure of the links that allow the user to move from one page to another.

Category: Concepts, Trends, and Challenges

Process-Oriented Reorganization Projects in Electronic Government

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INTRODUCTION

From the beginning of the 90s, public administration has been confronted by a series of new demands. Society has been transformed by the influence of new technologies. There is a strong trend towards growing individualization, whereby there are increasing demands by individuals on the state. Simultaneously, in the context of national and international competition, efficient and effective state activity and support for entrepreneurial activities in a region or country are becoming an increasingly decisive factor in location decisions. No one has yet succeeded in improving the performance capability of the state, in a manner and degree that is commensurate with the increasing number of responsibilities. According to Budäus and Schwiering (1999) a modernization and performance gap has arisen because of the difference between the volume of work and performance.

For some years, the term electronic government, coined from e-business, has been universally proposed as a way of closing this gap. The core of e-government as well as e-business is the execution of administrative processes (Langkabel, 2000, p. 6). In recent years, businesses have already initiated and successfully undertaken measures to strengthen the organization of business processes. At the same time, the academic disciplines of business management studies and business information technology have taken up this issue (Davenport, 1993; Earl, 1994; Hammer 1990; Hammer & Champy, 1993). Commensurately, fields such as process modeling, workflow management or process cost calculation demonstrate a deep understanding of theory and have consequently attained a high standard of development.

However, the practical application of this knowledge, acquired in the domain of public administrations, has only occurred to a limited degree. Alongside an insufficient translation of theoretical knowledge into practice, the urgent practical challenges of process management, for example, and the design of procedure models for specific domains, have not so far been adequately taken up by the relevant academic disciplines and conceptualized soundly.

The purpose of this article is to stimulate an improvement in the situation outlined above. The objective is the presentation of a systematic approach how to prepare process oriented e-government projects. As a rule, comprehensive preparation is essential for process modeling, because, on the one hand, the model design is characterized by a high degree of process complexity and on the other hand, the information model is characterized by a high degree of object complexity. When considering the aim of the modeling, it is necessary to determine both the object of modeling, and the modeling methods and tools.

As an introduction we first provide an overview of related work. In section one we briefly describe different modeling objectives and explain, why organizational design is one of the most important aims of process modeling in the context of e-government ("why" should be modeled). In section two we identify requirements for a modeling method based on the domain e-government and the modeling objective organizational design. The requirements lead to the selection of event-driven process chains (EPC) ("how" should be modeled).

In section three we show how the target environments for modeling projects can be identified. Based on a public service classification scheme we therefore introduce a two-phase procedure comprising the successive application of the portfolio analysis and the profile method ("what" should be modeled).

BACKGROUND

Business process modeling and business process reengineering are the dominating topics in the discussion of enterprise modernization (Davenport, 1993; Hammer, 1993; Hammer & Champy, 1993; Harrington, 1991; King, 1994).

Several methods, techniques and tools have been developed and implemented to support process oriented reorganization (Keen, 1991; Kettinger, Teng, & Guha, 1997). The Architecture of Integrated Information Systems (ARIS) presented by Scheer, is an approach for specifying organizations and information systems (Scheer, 2000). The four different perspectives data, functions, organization, and control, each consisting of the three layers of conceptual model, technical model, and implementation, can be used to model different aspects of a software system from a business perspective as well as an IT perspective.

Modernization efforts are also undertaken in the area of public administrations. The discussion of public administration modernization and e-government is often limited to the provision of online services and public administrations' Internet portals. Big steps towards an integrated European e-government were taken within the eGOV project, funded by the European Commission. Within this project, an integrated platform for online one-stop government was specified, developed, deployed and evaluated. Based on "life-events" the effectiveness, efficiency and quality of public administrations' services were improved (Krenner, 2002; Wimmer, 2002).

Much remains to be done, both optimization of services delivered via Internet (e.g., one-stop-government), and the optimization of public administrations' internal and inter-organizational processes (Traunmueller & Wimmer, 2001).

In order to reach the goals described we show one approach how the optimization of administration's processes can be prepared: the questions which will be answered are why, how and what should be modeled in order to generate benefits in public administrations through process oriented e-government projects.

PROCEDURAL MODEL FOR E-GOVERNMENT REORGANIZATION PROJECTS

Select the Modeling Objective

The main aims of process modeling according to Rosemann and Schwegmann (2002, p. 58) are organization and application system design.

Organization Design:

- Organization documentation
- Process-oriented reorganization
- Continuous process management
- Certification
- Benchmarking

Application System Design:

- Selection of ERP software
- Model-based customizing
- Software development
- Workflow management
- Simulation

Models for organizational design require a high degree of clarity, whereas models for application system design require a high degree of technical precision, because of their close relationship to the final implementation.

The above listed purposes of process modeling obviously force the process models to meet certain different requirements in terms of content and methodology. With respect to contents, the requirements differ in the related model components. The first step in order to improve public administration's processes and make them suitable for e-government applications should be organization design, in particular, the process-oriented reorganization. An examination of application system design is only considered worthwhile on the basis of organizational process improvements (Raymond, Pare, & Bergeron, 1995).

SELECT THE MODELING METHOD

Modeling Method: Requirements

There are various and diverse model types for modeling (business) processes. Petri-nets (Jensen, 1985), added-value chain diagrams (Porter, 1990) and event-driven process chains (EPC) (van der Aalst, 1999), are amongst the best known. The choice of a model type is influenced mainly by the purpose of the application and the requirements of the model users. Application aims, such as simulation and workflow management, require model types which produce detailed, precise, formally itemized models. Application objectives such as process-oriented reorganization require less formal models. In this case, *clarity* is especially important. For a modeling method to meet the requirements of administrative processes, their most salient characteristics need to be considered first (Scheer et al., 1996, p. 120):

- Information processing functions predominate. Even if actual products are being produced, information processing predominates as the main resource for the public administration is information.

- Business processes are regulated either by law or at least hinge on legal regulations. This frequently leads to inflexibility and long time horizons for change.
- The responsibility for business processes is divided among a number of people, who work only on a small portion of the process “bureaucratically”. There is an enormous flow of documents between the individual stages. Because of this decentralized structure it makes the integrated overview of a business process more difficult.
- Citizens must be treated equally, irrespective of origin and assets, because of legislation and its legal implications. A high degree of procedural soundness, stability and comparability must be ensured.

Based on the characteristics described, the most important requirements of a modeling method are summarized as follows:

- Simple principle, clear presentation
- Comparability between various models
- Presentation of information systems
- Presentation of organization units and places
- Presentation of information flow

Modeling Method: Selection

Based on these requirements, the event-driven process chain (EPC) is often selected as a method in several projects, because of its high degree of clarity, and its potential for integrated evaluation. The high level of clarity is especially important in the interview phases as the results are usually documented in process models and have to be verified by the employees. Moreover the final presentation of target processes has to be easily understandable for a range of individuals with heterogeneous backgrounds (e.g., mayor or information technology officer). The other advantage is that weaknesses in the processes could easily be identified by analyzing the models.

SELECT THE MODELING OBJECT

Before the first modeling process, relevant problem areas should be (1) identified, (2) classified and then (3) prioritized with respect to financial and personnel resource constraints.

1. Business process framework for identification of target environments

An analysis of the organizational structure of the public administration and its effects on the organizational structure should be summarized to serve as a guiding principle for the processes to follow. The most suitable way of doing so is to use a business process framework. A business process framework divides the structures of the administration on an abstract level by a selected organizational paradigm and clarifies the relationships between the individual parts of this framework. It is important to adapt the business process framework according to the gained recognition of required processes. Often, the final business process framework is not ready before the process modeling is completed. After the modeled processes are implemented or when presenting the organizational structure, the business process framework can then be ideally used as a communication means and as a navigator through a number of process models that were generated within the scope of a project.

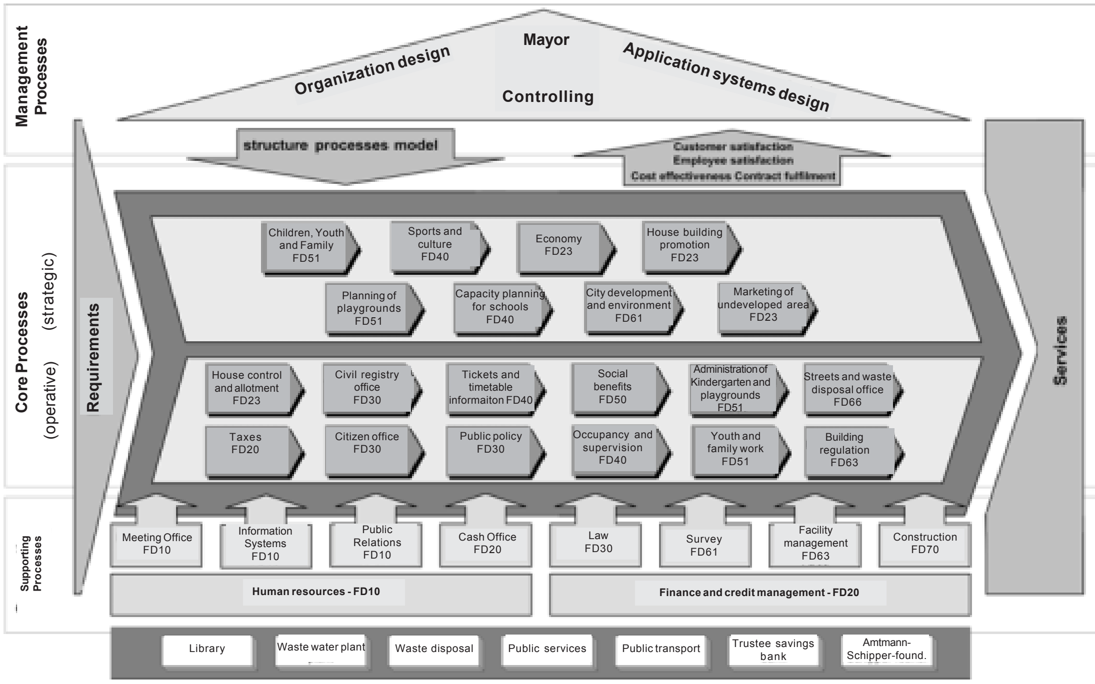
Figure 1 shows a framework for municipalities, which helps to identify potential target environments for organizational engineering. To support that, management processes, operative and strategic core processes and supporting processes are differentiated.

The most relevant processes for e-government projects are the core processes as they are directly connected to the environment consisting of citizens, companies and other administrations. After identifying the relevant target environments the next step is to classify the underlying processes, usually more than 1000 different ones in a common German municipality.

2. Classification of processes in target environments

A classification scheme is an appropriate way of structuring the identified services, taking into account different perspectives. In the context of the administration domain, the application of an internal and external perspective is provided, to show potential for improvements in administration (greater efficiency) and also for the citizens as customers (improved performance). The degree of interaction between citizens and local government can be a performance criterion. Three levels, information, communication and transaction have been widely used (Boller & Beuchat, 2002, p. 56; Budäus & Schwiering, 1999, p. 155). On the other hand, the degree of integration is used as a measure of the efficiency of a service and is part of the internal perspective. A hierarchy, for instance, can be structured according to whether a service is performed with media breaks, without media breaks, or completely automated. If the level of interaction and the degree of integration are combined, a matrix will be obtained, which can be of assis-

Figure 1. Framework for identification of processes



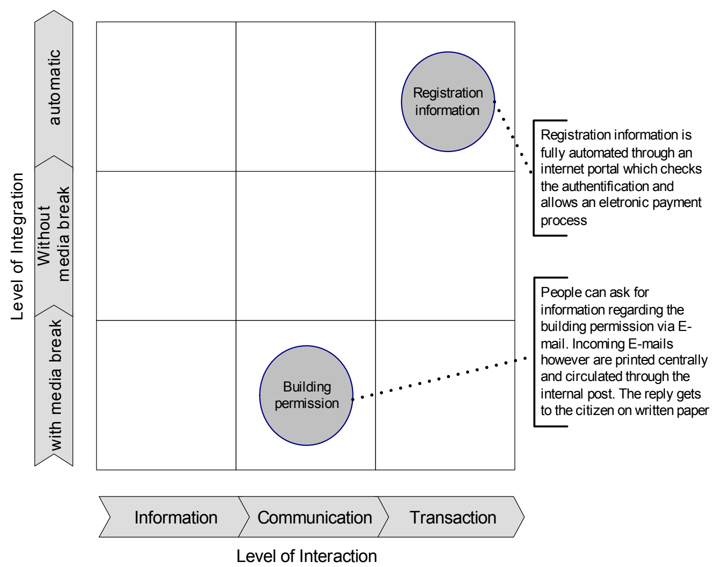
tance in categorizing and classifying existing services in a municipality (see Figure 2).

With the aid of a classification scheme, the extent of application of individual services can be visualized at a glance. In this manner, services, for example, can be identified, whose processing is already largely optimized and do not, therefore, need to be part of any reorganization project.

3. Prioritization of target environments

In order to select appropriate services on the basis of classification schemes, a two-phase procedure comprising the successive application of the portfolio method and the profile method is introduced. From phase to phase, the number of services considered and the level of

Figure 2. Classification scheme for administration services



precision of the investigation increase through using a rising number of decision-making criteria.

The *portfolio analysis* is a tool that, at minimal cost, can provide a basic overview of the most important qualitative features of a service and can convey its potential for a modeling project (Francis & Archer, 1971). It is then a question of which dimensions can provide the optimal prioritization of existing services.

- **Dimension 1:** The starting point is that all decisions have to be financially justifiable, because of the high pressure to contain or reduce costs. Hence local government should focus on services with a high number of cases as incremental costs decrease with an increased volume of users.
- **Dimension 2:** For every service performed on the part of local government, there is a user on the demand side. It is advisable first to aim for increased efficiency in areas of high usage through so called power users (e.g., businesses, associations and other external institutions), as the greatest results can be achieved there. Figure 3 shows the portfolio together with some selected services.

Recommendations for prioritization of implementation can be derived from the fields of the matrix (see Figure 3). The figures in the individual fields can be interpreted as *priority ratios*. The profile method, which is outlined in the following section, should therefore logically be used only for services that are found in field 1 of the portfolio.

Figure 3. Service performance portfolio

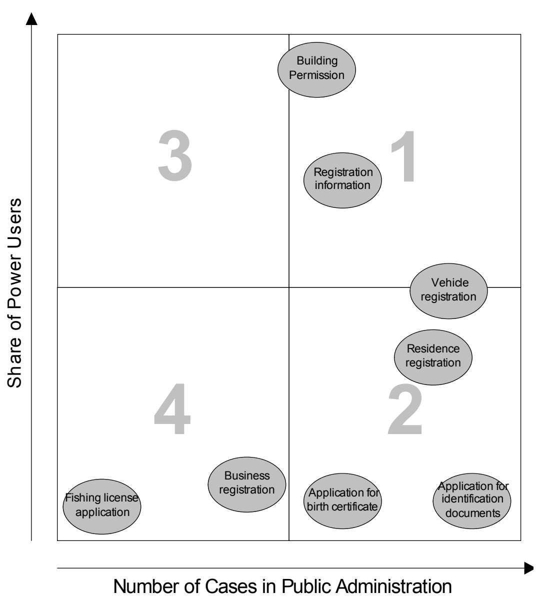


Figure 4. Service profile for registration information

Service:	Information from Citizen Register					
Evaluator:	Douglas Adams (City Adminstration)					
Date:	2003-02-24					
Evaluation Criterion	Assigned Value					
1. Transaction frequency Customer		1	2	3	4	5
2. Transaction frequency Administration		1	2	3	4	5
3. Organisational Complexity		1	2	3	4	5
4. Technical Complexity		1	2	3	4	5
5. Necessary Level of Security		1	2	3	4	5

The next step—the so-called *project profile method*—has the advantage of allowing the examination of the alternatives at one's disposal and with regard to several qualitative characteristics. Each aspect of an alternative is evaluated on a numerical scale of 1 to 5 and the total evaluation is depicted graphically. A distinctive positive feature is the explicit representation of evaluation criteria, which gives the decision-maker a more concrete picture of the individual services, than the portfolio presentation provides. A written definition of each numerical rating is given in the key.

The scale anchoring table provides a firm basis for evaluation and avoids any deviation in the results that could be caused by the subjective interpretations of different appraisers. The visualization of a service profile results in a matrix representation, which incorporates various evaluation criteria on one side and their possible ratings on the other. The relevant characteristics are marked by circles and connected with lines. This graphic presentation enables a fast visual estimation of a service. The choice of criteria for a service performance profile must be determined on a case-by-case basis. Figure 4 shows an example of a project profile with five features (in this case, for evaluation of the register information).

As with the portfolio method, in the case of service performance profiles, accurate results are less important in the context of prioritization, than the straightforwardness of the application.

After this phase—the organization possesses a prioritized list of processes which are suitable for process reorganization. The process modeling and reorganization itself will then commence with the phases:

- As-is modeling and process analysis
- To-be modeling and process optimization
- Process implementation and process roll-out
- Continuous process management

FUTURE TRENDS

It is clear that there are considerable structural analogies amongst various administrative processes within a civic authority, and to a greater extent with similar processes between authorities. In moving towards an extensive process oriented and IT-supported modernization of an administration, the development of a reference process model as a store of domain knowledge has the potential to significantly reduce the complexity of e-government projects and to simplify their implementation by means of an orientation around reference processes. Especially the use of business process performance metrics during the modeling process will allow the potential user of a reference model to assess its benefit by benchmarking the own process metrics against the reference model. With this approach the impact of reference models will become measurable.

CONCLUSION

The importance of the preparation of process modeling projects has been introduced. The three described steps have proven effective in achieving objectives and appropriate and correct for the several modeling projects in public administrations. Despite some remaining developmental barriers, process management in an e-government context, is a viable mechanism for advancing efforts to modernize an administration.

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KEY TERMS

Electronic Government (E-Government): E-government entails the simplification and implementation of information, communication and transaction processes, in order to achieve, by means of information and communication technology, an administrative service, within and between authorities and, likewise, between authorities and private individuals or companies.

New Public Management: New public management is a stream of thoughts aiming at applying business management concept to public administrations.

Process Management: Process management aims at codesigning organizations and information systems.

Procedural Model: A procedural model seeks to analyze a certain process, business process reorganization in this context, in order to identify distinct stages and steps which require the application certain tools and methods.

Reorganization: Reorganization aims at changing the structure, the processes and the policy of an organization.

Process Simulation for E-Commerce Systems

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INTRODUCTION

As a modern way to conduct business in the global economic environment, e-commerce is becoming an essential component integrated with traditional business processes in enterprises. To reduce risks and increase profits in e-commerce investments and to provide the best services to their customers, enterprises have to find appropriate ways to analyze their e-commerce strategies at the business planning stage. Strategic management tools are designed for enterprises to evaluate their business strategies, and can be used to evaluate an e-commerce business plan, as well. For example, the SWOT (strengths, weaknesses, opportunities and threats) analysis is regarded as a popular way to conduct an e-commerce business plan evaluation, with business environmental scanning based on internal environmental factors (strengths and weaknesses) and external environmental factors (opportunities and threats) (Turban, King, Lee, & Viehland, 2003). To facilitate the application of the strategic management tools, different forms of applications are adopted, such as checklist (OGC, 2004), rating system (UNMFS, 2004), expert system (PlanWare, 2004) and so forth. Among these, computer-driven business simulation tools enable participants to run with virtual business processes, experiment with different strategies and compete with other supposed companies or plans in a virtual business environment. As an example, the *Marketplace* (ILS, 2003; IDC, 2004) is a business simulator for integrative business courses that provides decision content, including marketing, product development, sales force management, financial analysis, accounting, manufacturing and quality management. Regarding the application of computer simulation in e-commerce, the *Marketplace* strategic e-commerce simulation is specifically designed, and it illustrates the business concepts of an e-commerce environment, as well (ILS, 2003). For an e-commerce system simulation, Griss and Letsinger (2000) studied agent-based flexible e-commerce systems with an experimental multi-player shopping game to experiment with alternative individual and group economic strategies, and to evaluate the effectiveness of agent-based systems for e-commerce. Both academic and professional practice have proved that using computer simulation is an effective, efficient and economical way for e-commerce business plan evaluation.

However, it is hard to conduct simulation based on the flowchart of business processes within the current e-commerce simulation environment as mentioned above. This actually provides a limitation for applying e-commerce simulation. In fact, computer simulation has tackled a range of business problems, leading to improving efficiency, reduced costs and increased profitability since the 1950s (Robinson, 1994). Simulation tools are on the increase in various application areas (Google, 2005) and process-oriented simulation has been increasing in popularity for business management (Swain, 2001). We believe that a process-oriented simulation for e-commerce system evaluation is more directly perceived through the human sense, and our interest is to conduct a quantitative approach to e-commerce system evaluation based on the theory of process simulation.

The e-commerce system simulation is an integrative procedure to run a business processes-oriented simulation program based on both internal and external business environmental factors to demonstrate the actual results of

Table 1. A statistic analysis of C&D waste disposal in Hong Kong (EPD, 1999/2002)

Year	Amount of Waste at landfills (ton)		Percentage of C&D waste (%)
	C&D waste	Total waste	
1998	7,030	16,738	42
1999	7,890	17,932	44
2000	7,470	17,786	42
2001	6,410	16,686	38

implementing an e-commerce business model by using computer-driven software toolkits. The e-commerce system simulation is an effective, efficient and economical approach, and can be used to experiment and evaluate different e-commerce business models or plans. The adoption of e-commerce system simulation can reduce potential risks in e-commerce system development, such as the huge amount of initial investments of time and money, and the long period from business planning to system development, then to system test and operation, and finally to exact return; in other words, the proposed process-oriented e-commerce system simulation can help currently used system analysis and development methods to tell investors in a very detailed way about some keen attentions, such as how good their e-commerce system could be, how many investment repayments they could have and in which area they should improve from initial business plans.

The definition of the proposed process-oriented e-commerce system simulation normalizes its procedure to apply a process simulation to experiment with an e-commerce model. In this regard, this article focuses on the adaptation of an e-commerce model into a process simulation environment by using an experimental case study. Results from this article include the conception of e-commerce system simulation, a comprehensive review of simulation methods adopted in e-commerce system evaluation and a real case study of applying simulation to e-commerce system evaluation. Furthermore, we hope that the adoption and implementation of process simulation approach can effectively support business decision-making, and improve the efficiency of e-commerce systems.

BACKGROUND

Generally speaking, construction and demolition (C&D) waste can be reduced by using innovative construction techniques and management methods. Although these approaches have proven to be effective to some extent, most of them are still in a stage of research, and contractors usually do not like to invest in high-cost techniques. For example, surveys show that local constructors in Hong Kong feel it is expensive to use new machinery and automation technology (Ho, 1997); most local constructors agree to adopt alternative low-waste but high-cost techniques only when they are demanded by the designers, the specifications or the clients (Poon & Ng, 1999). As a result, C&D wastes are normally not controlled effectively on sites in Hong Kong. According to statistical data, C&D debris frequently makes up 10%-30% of the waste received at many landfill sites around the world (Fishbein, 1998), but this figure has been more than 40% in recent years in Hong Kong. So there is an urgent need to deal with the problem and to find a practical solution for C&D waste reduction in Hong Kong.

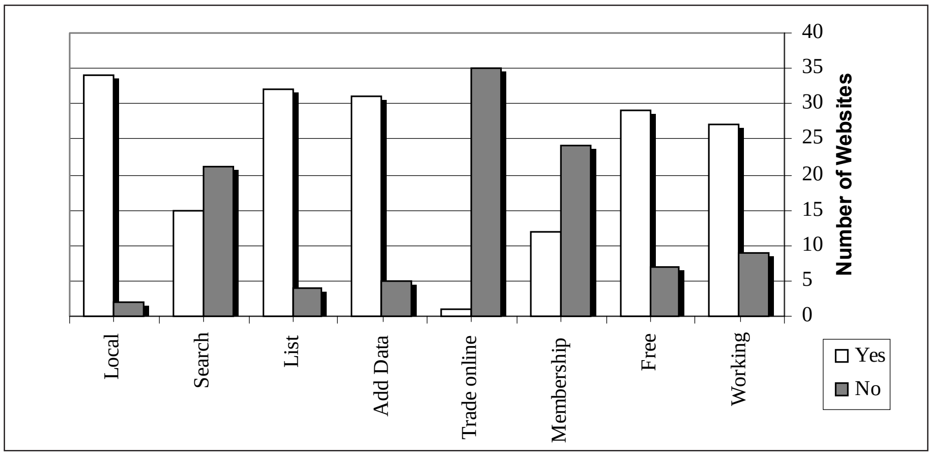
To deal with the serious problems in C&D waste management in Hong Kong, this article proposes an e-commerce model called Webfill for C&D waste exchange to enhance efficiency and effectiveness of the currently used charge system—that is, Trip-Ticket System (TTS) for C&D waste disposal—and accordingly, to reduce the total amount of C&D waste disposed to landfills in Hong Kong. To test whether the Webfill can provide an ideal result in e-commerce for C&D waste reduction, a simulation-based comparison between the existing TTS and enhanced TTS is conducted. With a full view of reducing C&D waste in Hong Kong, the Webfill as a waste exchange model can only work for reducing existing C&D waste; the control of waste generation cannot be expected. As a result, this article only focuses on the e-commerce model for C&D waste reduction at the post-construction stage and the process of e-commerce simulation.

E-COMMENCE SYSTEMS AND SIMULATION

Online Waste Exchange

The concept of waste exchange systems for exchanging industrial residues and information and for reducing the waste volume was introduced in the 1970s (Middleton & Stenburg, 1972; Mueller et al., 1975). In recent years, Web-based services for waste material and equipment trade and information exchange have been developed based on the

Figure 1. Feature comparison of C&D waste exchange Web sites



Internet, because it supports effective multimedia communication. Online search results shows that a number of Web sites are related to waste exchange, and some of them also provide in advance a special area for quality salvaged C&D waste at comfortable prices on their Web sites. However, it is apparent that no Web site has been found to be solely dedicated to e-commerce of C&D waste exchange. Appendices A and B summarize 36 online C&D waste exchange-related Web sites, and Figure 1 shows a statistic comparison of these Web sites.

According to the Web site review, we noticed that there exists a generic online C&D waste exchange model, which has been adopted by most of the observed Web sites (see Appendices A & B). The generic model can be developed based on common features existing in current waste exchange Web sites as summarized in Figure 1. Although there are some differences among their profile designs, the common features exist in data transfer and Web site functionalities.

In fact, e-commerce grows quickly in the construction industry as value-adding to business processes (Berning & Diveley-Coyne, 2000; DeMocker, 1999; NOIE, 2001; Waugh & Makar, 2001). According to the business model adopted, e-commerce systems can be categorized into three types: business-to-business (B2B) model (e.g., e-IDC.com), business-to-consumer (B2C) model (e.g., Build.com) and a combinatory model (e.g., Ei-Internets.com). Because the B2B model has proven sustainable and profitable in the e-market of the construction industry, it is most commonly used to develop e-commerce systems (Lais, 1999), and more than 90% of architects, designers and contractors expect to conduct more business over the Internet (Mark, 2000). We thus selected the B2B model to develop our online C&D waste exchange system that will be integrated with the TTS.

Webfill Model

Webfill is an e-commerce model for construction and demolition waste exchange in Hong Kong, and it has been further developed to an online C&D waste exchange portal for the Hong Kong construction industry. There are two basic models of business strategies for online exchange (Rappa, 2002): brokerage model and infomediary model. The brokerage model—for example, Marketplace Exchange—provides a full range of services covering the transaction process, from market assessment to negotiation and fulfilment, for a particular industry. The exchange can operate independently of the industry, or it can be backed by an industry consortium. The broker typically charges the seller a transaction

Figure 2. Webfill e-commerce model for C&D waste exchange

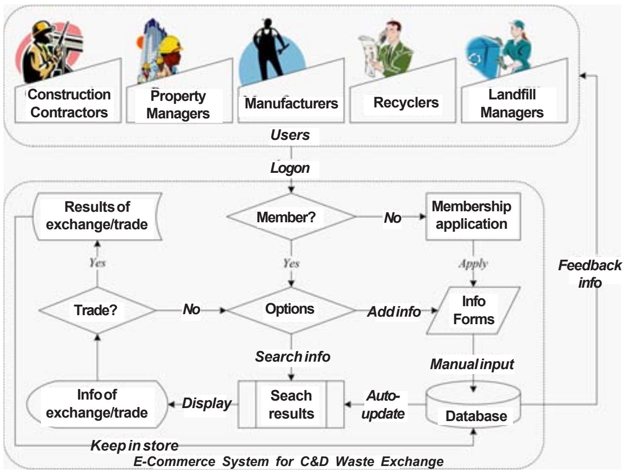


Table 2. Potential users and desires to and anticipated profits from Webfill

Users	***Roles***	***User requirements***		***Benefits***
		Sell	*Buy*	
Construction Contractors	Waste generation	Recyclable waste Residual materials	Recovered materials Residual materials	Reduce tipping fee Reduce wastage Save on buying materials
Property Managers	Waste generation	Recyclable waste Residual materials	Recovered materials Residual materials	Reduce tipping fee Reduce wastage Save on buying materials
Manufacturers	Waste recovery	Recovered materials	Recyclable waste; Residual materials	Save on buying raw materials Increase sell
Recyclers	Waste trade	Recyclable waste Residual materials Recovered materials	Recyclable waste Residual materials Recovered materials	Increase trade
Landfill Managers	Waste disposal	Recyclable waste	N/A	Decrease disposal of waste

Table 3. Parameters for the comparison simulation

Adjusted Items	*System Parameters*	*Real Characteristics*	*Simulation Settings*
Process Duration	40 hours	8 years (300 working-days/year)	1 min=1 day
Waste Quantity	1 unit	7,200 t/day (Mean value of the statistic data from 1998 to 2001)	2 unit=7,200 t waste rate is 3.6% 0.036×N(20,5)

fee based on the value of the sale. There also may be membership fees. On the other hand, the infomediary model—for example, Metamediary—facilitates transactions between buyer and sellers by providing comprehensive information and ancillary services, but does not get involved in the actual exchange of goods or services between the parties. The infomediary model is selected for the Webfill system. The information flowchart of Webfill is developed as described in Figure 2. This flowchart takes into account the common features of waste exchange systems summarized above as well as the functional requirements of e-commerce.

There are five kinds of potential users of the Webfill system, including construction contractors, property managers, manufacturers, recyclers and landfill managers. Table 2 describes these potential users regarding their roles and benefits in using the Webfill system. The Webfill system is able to attract those groups to work together, as the Webfill system creates a win-win situation for all of them.

Webfill Simulation

Although a demonstration Web site of Webfill was developed, it is still a question whether Webfill really can play an expected role in C&D waste reduction in Hong Kong. Besides research initiatives in a questionnaire survey regarding acceptance of the Webfill system, the Webfill model recalls a business process system, and we thus try to adopt the conception of an e-commerce system simulation for the experiment of the Webfill system based on process simulation with statistical parameters relating to the generation, reuse, recycling and disposal of C&D waste in Hong Kong. The simulation is conducted, which enables us to evaluate the performance of the Webfill system by comparing the results from two models, including simple TTS and Webfill-enhanced TTS. Considering the specific characters of the process flowcharts of the TTS and the Webfill system (refer to Figures 2-4), a commercial simulation software, that is, ProcessModel (processmodel.com), was selected as the tool to simulate the TTS and the Webfill-enhanced TTS.

Basic Parameters

Two basic steps are involved in developing a simulation model; one is to establish a process model for simulation, and the other is to set some basic parameters according to real conditions. A process model is a process flow diagram that uses associated data to describe a real-life process, where objects (graphic shapes) and connections (lines connecting the graphic shapes) are used to represent process elements and relationships, respectively. To compare the simulation results between the TTS and the Webfill-enhanced TTS, two process models are established (refer to Figures 3 and 4). Table 3 lists the parameters selected in the simulations. In addition to the parameters set in Table 3, we assume the quantity of C&D waste

Figure 3. Current simple TTS in Hong Kong

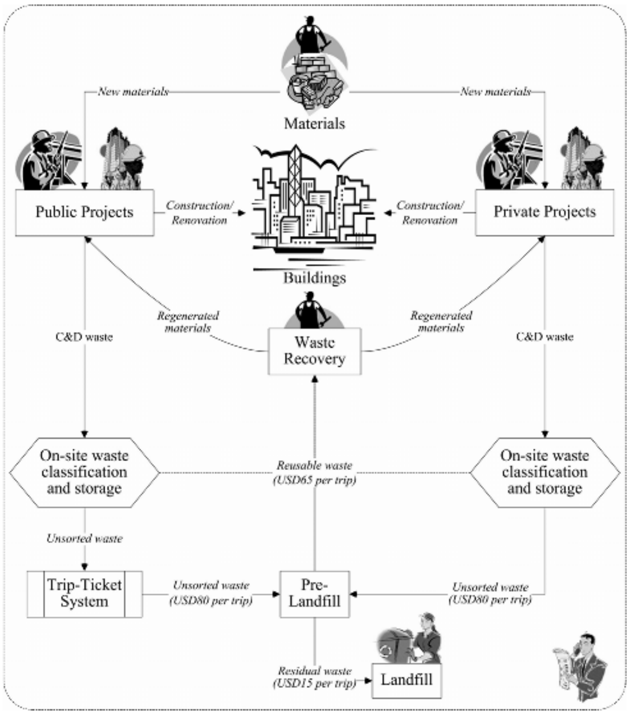
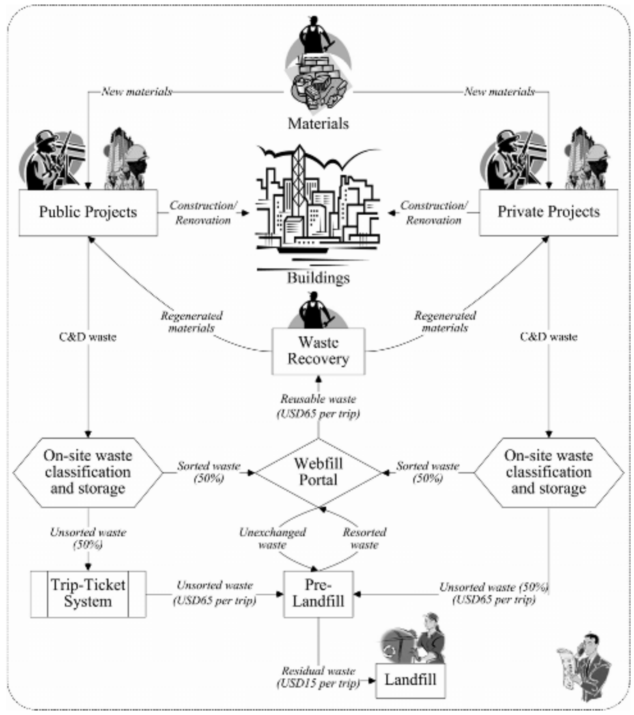


Figure 4. Proposed Webfill-enhanced TTS model



($G_{C\&Dwaste}$) generated by either the Public Projects or the Private Projects at the beginning of each of the two simulation models is set by Formula 1.

$$(G_{C\&Dwaste}) = 0.036 \times N(20,5) \qquad (1)$$

The amount of C&D waste is derived from the governmental statistic data of the C&D waste, and we assume a normal probability distribution for the ($G_{C\&Dwaste}$) estimates (EPD, 1999-2002).

Table 4. Simulation results and comparisons

Simulated Items	***TTS***	***Webfill enhanced TTS***	***Rates***
1. Landfill Utility (%)	**12.21**	**3.42**	**- 72%**
2. Waste Recovery Utility (%)	**1.75**	**16.33**	**+ 833%**
3. TTS Utility (%)	**6.08**	**3.92**	**- 46%**
4. Quantity of C&D waste (unit)			
Public project	**146**	**133**	**- 9%**
Private project	**147**	**140**	**- 5%**
Average	**146**	**137**	**- 7%**
5. Average waste cycle time (day)			
Public project	**6.4**	**9.4**	**+ 48%**
Private project	**4.3**	**7.9**	**+ 86%**
Average	**5.4**	**8.7**	**+ 67%**
6. Average value-added time (day)			
Public project	**2.2**	**3.8**	**+ 74%**
Private project	**1.1**	**3.1**	**+ 177%**
Average	**1.7**	**3.5**	**+ 126%**
7. Average waste transportation cost (USD)			
Public project	**91.55**	**138.85**	**+ 52%**
Private project	**87.11**	**130.83**	**+ 50%**
Average	**89.33**	**134.84**	**+ 51%**

Simulation Results

The simulation results and comparisons are presented in Table 4.

As shown in Table 4, after adopting the Webfill-enhanced TTS, the utility of landfill decreases by 72% and the utility of the TTS reduces by 46%, while the utility of waste recovery increases by 833%. Moreover, the total quantity of C&D waste reduces by 7%; the average waste cycle time increases by 67%; the average valued-added time of waste recovery lengthens by 126%; and the average waste transportation cost increases by 51%. These results indicate that the Webfill-enhanced TTS can reduce the amount of C&D waste at the landfill sites by increasing waste recovery and reuse.

Although it has been proven that the Webfill-enhanced TTS is more effective than simple TTS in C&D waste reduction, simulation results also indicate that the average waste transportation cost will increase, which means that the e-commerce system for C&D waste exchange will lead to more transportation from the construction industry, and more energy consumptions thereby. To reduce potential pollution due to the extra energy consumptions, simulation results also indicate necessary revisions to the Webfill model.

FUTURE TRENDS

The simulation reveals several unique results that other evaluation tools can hardly provide, and the successfully applied process simulation in e-commerce business plan evaluation reveals an emerging trend in e-commerce strategic management to support quantitative decision-making. Because process simulation is generally accepted in business management, it is an economical way to directly adopt a commercial process simulation package for e-commerce simulation. However, as there are currently some limitations in process simulation packages, such as no permission for users to modify internal and external business environmental factors based on their various experiments, it is essential to use business strategic management tools, such as the SWOT analysis, in e-commerce system evaluation as complements. In this regard, further research tasks are required to integrate current qualitative strategic management tools into the business process simulation environment.

CONCLUSION

This article introduces a quantitative approach to e-commerce system evaluation based on the theory of process simulation. The general concept of e-commerce system simulation is presented to reduce risks in e-commerce system development by simulating the initial e-commence business plan. To evaluate an e-commerce business plan, it is necessary to use a quantitative evaluation approach, and we believe that process simulation is an appropriate option. The overall objective of this article is to apply the theory of process simulation to e-commerce system evaluation, and we achieve this though an experimental study on a business plan for online C&D waste exchange. The methodologies adopted in this article include literature review, system analysis and development, simulation modeling and analysis, and case study. The results from this article include the concept of e-commerce system simulation, a comprehensive review of simulation methods adopted in e-commerce system evaluation and a real case study of applying simulation to e-commerce system evaluation. Furthermore, the Webfill simulation introduces a new area for e-commerce business plan evaluation, in which the concept of process simulation can be successfully implemented. We hope the adoption of process simulation can effectively support business decision-making and improve the efficiency of e-commerce systems.

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KEY TERMS

E-Commerce System Simulation: An integrative procedure to run a business processes-oriented simulation program based on both internal and external business environmental factors to demonstrate the actual results of implementing an e-commerce business model by using computer-driven software toolkits. It is an effective, efficient and economical approach, and can be used to experiment and evaluate different e-commerce business models or plans.

Trip-Ticket System (TTS): A recording system for orderly disposal of construction and demolition waste to disposal facilities in Hong Kong. Under the TTS, construction or demolition contractors are required to fill in a standard trip-ticket form outlining the details of the transportation vehicle, type and approximate volume of waste and the designated disposal facility. The trip-ticket is used for verifying a contractor's compliance with the policy requirements, and contractors are then charged by trip-tickets as their receipts from the disposal facilities.

SWOT Analysis: A popular way conduct e-commerce business plan evaluation with business environmental scanning based on internal environmental factors (strengths and weaknesses) and external environmental factors (opportunities and threats).

Waste Exchange System: An e-commerce system for exchanging industrial residues in the form of waste-related information exchange among waste generators, waste recyclers, waste users and possibly landfill managers, which can benefit the society by reducing the total waste volume and facilitating waste reuse, recycle and disposal.

Webfill: An e-commerce business model for construction and demolition waste exchange in the Hong

Kong construction industry, in which construction contractors, property managers, manufacturers, recyclers and landfill managers are all involved to participant the waste exchange. And it is being further developed to an online C&D waste exchange portal for the Hong Kong construction industry.

APPENDIX A: SAMPLE WASTE EXCHANGE WEB SITES

Abbreviations of the Web site's name, and details about these Web sites are listed in Table 1.

- **BFCC:** BuildFind Construction Classfieds <http://classifieds.buildfind.com/>
- **BRE:** BuildingREsources <http://www.buildingresources.org/>
- **BW:** Beyond Waste <http://www.sonic.net/~precycle/>
- **CalMAX:** California Materials Exchange <http://www.ciwmb.ca.gov/CalMAX/>
- **C&DME:** C&D Material Exchange <http://www.info.gov.hk/epd/misc/cdm/en_exchange1.html>
- **HH:** Happy Harry's used building materials <http://www.happyharry.com/hhub.htm>
- **HIMEX:** Hawaii Materials Exchange <http://www.maui.net/~mrghimex/himex1.html>
- **ID:** Industry Deals-an asset marketplace for used equipment and surplus inventory, and materials <http://www.industrydeals.com>
- **IME:** Indiana Materials Exchange <http://www.state.in.us/idem/imex/>
- **IMEX:** Industrial Materials Exchange <http://www.metrokc.gov/hazwaste/imex/>
- **IWE:** Illawarra Waste Exchange <http://www.globalpresence.com.au/waste_exchange/>
- **IWEN:** Industrial Waste Exchange Network <http://www.environ.wa.gov.au/iwe/>
- **IWEX:** Integrated Waste Exchange <http://www.capetown.gov.za/apps/iwe/default.asp>
- **KIME:** Kentucky Industrial Materials Exchange <http://www.kppc.org/kime/index.html>
- **LR:** Clubrecycle/Letsrecycle <http://www.letsrecycle.com/index.jsp>
- **Mat-Ex:** Western New York Materials Exchange <http://recycle.net/recycle/exch/mat-ex/index.html>
- **ME:** Materials Exchange <http://www.cheltweb.com/wow/wexhome.htm>
- **MIE:** Materials Information Exchange <http://cig.bre.co.uk/connet/mie/>
- **MME:** Minnesota Materials Exchange <http://www.mnexchange.org/>
- **NEME:** New England Materials Exchange <http://www.wastecapnh.org/nemex/>
- **NHME:** New Hampshire Materials Exchange <http://www.wastecapnh.org/nhme.htm>
- **NSME:** Nova Scotia Material Exchange <http://www.clean.ns.ca/materials_exchange/wxh.htm>
- **NYME:** New York Wa$te Match <http://www.wastematch.org/>
- **RBME:** Reusable Building Materials Exchange <http://www.rbme.com/>
- **RENEW:** Resource Exchange Network for Eliminating Waste <http://www.tnrcc.state.tx.us/exec/oppr/renew/renew.html>
- **RW:** Recycler's World <http://www.recycle.net/build/index.html>
- **SEMREX:** Southeast Minnesota Recyclers' Exchange <http://www.semrex.org/>
- **SNEME:** Southern New England Materials Exchange <http://www.rirrc.org/materials.shtml>
- **SonoMax:** Sonoma County's Materials exchange <http://www.recyclenow.org/sonomax/>
- **SWC:** Solid Waste.com <http://www.solidwaste.com/content/homepage/default.asp>
- **TME:** Tennessee Materials Exchange <http://www.cis.utk.edu/tme_titl.htm>
- **VCMAX:** Ventura County Materials Exchange <http://www.rain.org/~swmd/vcmax/>
- **WMCE:** Waste Management Commodities Exchange <http://commodities.wm.com/wmx/exchange.nsf>
- **WRAP:** The Waste & Resources Action Programme <http://www.wrap.org.uk/>
- **Wastechange:** The commercial Waste exchange <http://www.wastechange.com/>
- **WastexchangeUK:** Waste Exchange UK <http://www.wasteexchangeuk.com/Template.htm>

Product Configuration Systems

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INTRODUCTION

Product configuration systems are considered to be important enablers of the mass-customization strategy. They are the most successful applications of e-technologies and artificial intelligence in e-business, particularly in customer interaction. Product configuration systems support the acquisition of the customers' requirements while automating the order-taking process, and they allow customers to configure their products by specifying their technical requirements.

In this article, the state of the art is explained and the different product configuration systems are classified in a morphological box. The analysis of the criteria according to which configurators are designed thus far reveals a neglect of the front-end perspective. Therefore, necessary enhancements and development directions toward a comprehensive tool for customer interaction in mass customization are analyzed.

BACKGROUND

Product configuration systems or configurators are important enablers of the mass-customization (Pine, 1993) paradigm. Configurators are information tools that allow the automation of the order-taking process by automatically capturing customers' requirements without involving human intermediaries. Therefore, a configurator has additional relevance because it may be one of the few information systems with which the customer directly interacts in e-business (Bramham & MacCarthy, 2003).

Configurators can be implemented at the interface between a supplier and its customers over the Internet. Its principle task is to support customers in the self-configuration of their products according to individual requirements. For example, customers can be provided with the possibility to alter a basic product and also to graphically visualize the effects of these changes (e.g., http://www.customatix.com/).

Configurators support the configuration process that requires one to accurately understand the customer's needs and to create a complete description of a product variant that meets those needs. Given a set of customer requirements and a product family description, the task of configuration is to find a valid and completely specified product structure among the alternatives that the generic structure describes (Sabin & Weigel, 1998).

Product configurators have been employed in one form or another for many years. Freuder (1998) notes that Lucent Technologies has used product configurators for more than 20 years. Configurators support the configuration task, which is defined as the process of designing a product using a set of predefined components while taking into account a set of restrictions on how the components can be combined (Soininen, Tiihonen, Männistö, & Sulonen, 1998).

STATE OF THE ART AND TYPES OF PRODUCT CONFIGURATION SYSTEMS

Based on heterogeneous application scenarios and solution approaches, the technical literature discusses many types of product configurators. In the following, different classification criteria for product configurators are presented (Blecker, Friedrich, Kaluza, Abdelkafi, & Kreutler, 2005).

Knowledge Base

The representation of the domain knowledge may rely on different ontologies: (a) rule-based, (b) model-based, and (c) case-based approaches. Rule-based configurators work by executing rules with the following form: "if condition then consequence." The product solutions are derived in a forward-chaining manner. At each step, the system examines the entire set of rules and considers only the set of rules that can be executed next. The most important model-based representation types are logic-based, resource-based, and constraint-based approaches (Sabin & Weigel, 1998). Logic-based approaches are often based on description logic. Description logics are formalisms for representing and reasoning with knowledge. The inference mechanism is based on subsumption. However, resource-based systems are based upon a producer-consumer model of the configuration task. Each technical entity is characterized by the amount of resources it supplies, uses, and consumes. In constraint-based reasoning, components are defined by a set of properties and a set of connection ports. Constraints among components restrict the ways components can be combined (Tsang, 1993). The case-based approach relies on the assumption that similar problems have similar solutions. The knowledge necessary for reasoning consists of cases that record a set of product configurations sold to previous customers. The configuration problem is solved by finding and adapting a previous solution to a similar problem.

Strategy

From the point of view of mass customization, three main strategies with different requirements for configurators are distinguished, namely, assemble to order, fabricate to order, and engineer to order. The assemble-to-order concept enables customers to configure a product by combining a finite number of standard modules. However, the fabricate-to-order and engineer-to-order concepts may assume an infinite number of configuration possibilities. The technical realization of configurators for fabricate to order and engineer to order is more demanding than those for assemble to order because a parameterization of component dimensions should be made possible.

Organization

The organization of a configurator can be either central or distributed. A central configurator works locally and its configuration knowledge is completely stored in one unique system. All potential product instances that may represent a solution to the customer configuration problem are derived from these local data. However, the knowledge base of a distributed configurator is locally incomplete. It is integrated with other configurators (e.g., suppliers' configurators) in order to generate consistent product instances for specific customer requirements.

Internal vs. External

Internal configurators are only implemented for a company's internal use. For example, internal configurators support sales experts in capturing a customer's requirements and translating them into technical features without errors. External configurators are designed to provide customers with direct assistance during product configuration. They are equipped with front-end interfaces to facilitate the configuration task for customers.

Interaction Nature

The nature of interaction can be either off line or online. Off-line configurators work independently from networks. The necessary data for configuration are stored on a data carrier such as a floppy disk, CD-ROM, or DVD-ROM. After product configuration, customers can send the specifications via, for example, e-mail or fax. However, today, mainly online configurators are applied. They enable communication with customers over the Web. The configuration knowledge is stored on a central Web server. Online configurators can be further divided into two categories: online configurators with central data processing and online configurators with local data processing. Online configurators with local data processing require the loading of the configuration application (Java applets, full Java applications) onto the customer's local unit.

Update Execution

The update execution can be either push or pull based. A push mode is realized when the supplier's central unit containing the product configuration logic communicates product updates to the customer's local unit. In this mode, the central unit imposes the updates that have to be accepted by the local unit. In contrast, one speaks about a pull mode when the local unit retrieves the updates if required.

Scope of Use

Configurators can be categorized as single-purpose or general-purpose systems. A single-purpose system is developed to support the sales-delivery process of a product or a set of products of only one company or business field. Single-purpose configurators are called special-purpose configurators and may be designed for a particular industry such as, for example, the window and door industry. However, general-purpose systems are used to configure diverse product types in different companies (Tiihonen & Soininen, 1997).

Complexity

Tiihonen and Soininen (1997) distinguish between primitive, interactive, and automatic configurators. Primitive configurators are the simplest ones. They merely record the configuration decisions made by the user without checking the validity of the decisions. Interactive configurators are capable of checking as to whether the configuration decisions are valid. They also guide users in making all of the necessary decisions. In addition to the functionalities of interactive configurators, automatic ones are able to provide full support and to automatically generate parts of configurations or even entire configurations.

Integration Level

At the integration level, Blecker et al. (2005) distinguish between stand-alone, data-integrative, and application-integrative configurators. Stand-alone configurators cannot be integrated because they do not dispose of interfaces to other information systems. Data-integrative configurators enable one to avoid data redundancy. However, the application-integrative configurators enable the integration of whole applications. For example, when a configurator and Computer-Aided Design (CAD) system are integrated, drawings of new parts or components can be automatically generated for customers.

Solution-Searching Approach

Two main solution-searching approaches are discussed in the technical literature (e.g., Blecker et al., 2005): either by technical elements or by features. Searching by technical elements means that the configurator enables customers to start from a standard product and then to specify step-by-step product options. In contrast, a configurator working by features provides customers with the possibility to specify their requirements in terms of product functionalities. Based on the customers' specifications, the configurator searches for optimal product variants.

Product Life-Cycle Support

Product life-cycle support refers to the product reconfiguration that is necessary when the customer would like to upgrade the product by including new or better functionalities, or to replace nonfunctioning parts or modules for which identical replacements no longer exist (Sabin & Weigel, 1998). Different cases that can be encountered are (a) a configurator without a reconfigurator, (b) separate configurator and reconfigurator, and (c) integrated configurator and reconfigurator.

By presenting all of the results of the configurators' classifications in a morphological box (Figure 1), it is possible to provide software engineers and developers with the main dimensions to be considered when designing a configurator. The zigzag line shows the relevant characteristics of an example of a configurator software with respect to each dimension.

SHORTCOMINGS OF PRODUCT CONFIGURATION SYSTEMS

Compared to standard products, customers face a complex decision-making process when buying mass-customized products. They have difficulties in deciding on their preferences between different alternatives and in comparing performance and price ratios of distinct variants. This problem often arises because in practice the technological perspective generally dominates the user perspective when addressing configuration. In addition, in the technical literature, configuration tool kits are criticized more often. For example, Rogoll and Piller (2002) have shown through a market study on configurators that there is no standard software solution that is able to fulfill optimal requirements from the supplier's and customer's perspectives. Von Hippel (2001, p. 2) criticizes the implemented configurators in the automobile

Figure 1. Morphological box: Classification of configurators (Adapted from Blecker, Abdelkafi, Kreutler, & Friedrich, 2004)

Knowledge base	Rule based	Model based	Case based	
Strategy	Fabricators	Involvers	Modularizers	Assemblers
Organization	Central	Distributed		
Internal/external	Internal	External		
Interaction nature	Online central data processing	Online local data processing	Off line	
Update execution	Push	Pull		
Scope of use	Single purpose	General purpose		
Complexity	Primitive	Interactive	Automatic	
Integration level	Stand alone	Data integrative	Application integrative	
Solution-searching approach	Technical elements	Features		
Product life-cycle support	Configurator without reconfigurator	Separate configurator and reconfigurator	Integrated configurator and reconfigurator	

industry and points out that "automakers allow customers to select a range of options for their 'custom' cars—but they do not offer the customer a way to learn during the design process or before buying." Learning during the design process means that customers should be provided with the possibility to verify, before placing their buying orders, as to whether the configured product meets their expectations exactly or not.

Designers of configurators considerably concentrate on the back-end technical aspects and neglect the customer perspective. Especially in the business-to-consumer field, customers generally do not have sufficient product expertise. They cannot express their preferences in terms of technical specifications. Therefore, it is relevant to better assist customers during configuration in order to help them find satisfying product variants.

NECESSARY ENHANCEMENTS AND FUTURE DEVELOPMENT DIRECTIONS

From a customer-oriented point of view, it is necessary that configurators are extended with an additional component that aims at helping customers to better recognize their needs. This component is called an advisory system. Advisory systems for mass customization are software systems that guide customers according to their profiles and requirements through a customized advisory process, ending with the generation of product variants that better fulfill their needs. They are customer oriented and do not assume any specific technical knowledge of the product.

However, the classical advisory systems discussed in the technical literature often do not lead to a suitable advisory process during product customization. According to the customer-needs model (Blecker et al., 2005), there are three faults that may lead to problems in customer interaction. These faults arise when the following happen.

- The customers do not know their real needs.
- The customers cannot correctly express their real needs.
- The supplier wrongly interprets customer requirements.

In order to tackle these problems, two main levers are identified: (a) the dialogs with customers and (b) the mapping techniques that permit one to translate customer needs into product specifications and vice versa. Furthermore, these levers should be supported by adequate technologies and tools. Whereas the main identified technology is Web mining, which enables one to process Web data, the relevant tools to be implemented are customer-interest modeling and Web metrics. Both tools aggregate the data provided by Web mining in order to present them in an understandable goal-oriented form (Figure 2).

Dialogs with customers refer to the communication interface during interaction. Customers should not perceive complexity when specifying their requirements. Therefore, they should only be asked appropriate questions. When customers do not know their real needs, Kansei engineering and interaction-process simplification are suitable solutions, whereas when customers have difficulties in expressing their real needs, personalization and interaction-process simplification are especially relevant. However, the dialogs are unsuitable to solve the problem arising when the supplier wrongly interprets customer requirements. This is due to three main reasons.

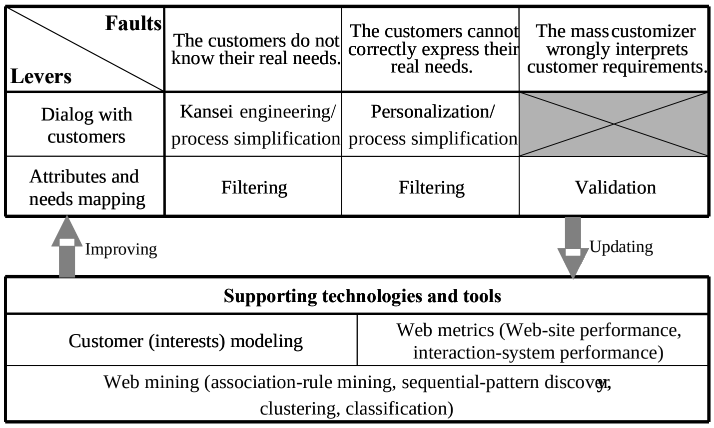
- Dialogs only deal with the front-end aspect between the customer and the interaction system.
- Dialogs do determine the communication process, but not the way information is interpreted.
- Only available information that is no longer the object of dialogs can be interpreted.

To make customers aware of their requirements, a potential solution is to conceive dialogs according to Kansei engineering, which uses verbal language that is near to the language customers are used to understanding. It is a "translating technology of consumer's feeling and image for a product into design elements" (Nagamachi, 1995, p. 2). For example, when buying a watch, customers are not asked to specify design components; they may be asked, for example, what social position they want to express.

Moreover, in order to not overstrain customers during the interaction process, it is relevant that the advisory system guides them to their optimal choices by following the shortest path. This refers to interaction-process simplification. For example, the advisory system appreciates the customer's knowledgeability and then accordingly estimates what technical parameters the user is able to specify. If some product parameters are too difficult, the advisory system can set default values without asking questions (Ardissono et al., 2003). A superfluous flexibility providing customers with the possibility to specify parameter values that are difficult will confuse rather than help them.

The gained customer data have to be used for personalization purposes. Personalization aims at recognizing special customer characteristics such as desires and preferences to individualize the interaction process. The advisory system should adapt the Web-site layout to customer requirements and also personalize the formulation of customer dialogs.

Figure 2. Levers and supporting technologies and tools for an advisory system (Adapted from Blecker et al., 2004)



The captured customer requirements during the interaction process have to be correctly translated into product specifications. This is ensured by mapping techniques that not only adequately transform customer preferences and requirements into product-specific characteristics (filtering), but also guarantee that product specifications are adequately mapped to customer needs (validation).

When customers do not know or cannot express their real needs, filtering methods are suitable solutions. For example, with content-based filtering, product configurations can be selected on the basis of correlations existing between product characteristics and the user's preferences that can be captured either implicitly or explicitly. This will considerably restrict the domain of the products' solution space that customers would be interested in.

As opposed to filtering, validation methods have to be implemented to ensure that the supplier did not wrongly interpret customer needs. Thus, the restricted solution space resulting from filtering can be further refined to ensure that the product specifications really correspond to customer requirements.

The described potential solutions have to be supported by Web mining. This technology aims at processing the raw data being stored in Web-server logs by applying data-mining techniques in order to extract statistical information, cluster users into groups, and discover correlations between Web pages and user groups (Eirinaki & Vazirgiannis, 2003). Web mining provides the information necessary to model customer interests in e-commerce and to compute relevant Web metrics.

Customer-interest modeling is a tool enabling one to better understand customer preferences and, thus, to correspondingly support the personalization of dialogs during the advisory process. Web metrics are necessary to measure the performance of the entire Web site and especially the performance of the interaction system. For example, it is relevant to appreciate how long one customer has spent on a certain Web page or what the average number of pages a customer browses is prior to their reaching the interaction system. From the Web-metrics analysis, proposals can be derived for process simplification that can be introduced either automatically online or off-line.

Recapitulating, with Kansei engineering and personalized dialogs, customers who have no technical knowledge about products are adequately assisted during interaction. Furthermore, process simplification permits customers to express their requirements in a fast-paced manner and with little effort. Due to filtering and validation methods, the advisory system generates optimal product alternatives. Moreover, the advisory system initiates a virtuous circle, which is ensured by a learning process consisting of the continuous improvement of the presented solutions and an updating of the data processed by Web-mining techniques. The more customers use the advisory system, the better they teach it what they would like, and the better the advisory system is at refining product suggestions leading to a better fulfillment of customer requirements.

CONCLUSION

Product configurators are the most important application of e-technologies in customer interaction. However, they are up to now mainly designed according to technical aspects, shown in the morphological box. It was exposed that the back-end perspective generally plays a more important role, whereas the front-end perspective is more or less neglected, especially in the business-to-consumer field. That is why it is relevant to extend configurators with a front-end component, which makes the task of searching product configurations among the solution space of the supplier easier for customers. Therefore, the notion of advisory systems is introduced. The advisory systems and configurators together form a comprehensive customer-oriented interaction system in mass customization.

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KEY TERMS

Advisory System: Front-end software system that guides customers according to their profiles and preferences through a personalized consulting process resulting in the generation of product configurations that better fulfill customers' needs. In opposition to the commonly used product-oriented interfaces in configurators, advisory systems are customer oriented and do not assume any specific technical knowledge of the product.

Filtering: A collective term for techniques that automatically select product attributes that meet customer profiles and preferences by applying predefined rules, similarities, or clustering.

Interaction System: Comprehensive entity for optimal customer-supplier interaction in e-business consisting of two separate yet interconnected information systems: an advisory component and a product configurator.

Mass Customization: Business strategy, often applied in e-business, that aims at satisfying the customer's individual needs with near-mass-production efficiency. In essence, mass customization describes the ability of a firm that provides customized goods in high volume for mass markets by deriving a high number of variants from a single or a few core products.

Morphological Box: Efficient tool for creativity and the structuring of ideas first introduced by Zwicky (1966). The main advantage of it is being able to present in a straightforward manner all of the possible solution alternatives for a specific problem.

Personalization: Matching categorized content with special customer characteristics such as desires and preferences in order to individualize an interaction process.

Product Configurator: Information system that supports customers during (online) product customization and the order-taking process, especially in e-business. It has the logic capabilities to create, maintain, and apply electronic product models in order to define all of the possible variants of a product and to display them to the customer.

Category: Concepts, Trends, and Challenges

RFID in the Retail Supply Chain

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INTRODUCTION

The use of RFID (radio-frequency identification) in the retail supply chain and at the point of sale (POS) holds much promise to revolutionize the process by which products pass from manufacturer to retailer to consumer. The basic idea of RFID is a tiny computer chip placed on pallets, cases, or items. The data on the chip can be read using a radio beam. RFID is a newer technology than bar codes, which are read using a laser beam. RFID is also more effective than bar codes at tracking moving objects in environments where bar code labels would be suboptimal or could not be used as no direct line of sight is available, or where information needs to be automatically updated. RFID is based on wireless (radio) systems, which allows for noncontact reading of data about products, places, times, or transactions, thereby giving retailers and manufacturers alike timely and accurate data about the flow of products through their factories, warehouses, and stores.

BACKGROUND

Management research and academic management literature on the use of RFID in the retail supply chain is still scarce. The technical aspects of RFID business applications have been highlighted in recent engineering and computer science publications (e.g., Glidden et al., 2004). Consulting-oriented papers have also offered in-depth technological overviews of state-of-the-art developments (e.g., among many others, Das, 2002; Harrop, 2004). Certainly, the technology has recently also been covered in management-related academic journals, which have focused on different aspects of electronic business and supply chain management (e.g., Angeles, 2005; Juels, Rivest, & Szydlo, 2003; McGinity, 2004; Loebbecke, 2004; Loebbecke & Wolfram, 2004; Singh, 2003).

However, as of late 2004, actual RFID applications in the real world, beyond lab studies or pilot projects, were still so new that academic research into their impact, lessons learned, and recommendations have not been possible. The main discussions of RFID applications currently appear in magazines, such as *Information Week*, *Infoworld.com*, and *RFID Journal*, in pamphlets written by technology consultants, and in the daily press. These publications focus mainly on case studies and discussions of business opportunities, but their life cycle time is too short to be included in this encyclopedia contribution.

TECHNOLOGICAL ISSUES

Using RFID, product data is automatically transmitted by radio signals. The key component of RFID technology is the RFID tag (called a transponder), which is a minute computer chip with an antenna. This tag is attached to transport packages (pallets or cases) or products (items). An RFID tag can carry an impressive array of data. Passive or semipassive tags identify themselves when they detect a signal from a compatible device, known as an RFID reader. As a tag passes through a radio-frequency field generated by a compatible reader, it transmits its stored data to the reader, thereby giving details about the object to which it is attached.

RFID systems operate in free air, that is, nonregulated frequencies of the wireless communications spectrum (called the radio-frequency spectrum). National regulations for radio communications vary and are established by different bodies. In the United States, regulations are less restrictive than in Europe, where the relevant spectrum is partially reserved for mobile telephone networks or medical services.

In retailing, a numeric, article-specific code (electronic product code, EPC) is stored on the RFID chip. The EPC is comparable to a conventional bar code. As soon as the chip comes within 39.37 inches (1 meter) of an RFID reader, it sends its numeric code to the reader. The reading device recognizes the EPC stored and matches it with other pieces of data, such as the price, size, weight, and expiration date of the product, stored in various databases.

Towards RFID Standardization

To achieve large-scale RFID usage in the retail supply chain, RIFD technology needs to be standardized. That process is currently under way. On the global front, two international bodies are involved: EPCglobal™ (http://www.epcglobalinc.org) and ISO, the International Organization for Standardization (http://www.iso.org).

EPCglobal was created in the fall of 2003 as a joint venture of EAN International (http://www.ean-int.org) and the Uniform Code Council (http://www.uc-council.org). The launch signaled the drive toward a worldwide, multiindustry adoption of the EPC, key identification aspects of RFID, and its network of links to Internet technologies. EPCglobal is leading the development of the industry-driven standards for the EPC Network (http://www.epcglobalinc.org) to support the use of RFID in information-rich trading networks. The association is working on the structure of the data stored in the transponder. It aims to define naming standards to foster the use of RFID technology between suppliers and retailers. Comparing EPC to the traditional EAN code, EPC stores only the serial number on the chip while EAN has extensive information on the chip. Hence, for the EPC, only the serial number needs to be coded and understood. The serial number then provides access to databases containing information about specific products.

The ISO standards for RFID, on the other hand, cover the physical characteristics of RFID labels and cards, the air protocols, the anticollision and transmission protocols, and commanded-set and security features.

As these two standardization bodies work on their separate issues, RFID choices made by players along the value chain can be both EPC and ISO compliant.

Technical Challenges on Data, Network, and Application Layers

Any RFID-enabled process begins with an RFID reader reading an RFID tag: The reader hits the tag with a radio beam and reads the data on the tag. Some readers are designed to simply pass the tag read along to an attached computer, relying on the computer to do validation (e.g., reading a check sum, elimination tag collisions, etc.). Other smart readers have the ability to validate data and even perform basic filtering.

With traditional bar code technology, the laser beams must have an unobstructed view of the bar codes to read them. Radio waves, however, do not require a line of sight; the signal can pass through materials, such as cardboard or plastic. With no line of sight required in RFID, multiple tags can be read simultaneously, even when hidden from sight. An RFID portal, for example, can read all the goods on a pallet with one pass. A bar code scanner would require each item to be scanned individually.

This RFID process presents challenges relating to the data, the network, and the application. An RFID reference architecture (RRA) addresses all three.

Data Layer

On the data layer, the RFID reference architecture determines what to do with the data gleaned from the tag. The following are examples of applications with increasing requirements for managing data.

1. **Querying Applications:** A conveyer belt that automatically routes cases to their destination needs to be able to simply pass the tag data on to the appropriate system, receive the response, and then purge the tag scan from its memory.
2. **Mixed-Goods Applications:** Assume a reader on a picking cart scans, say, every 5 seconds all tags within range (e.g., placed on the pallet). Such an application needs to be able to constantly evaluate each scan's results against expected results and alert the operator of exceptions.
3. **Smart-Shelf Applications:** Smart shelves keep track of the products placed on them. Scanning a 96-bit EPC-compliant RFID tag every 5 seconds in a distribution center that holds approximately 500,000 cases generates 32,958 gigabits of data every hour. The majority of this data should simply confirm the existence of the requisite number of cases on each shelf, and should therefore be disposable. The RRA needs to be able to filter and process such large amounts of data.

Applications built to track serialized data (such as EAN-128 numbers on pallets) should be able to accommodate the real-time stream of single-tag reads. Data requirements are much higher for systems that deal with the more granular serialized data that comes from RFID tagging at the case level rather than the pallet level. For example, take a distribution center that ships about 616,000 pallets to stores per year, each of which is duly recorded and serialized. Bringing that serialization down to the case level would require applications to handle approximately 46 million items—a 74-fold increase in data management and storage requirements over pre-RFID requirements (Metro Group, 2004). Systems that track at the item level generate orders of magnitude—more data than is currently common because each item is repeatedly scanned by the multiple readers, which report on everything within their range. The applications must be able to handle these voluminous, multiple real-time streams of data.

Network Layer

RFID-driven network requirements result mainly from the design of the data layer because the network must be capable of moving the quantity of data generated by the scans. For simple applications, 10-megabit Ethernet may suffice. For smart shelves to track individual items, though, the bandwidth requirements challenge even today's sophisticated gigabit Ethernet switches. Calculating-required network bandwidth, though, is straightforward.

For the physical location of readers and other hardware, RFID-based systems demand constant communication between each reader and the RRA, which in turn requires universal access to wireless networking throughout the physical facilities that use RFID.

Blurring the line between electronic security and physical security carries important network and security implications. With literally a computer on every pallet, case, or item, the distinction between data and product becomes less clear. Hence, while RFID reduces the accidental introduction of errors in the data, it increases the possibility of data corruption.

Item-level RFID creates additional networking and security challenges. While the traffic between readers and the store network can be secured through encryption, the standards-based data encoded on each EPC-RFID tag is, by definition, unencrypted. The contents of RFID tags can therefore be read by any reader tuned to the correct frequency. Thus, in an RFID-enabled environment, it is difficult to prevent a competitor's employee from walking through a store with a hand-held RFID reader and capturing the current inventory level. It is even more difficult preventing somebody from walking into the store with an RFID read-writer and, for example, flipping the privacy bit that deactivates each RFID tag in the store.

Application Layer

Enterprise applications that do not need to handle the raw RFID data are minimally affected. But, these same enterprise applications may need to handle messages from other applications in real time. RFID could affect these requirements. Furthermore, the data model used by enterprise applications must support serialization at the appropriate granularity. For example, a warehouse management system must be able to keep track of which specific cases have been removed from the building and which still remain.

RFID-BASED APPLICATIONS ALONG THE RETAIL SUPPLY CHAIN

In the retail supply chain, it is necessary to distinguish between RFID tag usage on pallets and cases on the one hand, and RFID item tags on the other.

Applications Using RFID Tags on Pallets and Cases

RFID tags on pallets and cases mainly require process innovations along the intercompany value chain. The following illustrates the potential use of RFID at the pallet and case levels throughout the value chain, from manufacturer to POS.

- **Product Transport:** The manufacturer or retailer affixes RFID tags to all product pallets and cases before they are shipped. The tags are electronically time-stamped and then entered into the central computer of the retailer's RFID goods tracking system. The tagged pallets and cases can thus be identified and located along the entire logistics chain, all the way to the sales floor.
- **Warehouse Dispatch:** Goods ready to be shipped to a store are taken from the central warehouse to the dispatch area. As they pass through the exit gate, an RFID transceiver reads the codes on the pallets and cases and passes this data on to the RFID goods flow system. The goods then have the status of being on route to their destinations.

Further RFID-driven processes follow in the store.

- **Goods Delivery to the Store Stockroom:** RFID helps match arriving goods to orders. When a truck arrives at a store, its pallets are once again identified by an RFID reader, which can handle as many as 35 pallet or case tags per second. The goods are then registered as being in the store stockroom.
- **Warehouse Management and Storage Processes:** Once received, the goods flow system registers the goods as being in the stockroom. Each storage location has an RFID tag, which is stored in the RFID goods flow system along with the RFID numbers of the pallets and cases stored at each location.
- **Transport of Goods into the Salesroom:** RFID readers, located at the store stockroom exit doors, identify every pallet and case that is moved into the store. These readers send the relevant RFID numbers to the RFID goods flow system, which identifies the products as having been transported into the store.

RFID tags attached to pallets and cases enable the tracking of the transport and whereabouts of goods throughout the supply chain. The fast and convenient data transfer enabled by RFID supports retailers in accelerating their work flows, increasing the transparency of their inventory, and improving the effectiveness of their processes.

- Warehouse and stockroom inventories can be monitored more accurately, and replenishment orders can be issued faster.

- Time lost from ordering incorrect supplies can be avoided.
- Store requirements can be uncovered earlier and deliveries received faster, thus improving the availability of the store's merchandise.
- Employees can recognize shelves about to run empty sooner; the chances of an item being out of stock can be reduced.
- Merchandise can be accurately located at all times.
- Inventories in warehouses, stockrooms, and shop shelves are more visible and easily tracked.
- An improved logging of sales indicates when and under which conditions goods are sold, improving management oversight.
- Quantities ordered can more accurately reflect demand.
- Manufacturers can better plan production.
- Less storage space is needed, reducing warehousing and handling costs.

Beyond the process improvements in stores, the use of RFID can further affect retailing and the retail value chain (Metro Group, 2004) by offering the following.

- Automation benefits from RFID providing savings in labor costs or time
- New process benefits from RFID enabling more efficient, faster, or less complex processes
- Collaborative benefits from data sharing among manufacturers and retailers

Furthermore, by gathering purchasing data at checkout, stores can use item-level RFID data to provide product information to consumers on the one hand, and gain customer information for itself on the other.

Applications Using RFID Tags on Items

RFID tagging at the item level, still in its early development, offers enormous opportunities but also additional challenges. The main opportunities are the following.

- New types of services in stores, such as personalized advertising displays and self-checkout (e.g., Loebbecke & Wolfram, 2004), aimed at increasing customer loyalty and promoting sales
- Electronic price labeling in stores, making price tags easier to understand and more current
- Improved theft protection in stores because products cannot be taken out of the store without payment (or notification of theft)

At the same time, with wider item-level tagging, deploying RFID-based solutions to a wider scale beyond company walls poses immense and complex challenges to all parties involved. Two main challenges are the business transformation needed to capitalize on the technology and the new technology infrastructure investments needed. So far, in spite of standardization and technological advancements, every retailer and manufacturer uses slightly, but importantly, different processes.

At this early stage of item-level RFID tags, three problem areas have become obvious.

- Tags on items that contain metal or liquids pose technical problems due to the product material itself.
- Data volume increases by orders of magnitude when each individual product is followed all the way through its product life cycle. Traditional information and data management technologies need revolutionary solutions.
- Privacy issues are delicate, both from legal and consumer views. Privacy violations have gained public attention, leading to increasing pressure on item-level tagging, which was intended to enhance customer convenience. Consumer and civil liberties advocates have viewed tagging as privacy invasion. They warn that authorities could be able to follow every move by each citizen through tags and dense networks of RFID readers, as well as through interlinked RFID profiles collected from a multitude of data readers.

While an overall rollout of item-level tagging is not expected to take place within the next 5 to 10 years, some applications at consumers' premises are already being pictured to increase customer demand for products and thus create a pull effect.

- An intelligent fridge could inform its owner when an RFID-tagged carton of milk is close to empty or the milk is approaching its expiration date. Such a refrigerator could conceivably send such messages directly to the retailer, thereby requesting replenishment.
- An intelligent washing machine could conceivably read the tags on the clothes and automatically initiate the correct washing program. It could even alert the owner when no appropriate washing program is possible, such as when the clothing in the machine should not be washed together.

CONCLUSION

The worldwide sales of RFID technologies in 2003 were estimated to be $1.3 billion. Current investments have concentrated on hardware, software, and related goods. There have been limited expenditures on integrating RFID into legacy IT and logistics infrastructures (OECD, 2004). But sales for integration services, estimated at almost $600 million in 2003, have been increasing, and they currently outpace the growth in product sales. Figures for the retail supply chain, however, are not available yet.

In the retail industry, RFID has shown the potential to significantly reduce the costs of getting products to consumers in stores. RFID can (a) increase accuracy, (b) gather information at new points in the supply chain, (c) make additional data available, (d) permit new kinds of collaborative sharing of data between retailers and manufacturers, and (e) provide interactivity between store and customer devices.

Customer satisfaction and customer loyalty have improved as a result of more reliable product availability, customized service, and more convenient shopping. These effects are likely to contribute to an overall increase in retail sales when databases are linked to customer devices, such as intelligent refrigerators, because they can automate stock deliveries and invoicing. Thus, with RFID technologies, retailers can better understand consumption patterns, manage their client relationships more individually, and tailor supply to demand.

So far, the main uses of RFID systems in logistics operations have been in the areas of production flow and supply chain and inventory management. Furthermore, RFID processes and databases can also be integrated with other back-office operations, such as accounting and personnel, with implications for the better management of cash flow and workers' schedules.

In conclusion, uses of RFID are still developing, and many firms investing in the technology do so under pilot programs. Much research on potential applications is under way. Overall, the main benefits will derive from more fully integrating RFID systems into broader business practices and interlinking organizations' RFID databases.

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KEY TERMS

Active RFID Tags: Tags containing their own power source (batteries).

Electronic Product Code (EPC): Global coding scheme, administered by EPCglobal, identifying an item's manufacturer, product category, and unique serial number. The numerical code is stored on the RFID chip, which is comparable to a conventional bar code.

EPCglobal: A joint venture between EAN International in Europe (http://www.ean-int.org) and the Uniform Code Council in the United States (http://www.uc-council.org) to administer the numbering and data standards for EPC (http://www.epcglobalinc.org).

Passive RFID Tags: Passive or semipassive tags identifying themselves when they detect a signal from a compatible RFID reader. When passing through a radio-frequency field generated by such a reader, they transmit the data on their chips to the reader, thereby giving details on the objects to which they are attached.

RFID (Radio Frequency Identification): Automatic identification system transmitting product data automatically by radio signals (noncontact). RFID systems operate in the free air areas of the wireless communications spectrum (radio frequency spectrum) across the regulatory boundaries of countries.

RFID Item-Level Tags: RFID tags with unique EPCs on individual items; every jacket has its own EPC.

RFID Pallet-Level and Case-Level Tags: RFID tags with EPCs per pallet or case integrated into the packaging material or sometimes attached during the production or logistics process, for example, as part of a printed label.

RFID Reader (Interrogator): Device communicating with RFID tags and passing the tag data in digital form to a computer system.

RFID Tag (Transponder): Key component of RFID technology consisting of a minute computer chip with an antenna attached to transport or product packages. Tags can be updated and reprogrammed.

Smart Labels: RFID tags looking like printed labels.

Category: Applications of E-Technologies

Secure Agent Fabrication, Evolution, and Roaming

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BACKGROUND

Agent-based e-commerce is a promising novelty that performs tasks such as payment, mediation, interaction, and sales promotion in simple and intelligent manners. The agents can be endowed with attributes such as mobility, intelligence, and autonomy.

Constructing appropriate architecture for agent systems in e-commerce is a fundamental consideration in facilitating agent-based transactions (Lee, Kang, & Lee, 1997). A practical way is to provide sites with methods to fabricate various agents according to the requirements of the clients. Due to the nature of e-commerce and the Internet, agents should be able to adapt to a changing environment automatically. Agents should therefore be able to evolve in terms of intelligence and also be able to roam so as to utilize the power of network computing (Guan & Yang, 1999; Yang & Guan, 2000). In order to meet the requirements discussed and to provide an environment for an in-depth research in e-commerce, this chapter proposes secure agent fabrication, evolution and roaming (SAFER) for e-commerce.

DESCRIPTION OF SAFER

Secure Agent Fabrication Evolution and Roaming (SAFER) is an infrastructure to serve agents in e-commerce and establish the necessary mechanisms to manipulate them. The goal of SAFER is to construct open and evolutionary agent systems for e-commerce. The SAFER architecture comprises different communities, as are described in Figure 1. Each community consists of the following components: Owner, Butler, Agent, Agent Factory, Community Administration Center, Agent Charger, Agent Immigration, Clearing House and Bank, which are illustrated in Figure 2. Each component will be elaborated in the following subsections.

Community

As is shown in Figure 1, we divide agents into SAFER communities and non-SAFER communities. Each SAFER community possesses a set of facilities ad individuals as described in Figure 2. The local community administration center will approve an applicant as a SAFER community member and issue it a digital certificate.

Agents can also migrate within communities. Therefore, in addition to permanent residence in a community, an agent can carry out its tasks in a foreign community. Visiting agents can register with the foreign community administration center as guests and obey migration rules. Figure 2 illustrates the concept of SAFER agent community.

A community is therefore the basic unit in SAFER e-commerce. It offers factories and evolution vehicles to

Figure 1. SAFER architecture (1)

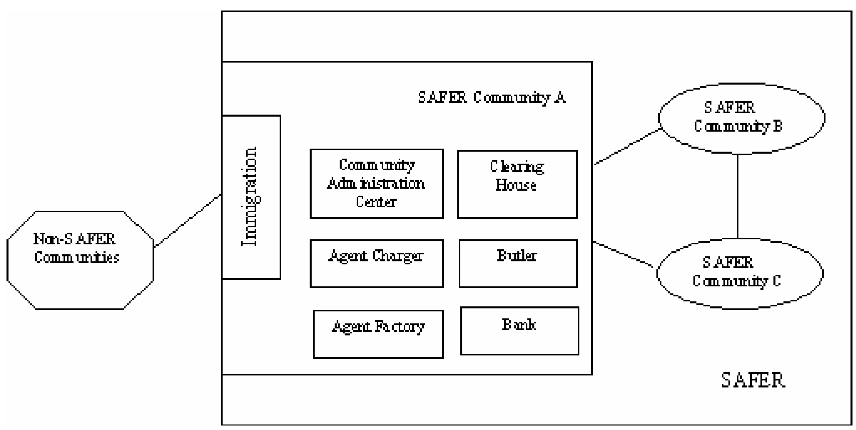
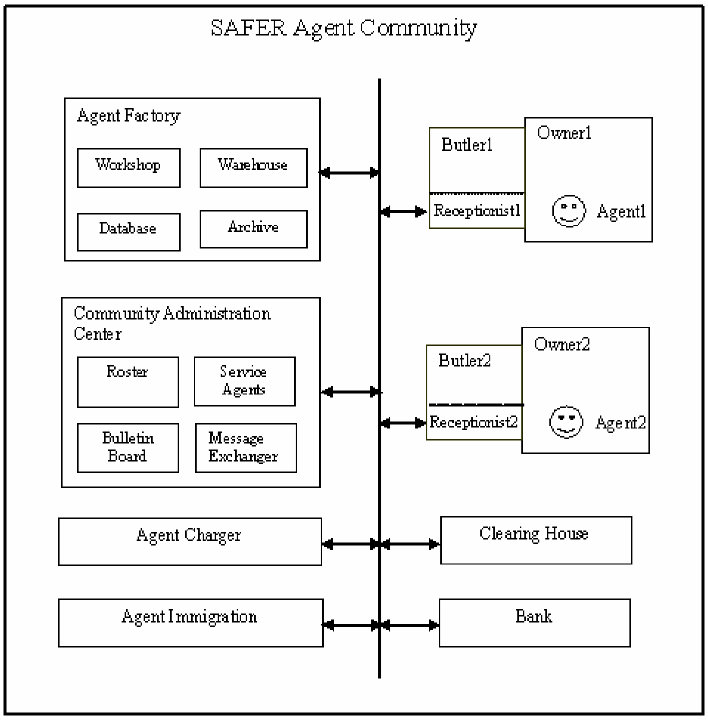


Figure 2. SAFER architecture (2)



fabricate e-commerce agents. Agents can therefore be regulated in order to perform their tasks more efficiently and their security enhanced.

Owner

Agents act on behalf of their owners. The owner therefore has the priority and responsibility for all his agents. The owner therefore has the responsibility for all his agents and controls them from creation to termination. Owners should register in the community administration center before having the access to the facilities of the community. The owner can authorize a butler to handle most of his tasks and reduce his burden.

Butler

An agent butler will, in the absence of the owner, make decisions on his behalf. As agents are dispatched for certain missions, the agent owner will issue authorization to them. The agent butler takes on the role of enforcing these authorizations when necessary. The butler is also involved when making payments during transactions with external parties and in keeping track of the agent's activities and its location.

Butlers can also detect agent loss or abduction. In order to ensure that an agent is "alive," critical agents are required to send a "heartbeat" signal back to the agent butler at fixed intervals. If the butler does not receive heartbeats from an agent after the fixed interval, the butler will immediately alert the agent owner and appropriate actions can be taken to either recover the agent or issue new agents to continue the mission.

Butlers also act as receptionists in agent roaming (Yang & Guan, 2000), coordinating agent transport, and servicing incoming and outgoing agents.

Agent

The SAFER e-commerce is based on agents. Each agent has a unique identification (in the form of owner-issued digital certificates) and belongs to one specified owner. According to the tasks assigned by the owner, we can classify agents into categories such as negotiation agents, payment agents, mediation agents, and so forth. Agents can be resting in the owner's computer when they are idle, or roaming from one host to another, or executing a task in a foreign host.

As an agent acts on behalf of its owner, it should have certain degree of intelligence. For example, an agent should be able to learn the owner's preference, adjust its behavior according to the task assigned and the resources available, and so forth. Mobile agents can carry important information when they are roaming through the network to complete transactions and should be immune from attacks from hackers or malicious agents.

Agent Factory

An agent factory consists of four components, namely, workshop, warehouse, database and archive. Workshop is the site where an agent is fabricated, fixed, and checked. Coarse agents that are suspended in fabrication and those waiting for further fixing or checking are queued in the warehouse. Database includes various ontology structures and standard modules to assemble different agents in the workshop. Archive is the set of the factory logs and information of agents that have undergone certain processes in the agent factory. An agent factory therefore provides the interface for owners to customize agents with desirable functionality.

Community Administration Center

The community administration center is responsible for administrative matters in the community. The administration center has a periodically updated roster of the community, which includes data on the registered facilities, owners, agents, and guest agents from other communities. The administration center is also responsible for information exchange and communication with other communities. Moreover, it collects information (such as addresses of new auction Web sites) from the Internet to update the databases in the agent factory.

Agent Charger

The agent charger is part of the security mechanism to ensure agent integrity in SAFER. "Agent battery" is carried by each agent and specifies the number of "actions" it can perform. The agent battery decreases its energy level (i.e., number of actions) by one, each time before an action is executed. If the level reaches zero, the agent is not allowed to perform any more action. In order to restore its energy level, the agent approaches an agent charger to regain its energy. Before restoring an agent battery, the agent charger should inspect the agent for its fitness and integrity.

Clearing Houses and Banks

In order to facilitate financial transactions and clearance, clearing houses and banks are included as separate entities in each SAFER community. If a transaction takes place within a community that does not involve any party of other communities, it can make an appropriate request directly to a local bank for immediate settlement. However, if a transaction involves parties from other communities, a clearing house must be used as the medium for settlement with different banks. Different from banks, clearing houses do not contain account information, as banks do. It is merely a medium through which interbank settlement can be facilitated.

Agent Fabrication in SAFER

In SAFER, agents are fabricated by an agent factory in their community, for the following reasons:

- Although some users may design agents themselves, most users do not have the ability to do so. Also, there are many types of software agents in e-commerce. It will be more convenient if an agent can be customized according to its own specification by using the agent factory.
- Adopting this mode of agent fabrication will enhance the security of SAFER e-commerce. Because information of all fabricated agents is stored in agent factories, agents can be administered more efficiently and safely.

Under SAFER, the fabrication of agents obeys prescribed routine procedures. An owner customizes new agents through the interface provided by an agent factory. When an agent factory fabricates a new agent, it chooses the corresponding ontology structure from the database, according to the requests from the owners. The agent factory then assembles the agents according to both the ontology structure and the owner's specification. The procedures of agent fabrication are demonstrated in Figure 3 and Table 1.

SAFER adopts a tree structure to express the ontology and agent. Figure 3 lays out an ontology structure for negotiation agents, and the details of nodes in Figure 3 are shown in Table 1. Terminal nodes are the "leaves" of the tree. They correspond to data and variable arguments such as node D1 for agent ID and node D2 for a destination. They can be customized or set to default value. The function nodes are internal nodes, showing the categories of their child nodes. The ontology structure also specifies the attribute of every node. If the node is indispensable in the structure, its attribute number will be zero. For example, node D1 in Figure 3 stands for agent ID, which is mandatory for every agent, its attribute is specified as zero, and the node is represented as D1/0. Similarly, if the node is optional or can be replicated to a

S

Figure 3. Ontology structure

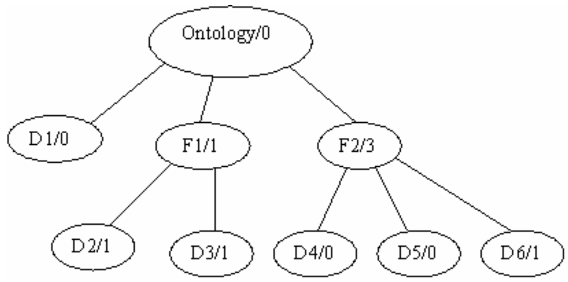
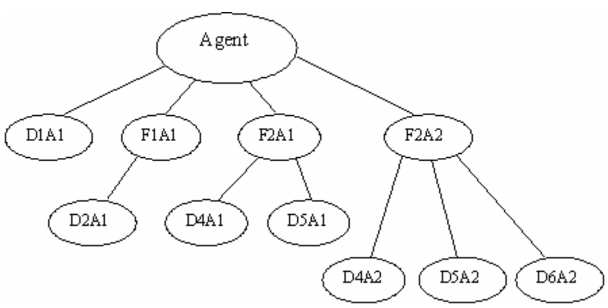


Table 1. Details of nodes in Figure 3

NODE	CONTENT	ATTRIBUTE
Ontology	Ontology Type	0
D1	Agent ID	0
F1	Destination site	1
D2	Destination 1	1
D3	Destination 2	1
F2	Negotiation Strategy	3
D4	Strategy Parameter 1	0
D5	Strategy Parameter 2	0
D6	Strategy Parameter 3	1

0 – Indispensable 1 - Optional
N – Maximum replication number (positive integer except1)

Figure 4. An agent fabricated using the ontology in Figure 3



maximum of *N* times, then the attribute for that node is represented with 1 or *N*, respectively. Examples are node D3/1 and node F2/3 in Figure 3.

When an agent factory fabricates a new agent, it arranges the data and functions according to the instructions from the ontology structure. Figure 4 demonstrates a negotiation agent fabricated according to the ontology structure illustrated in Figure 3, and the details of nodes in Figure 4 are specified in Table 2. The first two digits in the nodes of Figure 4 correspond to the nodes in the ontology structure in Figure 3. For example, node D1A1 corresponds to node D1, nodes D4A1 and D4A2 correspond to node D4. Note that node F1A1 in the agent has only one child node—D2A1—whereas node F1 in the ontology has two child nodes. This is because the attribute of node D3 in the ontology in Figure 3 is 1, which means that it is optional. So when the agent factory fabricates the agent, it can choose to assemble only one node under node F1A1, which means that node D3 has no counterpart in the new agent. The new nodes F2A1 and

Table 2. Details of nodes in Figure 4

NODE	CONTENT
Agent	Agent Name
D1A1	Agent ID
F1A1	Destination site
D2A1	Destination 1
F2A1	Negotiation Strategy 1
D4A1	Strategy Parameter 1
D5A1	Strategy Parameter 2
F2A2	Negotiation Strategy 2
D4A2	Strategy Parameter 1
D5A2	Strategy Parameter 2
D6A2	Strategy Parameter 3

Table 3. Details of nodes in Figure 5

NODE	CONTENT
Other Nodes	Same as in Table 2
F2A3	Negotiation Strategy 3
D4A3	Strategy Parameter 1
D5A3	Strategy Parameter 2

F2A2 are replications of node F2 in the ontology, because node F2 in the ontology has an attribute 3, which means that it can be replicated up to as many as three times. Node F2A1 has two child nodes and node F2A2 has three child nodes. Similarly, this can be seen from the attributes of the nodes D4, D5, and D6 in the ontology structure.

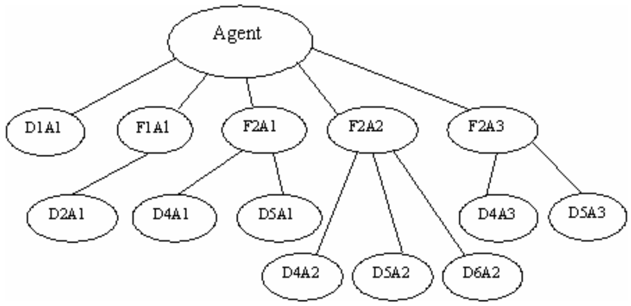
Agent Evolution

Agent evolution is one of the most prominent features of SAFER. Collaboration and competition exist among agents with similar goals. Agents can cooperate to adjust their strategies in order to negotiate with sellers and reach satisfactory deals. Competition between agents occurs when, for instance, a limited number of products are available. Agents that win the product will have an increased fitness, whereas agents that lose will also lose some fitness.

In this article, some evolution related attributes for agents are proposed, including the following:

1. **State of Agent:** Agent states include newborn, executing, suspended, communicating, and terminated. Evolution amongst these states can result in an agent migrating from one state to another.
2. **Agent Relationship:** Is two agents succeed in collaboration to embark on one task of if one agent gets useful information from another, their relationship becomes tighter. This relationship affects the track of their evolution.
3. **Agent Fitness:** This attribute indicates the ability of an agent to survive and adapt to the environment. The Agent fitness is evaluated based on the following factors
    a. the *integration of agents* and their susceptibility to attack and damage;
    b. The *history of agents,* including the number and quality of completed tasks; and
    c. the *agent evolution record*, which shows whether the agent's growth is healthy.

Figure 5. An agent after evolution



The evolution of agents and ontology structures are also implemented by tree structure. For example, if the negotiation agent in Figure 4 needs a new strategy to enhance its negotiation skill, its owner or butler will send the requests to the agent factory. The agent factory will add the requested modules to the agent. Figure 5 and Table 3 demonstrate the structure of the agent after evolution and details of nodes in the structure. The new node F2A3 and its child nodes D4A3 and D5A3 are built into the new agent as a new negotiation strategy. The same evolution procedures can be applied to the evolution of ontology structure.

A set of agent transport protocols has been designed for SAFER in (Yang & Guan, 2000) to allow intelligent agents to roam from host to host. The transport protocols designed provide a secure mechanism for agents in e-commerce to roam across different hosts and communities in SAFER.

IMPACT OF SAFER

We are implementing the SAFER architecture, which covers many facilities, such as butlers and agent factories, as well as routine procedures such as fabrication,

Figure 6. Supervised agent transport in SAFER

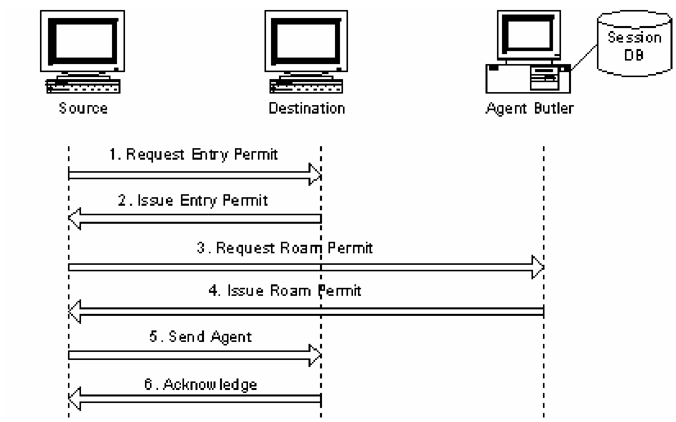
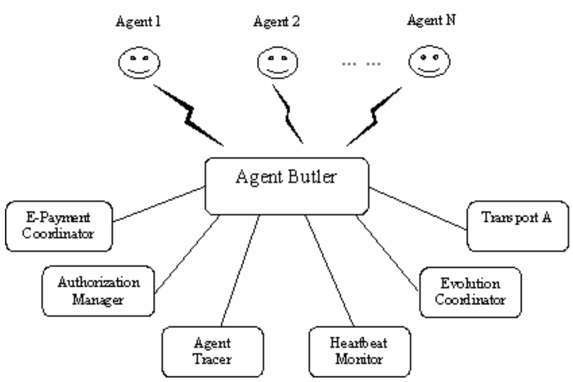


Figure 7. Prototype of agent butler



evolution, and roaming. Three transport protocols have been implemented: supervised agent transport, unsupervised agent transport, and bootstrap agent transport. We have successfully realized the transportation of an agent from one host to another in the above three different ways. A simplified implementation diagram of the supervised agent transport protocol in SAFER is shown in Figure 6 (Yang & Guan, 2000).

The prototype of an agent butler is being implemented. Functions designed for the agent butler include coordination of agent payment, management of authorization, keeping track of agent whereabouts, detection of agent abduction, coordination of agent evolution as well as assistance in agent roaming. Each function is implemented as a separate module in the agent butler, as shown in Figure 7.

Java is chosen as the implementation language, as it has a list of important features including robustness, security, and portability. The most important issue in e-commerce architecture is the security of the system. Java provides a three-layered security model and many mechanisms to enhance security protection.

CONCLUSION

In this article, the SAFER architecture for agent-based e-commerce was proposed. SAFER provides the facilities to serve agents in e-commerce and establishes the necessary mechanisms to manage and control their activities. We elaborated the functions of the components in SAFER and three aspects of SAFER: fabrication, evolution, and roaming.

SAFER provides an open and evolutionary agent architecture for e-commerce. With SAFER, conducting transactions in the Internet will be more secure and efficient. We have finished the design and implementation of the secure agent transport protocol in SAFER (Guan & Yang, 1999; Yang & Guan, 2000). We are trying to provide the basic modules and facilities, as we regard SAFER as our infrastructure for further research on e-commerce. As evolution is proposed in the SAFER architecture, its mechanism and theory presentation is also being constructed. Furthermore, we have developed the payment mechanism in SAFER, as it is essential in e-commerce.

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merce: Opportunities and challenges (pp. 321-336). Hershey, PA: Idea Group Publishing.

KEY TERMS

Adaptability: The ease with which software satisfies differing system constraints and user needs.

Agents: A piece of software that acts to accomplish tasks on behalf of its user.

Anonymity: The degree to which a software system or component allows for or supports anonymous transactions.

Client: In this article, "client" refers to customers who pay for good and services.

Confidentiality: The nonoccurrence of the unauthorized disclosure of information.

Cryptography: The art of protecting information by transforming it (i.e., *encrypting* it) into an unreadable format, called "cipher text." Only those who possess a secret *key* can decipher (i.e., *decrypt*) the message into plain text.

Flexibility: The ease with which a system or component can be modified for use in applications or environments other than those for which it was specifically designed.

Category: Applications of E-Technologies

Secure Agent for E-Commerce Applications

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INTRODUCTION

One hindrance to the widespread adoption of mobile agent technology (Johansen et al., 2002) is the lack of security. SAFER, or Secure Agent Fabrication, Evolution and Roaming, is a mobile agent framework that is specially designed for the purpose of electronic commerce (Guan & Yang, 2002, 2004; Yang & Guan, 2000; Zhu, Guan, Yang, & Ko, 2000). By building strong and efficient security mechanisms, SAFER aims to provide a trustworthy framework for mobile agents. Although such an agent transport protocol provides for the secure roaming of agents, there are other areas related to security to be addressed.

Agent integrity is one such area crucial to the success of agent technology. The integrity protection for agent code is relatively straightforward. A more complex code integrity scheme to handle code-on-demand is also proposed in Wang, Guan, and Chan (2002). Agent data, however, is dynamic in nature and will change as the agent roams from host to host. Despite the various attempts in the literature (Chionh, Guan, & Yang, 2001), there is no satisfactory solution to the problem so far. Some of the common weaknesses of the current schemes are vulnerabilities to revisit attack and illegal modification (deletion/insertion) of agent data.

DESCRIPTION OF SADIS

SADIS has been designed based on the following assumptions:

1. Entities including agents, agent butlers, and hosts should have globally unique identification number (IDs).
2. Each agent butler and host should have a digital certificate that is issued by a trusted CA. These entities will be able to use the private key of its certificate to perform digital signatures and encryption.
3. Whereas the host may be malicious, the execution environment of mobile agents should be secure and the execution integrity of the agent can be maintained.
4. Entities involved are respecting and cooperating with the SADIS protocol.

Key Seed Negotiation Protocol

The proposed key seed negotiation protocol defines the process for key seed negotiation and session key and data encryption key derivation. When an agent first leaves the butler, the butler generates a random initial key seed, encrypts it with the destination host's public key, and deposits it into the agent before sending the agent to the destination host. It should be noted that agent transmission is protected by the agent transport protocol (Guan and Yang, 2002), thereby protecting the system from being compromised by malicious hosts.

The key seed negotiation process is based on the Diffie-Hellman (DH) key exchange protocol (Schneier, 1996), with a variation. The agent will first generate a private DH parameter a and its corresponding public parameter x. The value x, together with the ID of the destination host, will be encrypted using a communication session key and sent to the agent butler.

The agent butler will decrypt the message using the same communication session key (discussed later). It, too, will generate its own DH private parameter b and its corresponding public parameter y. With the private parameter b and the public parameter x from the agent, the butler can derive the new key seed and use it for communications with the agent in the new host. Instead of sending the public parameter y to the agent as in normal DH key exchange, the agent butler will encrypt the value y, host ID, agent ID and current timestamp with the destination host's public key to get message M. Message M will be sent to the agent after encrypting with the communication session key.

$$M = E(y + \text{host ID} + \text{agent ID} + \text{timestamp}, H_{pubKey})$$

At the same time, the agent butler updates the agent's itinerary and stores the information locally. This effectively protects the agent's actual itinerary against any hacking attempts related to itinerary, thereby protecting against the data deletion attack.

When the agent receives the double-encrypted DH public parameter y, it can decrypt with the communication session key. Since the decrypted result M is parameter y and some other information encrypted with the destination host's public key, the current host will not be able to find out the value of y and thus find out the new key seed to be used when the agent reaches the destination host. It should be noted that this does not prevent the host from replacing M with its own version M' with the same host ID, agent ID, timestamp but different y. The inclusion of host ID, agent ID inside M can render such attack useless against SADIS. A detailed discussion on this attack can be found in the security analysis section.

Subsequently, the agent will store M into its data segment and requests the current host to send itself to the destination host, using the agent transport protocol (Guan & Yang, 2002).

On arriving at the destination host, the agent will be activated. Before it resumes normal operation, the agent will request the new host to decrypt message M. If the host is the right destination host, it will be able to use the private key to decrypt message M, and thus obtain the DH public parameter y. As a result, the decryption of message M not only completes the key seed negotiation process but also serves as a means to authenticate the destination host. Once the message M is decrypted, the host will verify that the agent ID in the decrypted message matches the incoming agent, and the host ID in the decrypted message matches that of the current host. In this way, the host can ensure that it is decrypting for a legitimate agent instead of some bogus agent. If the IDs in the decrypted messages match, the decrypted value of y is returned to the agent.

With the plain value of y, the agent can derive the key seed by using its previously generated private parameter a. With the new key seed derived, the key seed negotiation process is completed. The agent can resume normal operation in the new host.

Whenever the agent or the butler needs to communicate with each other, the sender will first derive a communication session key using the key seed and use this communication session key to encrypt the message. The receiver can make use of the same formula to derive the communication session key from the same key seed to decrypt the message.

The communication session key K_{CSK} is derived using the following formula:

$$K_{CSK} = \text{Hash}(\text{key\_seed} + \text{host ID} + \text{seqNo}).$$

The sequence number is a running number that starts with 1 for each agent roaming session, and is reset to 1 whenever the agent reaches a new host. Each message communicated will therefore be encrypted using a different key. As this means that the butler and agent will not be able to communicate if messages are lost without detection, SADIS makes use of TCP/IP as a communication mechanism. Once the communication is reestablished after a send failure, the sender will resend the previous message (encrypted using the same communication session key). The agent and the butler can therefore synchronize on communication session key calculations.

The agent encrypts host information with a data encryption key K_{DEK}. The data encryption key is derived as follows:

$$K_{DEK} = \text{Hash}(\text{key\_seed} + \text{hostID})$$

The details on encryption will be discussed in the next section.

Data Integrity Protection Protocol

The key seed negotiation protocol lays the necessary foundation for integrity protection by establishing a session-based key seed between the agent and its butler. Digital certificates also help protect the agent data integrity.

Our data Integrity Protection protocol is comprised of two parts: chained signature generation and data integrity verification. Chained signature generation is performed before the agent leaves the current host. The agent gathers data provided by the current host d_i and construct D_i as follows:

$$D_i = E(d_i + ID_{host} + ID_{agent} + \text{timestamp}, k_{DEK})$$

or

$$D_i = d_i + ID_{host} + ID_{agent} + \text{timestamp}$$

The inclusion of host ID, agent ID and timestamp is to protect the data from possible replay attack, especially when the information is not encrypted with the data encryption key, thereby creating an unambiguous memorandum between the agent and the host. The construction of D_i also gives the flexibility to encrypt the data or keep it in plain. After constructing D_i, the agent will request the host to perform a signature on the following:

$$c_i = \text{Sig}(D_i + c_{i-1} + ID_{host} + ID_{agent} + \text{timestamp}, k_{priv}),$$

where c_0 is the digital signature on the agent code by its butler.

One design focus of SADIS is not only to detect data integrity compromise, but also, and what is more important, to identify malicious hosts. To achieve malicious host identification, it is an obligation for all hosts to verify the incoming agent's data integrity before activating the agent for execution. In the event of data integrity verification failure, the previous host will be identified as the malicious host.

Data integrity verification includes the verification of all the previous signatures. The verification of signature c_0 ensures agent code integrity, the verification of c_i ensures data provided by host h_i is intact. If any signature failed the verification, the agent is considered compromised.

While the process to verify all data integrity may seem to incur too much overhead and somewhat redundant (e.g., why need to verify the integrity of d_1 in h_3 while host h_2 already verifies that), it is necessary to ensure the robustness of the protocol and to support the function of malicious host identification. Although the agent butler can eventually detect such data integrity compromise (since agent butler has to verify all signatures), but there is no way to establish the identity of malicious host(s).

Security Analysis

To analyze the effectiveness and reliability of SADIS, a detailed security analysis is performed subjecting SADIS to a variety of attacks. Based on the attack targets, the various attacks to SADIS can be classified into data attack, key attack, signature attack, itinerary attack, and composite attack. Composite attack refers to attacks that are combinations of two or more of the afore-mentioned attacks. The security analysis will be organized according to the previously mentioned classifications.

Data Attack

Data attack refers to any attempt that aims to compromise the data carried by an agent. Compromise can be in the form of data modification, deletion, or insertion.

Considering the data modification scenario, let us assume that the data targeted is D_i provided by host i, because the agent itinerary is protected by the butler and cannot be changed, only host i can produce a valid signature if the data were to be modified. However, even if the malicious party (or even host i) can produce a valid signature c_i' corresponding to D_i', since c_i is chained to the signature of the next host c_{i+1}, signature verification for host $(i+1)$ will fail. Therefore, in order to perform a successful data modification attack, the malicious host must be able to forge the signatures for all hosts in the itinerary since host i. As the only way to achieve this is to obtain the private keys of all the following hosts, data modification attack is extremely difficult under SADIS.

A number of the existing data integrity protocols suffer from data deletion attack. After analyzing the root cause of the vulnerabilities, it is realized that it is extremely important to protect the agent's itinerary. If the agent's itinerary is closely guarded by the butler, any data deletion will result in modification to the agent's itinerary and thus be detected.

Key Attack

Besides direct attack on data integrity, a malicious host may attempt to attack the various keys in order to compromise data integrity. There are three different types of keys in SADIS. They are session-based key seed, communication session key, and data encryption key. In SADIS, the key seed is kept by the agent and the butler separately. Attacks to the key seed can only target at the key seed negotiation protocol. As all communication in key seed negotiation is protected by the communication session key, we can safely rule out the possibility of any third-party malicious attempts to break the protocol. We can focus on the scenario where the current host attempts to break the key exchange to obtain the key seed to be used in the subsequent host.

First, as the DH public parameter is encrypted using the destination host's public key, the current host will not, without manipulation, be able to complete DH key exchange to find out the new key seed. Without the private key from the destination host, no one can obtain y to complete the key exchange. Furthermore, as the encrypted message contains the agent ID and destination host ID, the current host won't be able to send a bogus agent carrying this encrypted y to the destination host for decryption.

If the current host attempts to manipulate any one or both of these parameters, it is able to manipulate the key seed derived when the agent reaches the destination host. However, the change in key seed will be immediately detected when the agent communicates with the butler or vice versa. In order to perform a successful attack, the current host must therefore be able to obtain the key seed in the butler so that it can intercept and replace message communicated between the butler and the agent. Unfortunately, as illustrated earlier, there is no way the current host can find out the value of DH public parameter from butler y. Thus, the key seed will not be compromised.

Besides key seed, SADIS makes use of communication session key and data encryption key in the protocol. These two keys are directly derived from the session-based key seed using a hash function. As far as any third-party host is concerned, attack to communication session key or data encryption key is equivalent to attacking the encryption key given only the cipher text. Even in the extreme case when such a key is compromised, the loss is limited to the message it encrypts.

Signature Attack

Usually a malicious host would need to forge digital signature when it attempts to compromise data integrity. If data integrity is not compromised, there is no need to attack the chained signature at all.

Itinerary Attack

If the agent itinerary is not carefully protected, it may lead to compromise to data integrity, especially in the case of data deletion as illustrated earlier in the section. In SADIS, as the agent updates the butler of its next destination host as part of the key seed negotiation protocol, there is no additional overhead related to the itinerary protection mechanism. Therefore, there is no way a malicious host can perform any attack on the itinerary (except, of course, if it breaks into the agent butler).

Composite Attack

At times, in order to perform a successful attack, more than one area is targeted simultaneously. In addition to attacks with specific targets, there are certain general hacking techniques such as man-in-the-middle attack and replay attack. The design of SADIS employs a mechanism to protect the protocol against these hacking techniques. Through the use of communication session key, man-in-the-middle attack can be avoided. On the other hand, the use of sequence number in communication session key generation effectively protects the protocol from replay attack by a third party host. In addition, the inclusion of host ID, agent ID, and timestamp during the key seed negotiation process prevents the current host from performing a replay attack with the next destination host.

The design of SADIS does not have dependency on any specific encryption/hashing algorithm. In an unlikely scenario when one algorithm is broken, SADIS can always switch to a stronger algorithm.

Implementation

In order to verify the design of SADIS and assess its applicability, a prototype of SADIS is developed. The prototyping language is chosen to be Java, because of its platform independent feature.

Just like any other security mechanism, there is certain overhead associated with SADIS. The overhead is incurred as additional time required for processing as well as additional data carried by the agent. To assess the efficiency of SADIS, a study is performed on the prototype.

The result of this experimental study on SADIS is broken down, based on functionality and is shown in Table 1 and Table 2. It can be seen that the bulk of the overhead is incurred during key seed negotiation where the key exchange protocol and the public key operation is performed. Despite the relatively high overhead, this will not impact the overall performance of SADIS significantly because the frequency of agent roaming is low compared to the frequency of some other agent operations (such as agent-to-butler communication). As a result, the overhead incurred at this stage is "one-time" in nature. Other

Table 1. SADIS time efficiency (time taken for operations in milliseconds)—Performance without SADIS

Key Seed Negotiation (butler timing)	40	50	50	40	40	44.0
Key Seed Negotiation (destination host)	41	41	40	40	40	40.4
Agent Butler Communication (agent timing – send)	40	40	50	40	40	42.0
Agent Butler Communication (butler timing – send)	30	30	31	40	30	32.2
Agent Butler Communication (agent timing – receive)	10	10	10	10	10	10.0
Agent Butler Communication (butler timing – receive)	10	30	10	10	20	16.0

Table 2. SADIS time efficiency (time taken for operations in milliseconds)—Performance comparison with SADIS

Operation	1 (ms)	2 (ms)	3 (ms)	4 (ms)	5 (ms)	Avg (ms)	Overhead (ms)
Key Seed Negotiation (butler timing)	250	260	250	220	260	248.0	204.0
Key Seed Negotiation (destination host)	290	281	260	280	290	280.2	239.8
Agent Butler Communication (agent timing – send)	60	60	70	50	60	60.0	18.0
Agent Butler Communication (butler timing – send)	41	50	40	40	40	42.2	10.0
Agent Butler Communication (agent timing – receive)	10	20	10	10	10	12.0	2.0
Agent Butler Communication (butler timing – receive)	30	30	30	20	20	26.0	10.0

Table 3. SADIS data overhead

	Original Data Size (bytes)	Maximum Overhead (bytes)	Overhead	OKGS Overhead
1	1800	96	5.33%	33.87%
2	2001	96	4.80%	37.73%
3	5000	96	1.92%	N/A
4	10000	96	0.96%	N/A
5	100000	96	0.10%	N/A

than in the key seed negotiation, the time overhead incurred elsewhere in the protocol is negligible.

Other than overhead in terms of processing time, there is certain overhead to the data size as well. SADIS is designed to produce almost fixed data overhead regardless of the data size. SADIS therefore tends to be more efficient when actual data size is higher. This ability to limit the size of overhead data regardless of actual data size is an improvement in efficiency over existing work. The last and most significant overhead is the digital signature created by the host. The overhead of digital signature is a fixed length of 64 bytes. Altogether, SADIS has a maximum data overhead of 96 bytes.

As the statistics show, SADIS is optimized to improve time efficiency and data efficiency compared with related work in the literature. The feasibility and practicality of SADIS is thus demonstrated through the prototype.

IMPACT OF SADIS

Various techniques have been developed to protect agent integrities (Borselius, 2002), based on trusted hardware, trusted host, and conventional contractual agreements. SADIS addresses the problem of data integrity protection via a combination of techniques such as execution tracing, encrypted payload, environmental key generation, and undetachable signature. The security of SADIS is completely based on its own merits without making any assumption about the integrity of external hosts. SADIS also makes use of a negotiated key seed to generate data encryption key. Therefore, no random value needs to be encrypted and stored with the agent. With SADIS, the data and the communication keys undergo one time encryption. Thus, even if some of the keys are compromised, the key seed will still remain secret.

CONCLUSION

In this article, SADIS—a new data integrity protection protocol—has been proposed. Besides being secure against a variety of attacks and robust against vulnerabilities of related work in the literature, the research of SADIS includes the objective of efficiency. Unlike some existing literature, the data integrity protection protocol aims not only to detect data integrity compromise, but more important, to identify the malicious host. With security, efficiency, and effectiveness as its main design focuses, SADIS works with other security mechanisms to provide mobile agents with a secure platform.

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KEY TERMS

Agents: A piece of software, which acts to accomplish tasks on behalf of its user.

Cryptography: The art of protecting information by transforming it (*encrypting* it) into an unreadable format, called "cipher text." Only those who possess a secret *key* can decipher (or *decrypt*) the message into plain text.

Flexibility: The ease with which a system or component can be modified for use in applications or environments other than those for which it was specifically designed.

Protocol: A convention or standard that controls or enables the connection, communication, and data transfer between two computing endpoints. Protocols may be implemented by hardware, software, or a combination of the two. At the lowest level, a protocol defines a hardware connection.

Security: The effort to create a secure computing platform, designed so that agents (users or programs) can only perform actions that have been allowed.

Category: Concepts, Trends, and Challenges

Security Issues Concerning Mobile Commerce

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INTRODUCTION

Electronic commerce or e-commerce can be briefly defined as a financial transaction or commercial information between two parties based on data transmitted over communication networks (Soriano & Ponce, 2002). It relies upon users' interventions to initiate a transaction and select the main steps of the process. Users' actions stem from a succession of virtual decisions. Indeed, when shopping with a virtual catalog, customers can select products which meet their needs, tastes, and respect their price range. Such decisions consistently require the users' input, thus costing them both time and money. These costs are even more exorbitant when a search is launched for an order that includes a variety of products from different sources which have different characteristics (price range, delivery dates, etc.). When transactions involve users who are moving or take place over mobile networks, this is referred to as *mobile electronic commerce*, a specific type of e-commerce.

Mobile electronic commerce (or m-commerce) refers to an ability to carry out wireless commercial transactions using mobile applications within mobile devices, such as mobile phones and personal digital assistants (PDAs). It is generally defined as the set of transactions or processes which can be carried out over a wireless mobile network. According to this definition, m-commerce constitutes a subset of all electronic commercial transactions (electronic commerce or e-commerce) from business to consumer (B2C) or business to business (B2B). Thus, short personal messages such as those from SMS (short messaging system) sent between two individuals do not fall into the category of m-commerce, whereas messages from a service provider to a salesperson or a consumer, or vice versa, do fit this very definition. M-commerce appears as an emerging manifestation of Internet electronic commerce which meshes together concepts such as the Internet, mobile computing, and wireless telecommunications in order to provide an array of sophisticated services (m-services) to mobile users (Varshney, Vetter, & Kalakota, 2000; Veijalainen, Terziyan, & Tirri, 2003).

E-commerce includes an initial step where consumers search for a product they wish to purchase by virtually visiting several merchants. Once the product is found, negotiations can take place between the customer and the merchant (electronic negotiation or e-negotiation) (Paurobally, Turner, & Jennings, 2003). If an agreement is reached, the next step is the payment phase. At each step of the process, some problems arise, such as transaction security, confidence in the payment protocol, bandwidth limitations, quality of service, shipping delays, and so forth (Younas, Chao, & Anane, 2003; Zhang, Yuan, & Archer, 2002). The peak withdrawal periods have always presented a major challenge for certain types of distributed applications. The advent of m-commerce further highlights this problem. Indeed, in spite of rather optimistic predictions, m-commerce is plagued by several handicaps which hinder its commercial development, security being the main one.

Many market research studies, like those carried out by Strategy Analytics and the Gartner Group, predicted that by 2004 there would be over one billion wireless device users, some 600 million wireless Internet subscribers, a $200 billion m-commerce market, and 40% of consumer-to-business e-commerce will take place over Web-enabled phones (Gosh & Swaminatha, 2004). However, these business opportunities could be compromised by new security risks specific to the wireless medium and devices. As a result, the potential boom in the number of new m-commerce applications and markets can be achieved if and only if security and privacy can be integrated into online m-commerce applications.

This article analyzes some major security issues concerning mobile commerce. The next section presents background and related work, followed by a summary of some security issues and challenges. Future and emerging trends in secure m-commerce are then outlined, and the article is concluded.

BACKGROUND

While e-commerce systems are designed for purchases conducted on the wired Internet, m-commerce is extended to handle the mobility aspects related to the user equipment such as a mobile phone or a PDA. One of the main characteristics of an m-commerce system is the use of the Internet as the backbone and e-commerce with mobile terminals as user equipment. M-commerce applications can be as simple as a system to synchronize an address book or as complex as the system used to enable credit card transactions. They are deployed using mobile middleware which can be defined as a functional layer of software provided by application developers to link their e-commerce applications to an operating system and various mobile networks to allow their applications to bypass certain mobility issues.

Any party engaging in business needs a certain level of security. Security relies on a set of basic concepts and requirements such as: confidentiality, authentication, integrity, non-repudiation, and authorization. Confidentiality assures that the exchange of messages between parties over wireless access networks or global networks is not being monitored by non-authorized parties. Authentication ensures that the parties engaging in business are who they claim to be. Integrity allows users to verify whether modifications have occurred; however, it does not guarantee that information has not been altered. Non-repudiation certifies that the business transactions the parties engage in are legally binding. Authorization refers to a set of access rights assigned to an entity by a certification authority (CA). It does not guarantee that messages received do really come from a given counterpart; that is the task of authentication.

In a wired network, the secure socket layer (SSL) protocol and the transport layer security (TLS) protocol, which are well-established security protocols, provide privacy and data integrity between two communicating applications. In fact, HTTP over TLS-SSL is used to secure transactions for security-sensitive applications like m-commerce. It is generally known that these protocols do not adapt well to wireless environments with reduced processing capability and low-bandwidth links. Indeed, wireless devices such as cellular phones and PDAs have limited storage and minimal computational capacity. As a result, security issues were not taken into account when they were designed.

The scheme devised during the wireless application protocol (WAP) forum, which has defined an entirely new suite of protocols, uses a WAP gateway or proxy between the wireless and wireline environments to ensure connection and security. The SSL and TLS ensure security within the Internet, while the wireless transport layer security (WTLS) protocol ensures secure channels between the client and the WAP gateway. Transactions between WTLS and TLS are executed by the WAP gateway. However, the use of the WAP proxy, which is also a point of failure, does not allow for end-to-end security. As a matter of fact, because there are storage and translation operations at the WAP proxy, it becomes a point of entry for attacks. A solution to strengthen this weakness was provided by Soriano and Ponce (2002). They suggested providing a secure end-to-end tunnel between an Internet server and a mobile user by implementing a TLS compatible security layer at the wireless application environment (WAE) layer on the client side, named WAE-Sec. WAE-Sec therefore prohibits translations by the WAP gateway and permits compatibility with the TLS protocol. Note, however, that this solution resembles the one proposed by Gupta et al. (2001).

On the other hand, Tang, Terziyan, and Veijalainen (2003) have defined other related security issues to m-commerce, namely hostility, information security, and vulnerability. Hostility means that dishonest customers who get fraudulent identities by stealing mobile devices can make illegal operations and, thus, should be quickly identifiable. Information is more vulnerable in wireless networks since other parties can easily intercept it. The solution is to encrypt data with adequate keys. Vulnerability arises from a malfunctioning of the mobile device itself or from the physical access of malicious persons to the terminals. To remedy these additional problems, Tang et al. (2003) suggested the use of a mixed personal identification number (PIN) storage scheme which let the PIN be partially stored on the mobile device while the remainder of the PIN is stored on the network. Researchers assume that the probability of discovering the PIN located at two different places does not depend on the length of the PIN nor on the fact that a single part was discovered. Thus, discovering the whole PIN will require digging and/or guessing for twice as long than if the PIN was located at a single place. The improvements brought about by this strategy have been shown using a probabilistic model, but its implementation has yet to be investigated.

A new protocol for m-commerce was proposed by Katsaros and Honary (2003). Fully applicable to third-generation mobile networks, this protocol is characterized by three novel properties, as opposed to the existing methods of m-commerce. In fact, it provides a simplified and secure transaction method, minimizes the number of entities involved in the transaction, and finally reduces the probability of security threats, thus reducing the risk of fraud. Unfortunately, this protocol does not solve certain security issues related to m-commerce.

SECURITY ISSUES AND CHALLENGES

Mobile commerce provides an exciting new set of capabilities which can lead to new services that enhance the end-user's experience. With these new business opportunities, the risk of new security threats also arises. New mobile devices such as PDAs and mobile phones enable easy access to the Internet and strongly contribute to the development of m-commerce services, while Smartcard platforms will enable operators and service providers to design and deploy new m-commerce services. Such technologies must guarantee a high level of security of customer information and transactions in order to be adopted and widely deployed. Thus, establishing security mechanisms which allow diverse mobile devices to support a secure m-commerce environment on a wireless Internet is a critical challenge.

There are a lot of other security issues and challenges related to m-commerce: security of the transactions, security of the payments, security of customer information, end-to-end security, authorization mechanisms, and so on. Providing security provisions for the m-commerce community is challenging due to the insecure air interface of wireless access networks, and limited computational capability of mobile devices and users' mobility (He & Zhang, 2003). The limited equipment resources require the e-payment protocol in the wireless Internet environment to be designed in consideration of the efficiency of the computing functions and the storage device. In this context, security issues, like those dealing with service and subscriber authorizations in enhanced prepaid implementations for m-commerce, must be addressed. In fact, client application and subscriber-level authentication and authorization are key mechanisms used to regulate access to and usage of content-based transactions in m-commerce. The objective is to provide an enriched rating engine and a highly configurable feature set for service and content charging on wireless networks (Cai et al., 2004).

Smartcard platforms will enable operators and service providers to design and deploy new m-commerce services. This development can only be achieved if a high level of security is guaranteed for the transactions and customer information (Renaudin et al., 2004). In this context, smartcard design is very challenging when it comes to providing the flexibility and the power required by the applications and services, while at the same time, guaranteeing the security of the transactions and the customer's privacy.

On the other hand, as the number of users of wired and wireless Internet services is increasing exponentially and m-commerce services are going to be activated, it is quite necessary to establish a wireless Internet public key infrastructure (PKI) service which accepts diverse mobile devices to support secure m-commerce environments on the wireless Internet. In this context, security/payment policy algorithms must be designed in order to dynamically adapt the level of security according to the domain-dependent properties and the independent properties to support secure m-commerce transactions and payment on wireless Internet (Kim et al., 2002).

An e-payment system for m-commerce uses existing wired systems as is. However, it implies certain security and inefficiency problems. In fact, the limited amount of equipment required by the e-payment protocol in the wireless Internet environment allows for the highest level of the efficiency pertaining to the computing function and the storage device. The issue is the basis of the design of an e-payment system for m-commerce that minimizes public key computing and guarantees anonymity concerning personal and purchasing information, as well as spatial storage efficiency (Kim, Kim, & Chung, 2003).

Another issue in m-commerce security concerns the increasing number of destructive messages with viruses that can harm mobile devices. Such an issue is truly critical in the context of mobile applications which are generally deployed by small mobile devices with limited processing and storage capabilities.

Mobile commerce involves many risks related to security and privacy (Ghosh & Swaminatha, 2004). In fact, wireless devices introduce new security threats which are specific to their mobility and communication medium. Most Web sites are not currently configured to deal with the intermittent service failures which frequently occur during wireless connections. Furthermore, the most popular implementations of the WTLS protocol do not re-authenticate principles or double-check certificates once a connection has been established. As a result, attackers can take advantage of this vulnerability and compromise the integrity of the wireless networks which support the m-commerce applications.

The most significant security and privacy risks for wireless devices involved in m-commerce applications are: platform risks, software application risks, security risks of WML Script, among others (Ghosh & Swaminatha, 2004). Platform risks are related to the fact that many manufacturers have failed to include some basic operating system features necessary to enable some kinds of secure computing: memory protection for processes, protected kernel rings, file access control, authentication of principals to resources, biometric authentication, and so forth. Without a secure infrastructure provided by the platform and used by the device running m-commerce applications, it is difficult to achieve secure m-commerce.

Software application risks are related to the capability to design and develop secure wireless applications using good software engineering and assurance methods. One of the most important issues in this context is the ability to develop software for sending and executing mobile codes and agents to wireless devices, by taking into account the need to reduce the communication load on extremely bandwidth-limited wireless links.

Security risks of WML (wireless markup language) are related to the lack of access control for WML scripts, meaning that the type of attacks that can be launched using WML script is limited only by the imagination of malicious script writers. More generally, such risks are based on a fundamental lack of a model for secure computation (Ghosh & Swaminatha, 2004).

FUTURE TRENDS

Despite the differences between wired and wireless networks, both networks are vulnerable to the same kinds of attacks. Nevertheless, wireless networks, as the core infrastructure which supports m-commerce, are basically more exposed to security attacks due to the type of communication channel used.

Future trends in this field consist of considering hardware, software, and data as elements to be protected against security attacks in mobile environments. In particular, m-commerce deals with payments over the Internet, electronically sending both services and information, storage of consumer information on resources available from the Internet, as well as all other issues related to online shopping. Much research tackles security problems related to the overall process of m-commerce. Some of these problems will likely be solved in the near future on some levels by modifications to existing protocols. In particular, problems related to the wireless application protocol (WAP) are considered highly critical. In this context, data encryption over communication channels constitutes the strongest perceived security issue in the system.

Finally, other research directions address the setup of a trustworthy relationship with customers in order to deliver the service in due time. This also includes security issues related to the lack of anonymity and the possibility for an attacker to gain access to the users' account number and their identities, particularly in the context of payments with credit cards.

CONCLUSION

This article analyzed some major security issues in mobile commerce. After a presentation of background, some security issues and challenges, then future and emerging trends in secure m-commerce were outlined. A set of privacy risks were also mentioned and their relationships to software development were outlined. In fact, the nature of the communication medium requires a degree of trust and cooperation between nodes in wireless networks. There is a certain risk that trust and cooperation are exploited by malicious entities to collect confidential information and disseminate false information. Other risks are related to the platform, the software application, and the WML scripts. The most significant risk to m-commerce systems is related to a malicious code which has the ability to undermine other security technologies as it resides on the device, thus having all of the owner's privileges. For all these reasons, encrypted communication protocols are necessary to provide confidentiality, authentication, integrity, non-repudiation, and authorization of services for m-commerce applications.

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KEY TERMS

Authentication: Technique by which a process verifies that its communication partner is who it is supposed to be and is not an imposter. It makes sure that the parties engaging in business are who they claim to be. Integrity allows the system to verify whether modifications have occurred; it does not ensure that information was not altered.

Authorization: One or many access rights assigned to an entity by a certification authority (CA). Authorization does not make sure that messages received really do come from a given counterpart.

Confidentiality: Assures that the exchange of messages between parties over wireless access networks or global networks is not being monitored by non- authorized parties.

Electronic Commerce (E-Commerce): Set of transactions or processes which can be carried out between two parties based on data transmitted over communication networks. E-commerce relies upon users' interventions to initiate a transaction and select the main steps of the process.

Integrity: Allows the system to verify whether modifications have occurred; it does not make sure that information was not altered.

Mobile Commerce (M-Commerce): Refers to an ability to carry out wireless commercial transactions using mobile applications within mobile devices, such as mobile phones and personal digital assistants (PDAs). It is generally defined as the set of transactions or processes which can be carried out over a wireless mobile network.

Mobile Middleware: The functional layer of software provided by application developers to link their e-commerce applications to an OS and various mobile networks to allow their applications to bypass certain mobility issues.

Non-Repudiation: Makes sure that the business transactions the parties engaged in are legally binding.

Public Key Infrastructure (PKI): Security mechanism based on public key cryptography used to provide end-to-end security required for the information, services, and means of access. The core component of a PKI is the certification authority (CA). This authority is trusted by the end entities in its administrative domain and is responsible for the status of the certificate it issues.

Security, Privacy, and Trust in Mobile Systems

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INTRODUCTION

Access to general purpose information and communication technology (ICT) is not equally distributed on our planet: developed countries represent about 70% of all Internet users, while its percentage of Internet hosts has raised from 90% in 2000 to about 99% in 2002.

Things change dramatically if we look at mobile and wireless technology: developing countries already represent about 40% of mobile connections in 2000, with a foreseen growth rate that is faster in developing countries than in developed ones in the period 2000-2005 (mainly due to India and the People's Republic of China). This trend is driven by the new perspectives offered by mobile electronic technology applications that provide an alternative to poor telecommunication infrastructures still common in many developing countries. The technological evolution in wireless data communications is introducing a rich landscape of new services relying on three main technologies:

- proximity (or personal) area networks (PANs), composed of personal and wearable devices capable of automatically setting up transient communication environments (also known as *ad hoc* networks);
- wireless local area network technologies (WLANs); and
- a third generation of mobile telecommunications (3G), gradually replacing General Packet Radio Service (GPRS) and the related set of technologies collectively called "2.5 Generation" (2.5G).

PAN is a new technology bringing the "always connected" principle to the personal space. On the other hand, 3G systems and WLANs have coexisted for a while; what is new is their interconnection, aimed at decoupling terminals and applications from the access method. 3G mobile networks already provide video-capable bandwidth, global roaming for voice and data, and access to Internet-rich online content.

Thanks to their increasing integration, PANs, WLANs, and 3G networks will extend the user's connectivity in a complementary and hierarchical manner; in the fullness of time, they will provide all the functionalities of an *Integrated Services Multimedia Network* (ISMN), enabling a whole set of new business models and applications.

The fusion of these technologies will eventually result in an ultimate ubiquitous wireless system that will be operated from anywhere, including homes, business locations, vehicles, and even commercial aircrafts.

However, although wireless communications provide great flexibility and mobility, they often come at the expense of security. Indeed, wireless communications rely on open and public transmission media that expose new vulnerabilities in addition to the security threats found in wired networks. A number of specific open issues and even inherent dangers, some of which had been already identified and described in the early stages of wireless technology adoption, are yet to be solved (Howard, 2000). For instance, with wireless communications, important and vital information is often placed on a mobile device that is vulnerable to theft and loss. In addition, information is transmitted over the unprotected airwaves, and finally, 3G networks are getting smaller and more numerous, causing opportunities for hackers and other abusers to increase.

BACKGROUND

2G and 2.5G Mobile Authentication

GSM 2G systems introduced the *Subscriber Identity Module* (SIM) cards containing the user's identity and an authentication key (i.e., a shared secret key) supposed to last for the entire duration of the subscription. SIM-based authentication does not require any user action, other than entering the familiar four-digit *Personal Identification Number* (PIN) into the terminal. With GSM, a temporary user identity is allocated by the area operator where the user is located and is reassigned to another user as soon as the original requestor leaves the area. With the advent of 2.5G systems, enhanced by the *General Packet Radio Service* (GPRS), overlaying, certificates-based authentication became possible (Smith, 2002).

3G Authentication and On-the-Air Confidentiality

In the design of 3G systems like UMTS, a new security architecture was introduced (Blanchard, 2000). The new approach maintained backward compatibility with GSM, while trying to overcome some perceived weaknesses of 2G systems. Like in 2G systems, 3G systems identify users by means of the identity stored in the SIM. Differently from 2G systems, 3G authentication was designed with the following features:

- **Mutual Authentication:** Both the user and the network operator are identified in the authentication exchange.
- **Key Freshness:** Assurance that authentication information and keys are not being reused.
- **Integrity of Signaling:** Protection of service messages, for example, during the encryption algorithm negotiation.
- **Strong Encryption:** Strong cryptography, obtained via a combination of key length and algorithm design, is performed inside the core network rather than at the periphery.

Early Identity Management Systems

Starting from the late '80s, many examples of *Identity Management (IM)* systems have been proposed. In 1985, Chaum (1985) considered a device that helps the user with payment transactions and upholds the user's privacy. Clark (1993) proposed the *digital individual*, the individual's data shadow in the computer system which can be compared to user's identity.

Digital security and, more generally, digital identity management have grown fast in recent years, especially in mobile scenarios where personal communication and new computing devices will generate new security and integrity requirements for users and service information (Jendrike et al., 2002; Roussos & Patel, 2002).

MOBILE IDENTITY MANAGEMENT

Personal Identity Management in 3G Mobile Systems

Privacy and security issues related to mobile systems have been often described in terms of traditional security functionalities (e.g., access control, integrity, authentication, non repudiation, availability, and confidentiality). However, recent developments in ICT-based business models revealed the necessity to approach the concept of privacy and security more broadly, embracing not only the technical aspects, but also socioeconomic issues (Kagal, Parker, Chen, Joshi, & Finin, 2003). The ongoing transition from monolithic and localized systems, mainly based on single technology and weakly opened to integration, towards multi-application, multi-access, multi-player, distributed, and heterogeneous scenarios, is generating a context in which mobile applications and systems could play a strategic role. In other words, technology and business must be strongly Internet-worked with users' social dynamics, standards, policy, and regulation to create a digital identity management framework where digital identity is conceived as "an electronic representation of individuals' or organizations' sensitive information" (Damiani, De Capitani di Vimercati, & Samarati, 2003). Support offered by this framework is crucial for building and maintaining trust relationships in today's globally interconnected society because it:

- offers adequate security and availability;
- permits the presentation of a different subset of the users' identity depending on the ongoing and perceived application and communication context;
- guarantees that identity, personal data, and user profile (including location-based information) are safeguarded and no thefts will happen.

A *Digital Identity Management Framework* is realized by taking into consideration both the architecture of the framework, and those external elements that may influence an identity manager (e.g., regulations, standards, and so on). In particular, with respect to the framework's architecture, the following main elements can be recognized.

User

The service requestor associated with a profile. The digital identity management framework should let the user keep her desired level of privacy depending on the situation, presenting multiple user "appearances'' in different circumstances. In a mobile scenario, a portable user identity might include the following information:

- *Profile information* that consists of a number of static (e.g., date of birth, place of birth) and dynamic (e.g., technical skills and role) attributes.
- *Usage preferences* (e.g., browser settings) and other personal preferences that do not depend on the system (e.g., UK or U.S. English spelling).
- *Behavioral information* that may be derived by an history of previous interactions with the system.

Service Provider

The supplier of network services and applications.

Context

The particular situation in which users interact with the system. It includes the channel information (e.g., device and network features), the location information (e.g., cell, country, town), and time information.

Communication

This is based on well-known mechanisms to enable anonymity and confidentiality. With regard to anonymity, it is interesting to see that is possible for users to remain anonymous even in a world of SIM-based authentication. The authentication step is not repeated when roaming, because a user holds a reusable, temporary identification provided by the local mobile network. At the network level, therefore, mobile users have no fixed device address and, in principle, are identified only by the location.

Device

The terminal that provides the physical layer services (e.g., a radio interface) used to communicate data and to interact with context and service providers. Moreover, the device becomes the physical place where the user profile, context, and communication could be revealed and analyzed. For this reason, the terminal must be able to change the information it discloses much in the same way as the user.

The relevant external aspect that may most influence the Digital Identity Management Framework is as follows.

Shared Principles

Mobile privacy and identity management are realized to implement the following main principles:

- **Confidentiality:** Information must be accessible only by the intended receiver. Confidentiality can be split into three main elements: confidentiality of the message content, protection of location information, and support for sender/receiver anonymity.
- **Integrity:** Transmission of information is carried out by means of cryptographical mechanisms to identify and detect tampered data.
- **Notice:** An alert service must be available to draw the user's attention to situations in which privacy and security could be affected. Notice mechanisms should be manual whenever automatic solutions could compromise the user's security.
- **Data collection:** Users should be able to actively manage their own data, deciding whether and which identity is presented to devices and applications (Ceravolo, 2003). Data collection must be inspired to the principle of data minimization, by which data should only be collected for a specific purpose.

Wireless Heterogeneous Environments: Toward Ubiquitous Networking

One of the most challenging goals in the field of mobile services is the integration of different wireless technologies, like 2.5 or 3G cellular networks and WiFi (IEEE 802.11b and 802.11g) into the more general landscape of *ubiquitous networking*. Ubiquitous networking is aimed at addressing the users' need of seamlessly roaming from one connection mode to the other without impairing their ongoing operations. Accordingly, multimode cards (e.g., LAN-WLAN-GPRS cards) have been launched on the market and are becoming increasingly affordable. In particular, the advent of 3G is likely to make those multimode cards rapidly evolve to the LAN-WLAN-3G setting thus transforming portable devices—cellular phones, laptops, and PDAs—in *multimode devices*.

However, to foster effective mobility and ubiquitous computing through networks built on different wireless technologies, many fundamental issues need to be taken into consideration. An important one is the integration at link level between WiFi and GPRS/3G, which could result in a uniform network level. Realizing a uniform network layer between WiFi and GPRS/3G, in turn, may facilitate *transparent mobility*, that is, the possibility for users to automatically switch from one wireless network to another (possibly based on a different technology) without any detriment to ongoing Internet transactions or application service provision. There are many high-value mobile application services that will greatly benefit from transparent mobility such as telemedicine, Intelligent Transport Systems (ITS), and mobile Geographical Information Systems (mGIS).

More precisely, transparent mobility is characterized by successfully migrating live TCP connections during the handoffs through different wireless technologies (WLAN à GPRS/3G handoff and GPRS/3G à WLAN handoff). To do this, not only is a seamless inter-network handoff mechanism sufficient, but also the connectivity (as devices keep moving across environments while still minimizing any disruption to ongoing flows during switchovers) is another important aspect.

A mechanism that enables this has to exhibit a low handoff latency, incur little or no data loss (even in highly mobile environments), scale to large inter-networks, adapt to different environments, and act as a conjuncture between heterogeneous environments and technologies without compromising on key issues related to security reliability (Vidales, Patanapongpibul, & Chakravorty, 2003). For all these reasons, transparent mobility is indeed one of the most challenging goals of ubiquitous computing in wireless heterogeneous environments.

Network technologies that are actively used for such systems are: *Mobile IPv4* (MIPv4) and *Mobile IPv6* (MIPv6) (Chakravorty, Vidales, Subramanian, Pratt, & Crowcroft, 2003). MIPv4 is the network technology traditionally used to foster seamless roaming for ubiquitous computing systems, mainly due to its compatibility with the wired IP-based network infrastructure. Nevertheless, MIPv4 limitations have forced the development of overly complex systems and protocols. MIPv6 promises to overcome some of MIPv4 limitations and improve security, although it has other disadvantages in high mobility scenarios (Chakravorty et al., 2003; Perkins, 1996). An IETF working group, called *Seamoby* (Kempf, 2002), has been formed aiming to resolve complex interactions of parameters and protocols needed for seamless handoffs and context transfers between nodes in an IP access network.

Multihop Hotspots

Hotspot providers in public areas represent key components of a heterogeneous wireless infrastructure for mobile users, which could be used to access WLAN services while moving. *Multihop hotspots*, in particular, are hotspots through which users could roam seamlessly. Considering heterogeneous environments, users could hop through hotspots that are either physically contiguous, thus directly switching from one hotspot to another, or through a sequence of multimode handoffs between hotspots and GPRS/3G cells (Balachandran, Voelker, & Bahl, 2003).

With respect to security, hotspots still have significant open issues. One is *authentication* that is currently implemented with different and incompatible techniques by commercial WiFi networks. For instance, since hotspots are often under the control of different providers, users will have to repeat the authentication procedure (possibly different for each hotspot) at each hotspot location. Also, some commercial hotspot providers offer access to users through preestablished accounts, while others offer scratch-off cards containing a one-time login and password. A uniform and shared authentication infrastructure is fundamental for effective multihop mobility since highly mobile users cannot be required to cope with different authentication schemes, mechanisms, and configurations at each handoff. Clearly, the goal of providing fast and seamless authentication, while simultaneously ensuring user accountability, raises several research problems that are today still unsolved:

- **Ease of Access:** Single-Sign-On (SSO) features encompassing multihop hotspots are needed to support transparent mobility and reduce the latency.
- **Identity Management:** The mobile identity a user presents to each network provider could change according to context-related information such as provider reputation, QoS, location, or another contextual attribute.
- **Third-Party Authenticators:** Should authentication be delegated to dedicated third parties offering such a service for the whole multihop infrastructure?

Mobile User Recovery

VanderMeer, Dutta, Ramamritham, and Navathe (2003) addressed the problem of recovering Internet transactions initiated by mobile users. The issue is new and relevant since it presents many differences with respect to classical database transaction recovery techniques. Also, it appears extremely important in the context we have considered, since there is not only the case of recovery after a network failure, but there is the peculiar situation of recovery user activity after a handoff. This aspect is an additional novel issue to the most general problem of mobile user recovery.

This issue also has significant links with security and privacy since mobile user transactions and mechanisms for recovery could carry security risk and be targets of network attacks and subversion attempts. If network attacks would eventually succeed, it will be possible for an intruder, for example, to subvert the recovery mechanism and then recover transactions of other users, possibly gaining their privileges. By attacking a recovery mechanism, it could also be possible to access transactions' state information that still could let intruders impersonate users or gather sensitive information. Denial-of-service towards recovery systems is another threat that might severely impair the benefits of the infrastructure for ubiquitous computing and transparent mobility.

Security research in this area is still at the beginning since even operational features, like mobile user recovery, are in their initial stages. Despite this, the issue looks extremely important for the future evolution of ubiquitous computing and transparent mobility (VanderMeer et al., 2003). Several important issues that may affect security arise:

- **Secure Storage and Access to Logs and Recovery Procedures:** There could be different choices, from storing logs and procedures locally to the device, storing them at network gateways or at specialized recovery hosts. Indeed, a support to recovery features from the network infrastructure is needed. This introduces security issues related to trust relationships and authentication, with third parties or networked components in charge of user sessions recovery.
- **Trustworthy Generation, Management, and Usage of Users, Logs and State Information:** State information must be protected from tampering and disclosure since network components in charge of generating and storing state information are possible points of attacks.

FUTURE TRENDS

Ubiquitous computing in wireless heterogeneous environments and the ever-increasing interoperability between heterogeneous technologies are some of the most relevant trends in the field of mobile systems. However, such systems need operational features and security requirements that still have to be provided (Vidales et al., 2003). For instance, two interesting and fundamental open issues are the following:

- **Link-Switch Decision Rule-Base:** Current schemes that regulate handoffs operate based on link layer information, such as signal strength. However, this could be insufficient to assist the handoff process in heterogeneous environments. Signal quality, costs, and security requirements might be other parameters that need to be evaluated to decide the handoff.
- **Context-Awareness:** A mobile device context involves aspects such as physical context variables (e.g., device location, movement direction, velocity, and so on), application characteristics, and of course, user-based preferences. Context-awareness is necessary to take informed decisions about switching to a different network and provider.

CONCLUSION

The amount of mobile computing is expected to increase dramatically in the near future. As the users' demands increase with the offered services of mobile communication systems, the main expectation on such systems will be that they provide access to any service, anywhere, at anytime. Indeed, in today's highly connected and highly mobile environments, the secure transmission of information is imperative for every enterprise, and will grow in significance as mobile devices, networks, and applications continue to advance. However, the promise of mobile computing technologies further increases privacy and security concerns. In this article we have discussed the need for privacy and security in mobile systems and have presented technological trends that highlight that this issue is of growing concern.

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KEY TERMS

3G: The third generation of mobile communications technology.

Digital Identity Management System: A system related to the definition and lifecycle of digital identities and profiles as well as environments for exchanging and validating this information.

Multihop Hotspots: Hotspots through which users could roam seamlessly.

Privacy: Socially defined ability of an individual to determine whether, when, and to whom personal information is to be released.

Security: The combination of integrity, availability, and secrecy.

Ubiquitous Computing: A vision where computers are made available throughout the physical environment, but effectively invisible to the users.

Wireless Local Area Network: Local area network that uses radio waves as its carrier.

Semantics for E-Commerce Applications

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INTRODUCTION

A few years ago, e-commerce applications were mainly focused on handling transactions and managing catalogs. Applications automated only a small portion of the electronic transaction process, for example: taking orders, scheduling shipments, and providing customer service. E-commerce was held back by closed markets that could not use distributed services, due to the use of incompatible communication protocols.

Recently, business needs are evolving beyond transaction support to include requirements for the interoperability and integration of heterogeneous, autonomous, and distributed service. Enabling technologies and business-centered design methodologies have addressed the shortcomings of contemporary e-commerce applications. New technological development such as Web services, Web processes, and semantics have allowed the creation of a new bread of e-commerce applications which can orchestrate cross-organizational and distributed services.

Web services and processes refer to a set of technologies that can universally standardize the communication of applications in order to connect systems, services, business partners, and customers cost-effectively through the World Wide Web. Semantics provide an agreed understanding of information between and among Web services encouraging the development of interoperable systems that can help create and support new collections of services to better meet the demands and expectations of customers.

In this article, we present seven reasons why semantics should be an integral part of Web services and Web processes technology managing e-commerce applications.

BACKGROUND

As organizations are increasingly faced with the challenge of managing e-commerce applications, important technological development such as Web services, Web processes, and semantics are emerging.

The main idea of Web services is to encapsulate an organization's functionality or service within an appropriate interface and advertise it in the Web using the Web service definition language (WSDL) (Christensen, Curbera, Meredith, & Weerawarana, 2001). Web services are a very general model for building distributed applications which can be used to link together computer programs from different suppliers and technologies. The principles behind Web services are very simple:

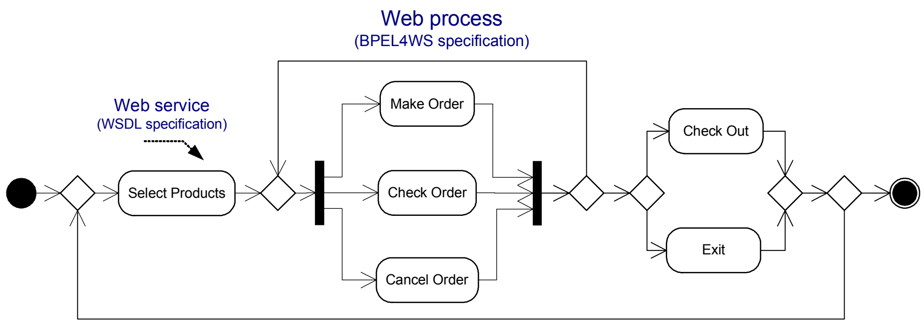
- A provider defines a standardized format for requests and responses for its Web services.
- A computer makes a request for the Web services across the network.
- The Web services perform some action and send the response back.

While in some cases Web services may be utilized in an isolated form, it is natural to expect that Web services will be integrated as part of Web processes. A Web process is an abstraction of a business process. It comprises a number of logic steps (i.e., Web services), dependencies among services, process flow, routing rules, and logic to control and coordinate services and partners. The most prominent solution to describe Web processes is BPEL4WS (BPEL4WS, 2003). BPEL4WS (Process Execution Language for Web Services) is a specification that enables a business process to be performed using a number of Web services, possibly provided by several companies. Figure 1 illustrates how a Web process can model an e-commerce application.

WSDL and BPEL4WS specifications are shallow and focus only on syntactical descriptions of Web services and Web processes. As a consequence, these descriptions are inadequate for an automated discovery or composition of Web services. Much richer and deeper machine-processable descriptions are required.

Several researchers have pointed out that Web services should be semantically enabled (Cardoso & Sheth, 2003; Fensel, Bussler, & Maedche, 2002; Martin et al., 2004). Semantics are indispensable to develop distributed e-commerce applications over the Web due to its heterogeneity, autonomy, and distribution. Semantics articulate a well-defined set of common data elements or vocabulary allowing a rich description of Web services and Web processes which can be used by computers for an automatic or semi-automatic processing and management of e-commerce applications.

Figure 1. Example of a Web process modeling an e-commerce application



THE IMPORTANCE OF SEMANTICS FOR E-COMMERCE APPLICATIONS

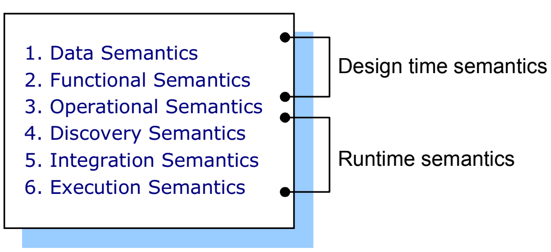
Semantic Web services will allow the automatic search (Klein & Bernstein, 2001), discovery (Verma et al., 2004), composition (Cardoso & Sheth, 2003), integration, orchestration (WSMX, 2004), and execution of inter-organizational services, making the Internet become a global common platform where organizations and individuals communicate among each other to carry out various e-commerce activities and to provide value-added services.

The idea of the "Semantic Web" (Berners-Lee, Hendler, & Lassila, 2001) catches on and researchers, as well as companies, have already realized the benefits of this great vision. Major companies and others are interested in creating industry-wide open e-business specifications for Semantic Web services and processes.

Different types of semantics can be used to enhance e-commerce applications. Semantics increase the description of capabilities, requirements, effects, and execution of Web services using ontologies (Gandon, 2002). E-commerce applications can benefit from six different kinds of semantics as illustrated in Figure 2.

These different types of semantics are discussed in the following sections.

Figure 2. Different types of semantics for e-commerce applications



Data Semantics

As e-commerce applications interconnect enterprises, Web services need to become available across systems, departments, and organizations. When organizations try to access and use local and remote Web services, they realize that their interfaces refer to incompatible data schema and cannot be called without a translation effort. In general, there is no common understanding which allows the data schema present in Web services' interfaces to be systematically manipulated.

Despite the fact that Web services use the same standardized technology, this incompatibility arises from semantic differences of data schema. In an e-commerce application, all the Web services take a set of data inputs and produce a set of data outputs represented in a WSDL specification file. However, the specification provides only syntactic and structural details of the input/output data. Each data schema is set up with its own structure and vocabulary. For example, a Web service may contain an output structure called "client" which includes the name, address, city, country, and telephone of a client; another Web service may have an input structure called "customer" and subdivides it into first name, last name, address, and tel. In such a scenario, how can the data output of the first Web service be transferred to the input of the second Web service? While the two structures do not match syntactically, they match semantically. To allow Web services to exchange data at the semantic level, the semantics of the input/output data has to be taken into account. Hence, if the data involved in Web service operations is annotated using an ontology (Patil, Oundhakar, Sheth, & Verma, 2004), the added semantics can be used in matching the semantics of the input/output of Web services when exchanging data, which was not possible when considering only syntactic information.

Functional Semantics

The goal of specifying the functionality of a service has a long tradition in computer science and includes work in the fields of program methodology, formal programming language semantics, and software engineering. The problems are complex, but the potential payoff is enormous.

Web service specifications are based on the WSDL standard that only defines syntactic characteristics. A WSDL document contains a set of definitions describing Web services using input and output messages, and operations. The signature of an operation provides only the syntactic details of the input data, output data, and operation's name.

Technological solutions to construct e-commerce applications based on Web services' operations signatures are not sufficient since services' functionality cannot be precisely expressed. Two services can have an operation with the same signature even if they perform entirely different functions. For example, a Web service called "add" that performs the addition of two integers taking the numbers as input and producing the sum as output (i.e., *add(x,y)=x+y*) will have the same signature of another service with the same name that performs the logarithmic addition of two numbers that are provided as input (i.e., *add(x,y)=log x+ log y*).

As a step towards representing the functionality of a service, Web services can be annotated with functional semantics. This can be achieved by having a functional ontology in which each concept/class represents a well-defined functionality.

Operational Semantics

When Web processes model e-commerce applications, suppliers, and customers define a binding agreement between the two parties, specifying operational constraints, also known as quality of service (QoS) requirements, such as goods to be delivered, deadlines, and cost of services or products.

The autonomy of Web services does not allow for business analysts to identify their operational metrics. When developing e-commerce applications it is indispensable to analyze and compute the QoS of the services and processes available to customers (Cardoso, Miller, Sheth, Arnold, & Kochut, 2004). This allows organizations to translate their vision into their business processes more efficiently, since Web processes can be designed according to QoS metrics. The management of QoS directly impacts the success of organizations participating in e-commerce applications. A good management of quality leads to the creation of quality products and services, which in turn fulfill customer expectations and satisfaction. To achieve these objectives, operational metrics need to be described using operational semantics which represent the QoS model of services and processes.

Operational semantics (Cardoso, 2002) are very important, not only because they allow to specify the QoS of services, but also because they allow the computation of the QoS of Web processes that orchestrate Web services that use, for example, different unit systems. A Web process may orchestrate two Web services, one that uses the English metric system and the other that uses the International System of Units. In order to compute meaningful values for the QoS of the overall process, a conversion of units need to be done. For example, a conversion from miles to kilometers. Operational semantics can make this conversion task automatic and very simple.

E-commerce applications that have a worldwide spread inherently need to use operational semantics to resolve the differences that exist among operational measurement adopted and followed by different countries. Two ontologies can be devised to describe operational characteristics: *Domain Independent* QoS and *Domain Specific* QoS ontologies. The first ontology, accounts for the evidence that Web services in different domains can have different quality aspects. The second ontology is to be applied to services in all domains irrespective of their functionality or specialty.

Discovery Semantics

After a Web service is developed and annotated with data, functional, and operational semantics, it has to be advertised to enable discovery. The Universal Description, Discovery, and Integration (UDDI) (UDDI, 2002) registry is a system to open doors for the success of service oriented computing.

UDDI registries enable global e-commerce by creating an organized approach to categorizing, storing, and retrieving information about the kind of services provided and who provides them. One of the major benefits of being listed in a public UDDI registry is that it provides equal exposure for all organizations. A large international organizations and a small locally owned company are listed in the same way.

Currently, UDDI only supports keyword (string) matching, which is considered the simplest type of syntactic matching. Therefore, the present discovery supported by UDDI is inefficient as services retrieved may be inadequate due to low precision (many services not wanted) and low recall (missed services that need to be considered). Effectively discovering relevant Web services in a scalable way is what is required to accelerate the adoption of Web services. To meet this challenge, UDDI registries need to support not only syntactic matching, but also semantic matching (Verma et al., 2004). Semantic matching is the process of matching requests to Web services on the basis of the requested Web services functionality (functional semantics). Here again, Web services may not match syntactically but match semantically.

Integration Semantics

Integration is a key issue in e-commerce because more and more companies are creating business-to-customer (B2C) and business-to-business (B2B) links to better manage their value chain. Automating inter-organizational Web processes across supply chains presents significant challenges (Stohr & Zhao, 2001). In order for these B2C and B2B links to be successful, Web services from multiple companies need to be integrated to interoperate seamlessly.

Compared to traditional distributed applications, Web services are highly autonomous and heterogeneous. Therefore, sophisticated methods are indispensable to support the integration of Web services. Here again, one possible solution is to explore the use of semantics to enhance the interoperability among Web services.

To achieve interoperability of e-commerce applications, it is necessary to address the problem of semantic integration—the identification of semantically similar objects that belong to different systems and the resolution of their schematic differences (Kashyap & Sheth, 1996). When Web services are put together, their interfaces (inputs and outputs) need to interoperate (Cardoso & Sheth, 2003); therefore, structural and semantic heterogeneity needs to be resolved. Structural heterogeneity exists because Web services use different data structures to define the parameters of their interfaces. Semantic conflicts occur when a Web service output connected to another service input does not use the same interpretation of the information being transferred. The general approach to semantic integration has been to map the local terms onto a shared ontology. Even though a shared ontology ensures total integration, constructing such an ontology has been costly (Rodríguez & Egenhofer, 2002). Recently however, significant progress is being made to deal with the issues of ontology evolution/management (Gandon, 2002) and multi-ontology environments (Fonseca, 2001), leading to increased momentum in developing and applying semantics to enable the integration of different systems.

Execution Semantics

Execution semantics of a Web service (WSMX, 2004) encompasses the ideas of message sequence, conversation pattern of Web service execution, flow of actions, preconditions, and effects of Web service invocation. Some of these details may not be meant for sharing and some may be, depending on the organization and the application that is exposed as a Web service. In any case, the execution semantics of these services are not the same for all services and hence before executing or invoking a service, the execution semantics or requirements of the service should be verified.

Some of the issues and solutions with regard to execution semantics are inherited from traditional workflow technologies (Cardoso, 2005). However, the globalization of e-commerce, Web services, and processes result in additional issues. In e-commerce, using execution semantics can help in dynamically finding partners that will match not only the functional requirements, but also the operational requirements. Also, a proper model for execution semantics will help in coordinating activities in e-commerce applications that involve multiple parties.

FUTURE TRENDS

According to TopQuadrant, a consulting firm that specializes in Semantic Web technologies, the market for semantic technologies will grow at an annual growth rate of between 60% and 70% until 2010, when it will grow from its current size of U.S. $2 billion to $63 billion. Existing applications that will add Semantic Web capabilities include Adobe's Extensible Metadata Platform and Oracle's database.

Semantic software is being experimentally used by banks to help them to comply with the U.S. government's Patriot Act (the Patriot Act requires banks to track and account for the customers with whom they do transactions), by a European police force to follow crime patterns, and by a telephone service provider to create applications that provides information about pay-per-view movies (Lee, 2005).

In addition to investment banks, the Metropolitan Life Insurance Company, the U.S. Department of Defense, and the Tennessee Valley Authority have also used semantic software to integrate enterprise data, to comply with federal regulations.

For Web services and Web processes to become a platform for semantic service oriented computing to fully support e-commerce application, academic and industrial researchers will need to create ontologies, terminologies, technologies, and products that enable sophisticated solutions for the annotation, advertisement, discovery, selection, composition, and execution of Web services.

Three major projects will provide, in the near term, several advances in the area of Semantic Web processes. The Semantic Web Services Initiative (SWSI), an initiative of academic and industrial researchers, has been composed to create an infrastructure that combines the Semantic Web and Web services to enable the automation in all aspects of Web services. In addition, to providing further evolution of the ontology language for Web services, OWL-S (OWL-S, 2004), SWSI will also be a forum for working towards convergence of OWL-S with other research efforts in this area.

The METEOR-S (LSDIS, 2004) (METEOR for Semantic Web services) project is focused on the usage of semantics for the complete lifecycle of Semantic Web processes and targets research on four important areas, namely; annotation, discovery, composition, and execution of Web services.

Finally, DERI (DERI, 2004) is currently working on a project titled Semantic Web-Enabled Web Services (SWWS). Important objectives of the SWWS initiative include: providing a richer framework for Web service description and discovery, as well as, providing scalable Web service mediation middleware based on semantic data, process ontologies, and semantic interoperation.

CONCLUSION

E-commerce has permanently changed the manner trading activities are carried out. Consumers can now acquire services and products from a diversity of Web sites. With the spread of the Web, a new technology has surfaced for the development of e-commerce application: Semantic Web processes.

This new trend in the global economy requires the ability to deploy e-commerce applications based on Web processes from the aggregation and orchestration of distributed Web services. Several researchers agree that it is essential for Web services to be semantically enabled in order to efficiently develop and execute Web processes.

In this chapter we have presented a set of challenges that the emergence of e-commerce and Semantic Web processes has brought to organizations. Designing Semantic Web processes entails research in two areas: Web services and the Semantic Web. We have presented how applying semantics to each of the steps in the Web process lifecycle can help address critical issues such as Web services annotation, discovery, selection, integration and execution.

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KEY TERMS

BPEL4WS: BPEL4WS stands for Business Process Execution Language for Web Services. It provides a language for the formal specification of business processes. It extends the Web services model and enables it to support business transactions.

Business Process: A set of one or more linked activities which collectively realize a business objective or goal, normally within the context of an organizational structure.

HTTP: The underlying protocol used by the World Wide Web. HTTP defines how messages are formatted and transmitted between Web servers and browsers.

Ontology: An ontology provides the basis of representing, acquiring, and utilizing knowledge. Ontologies consist of entities, attributes, interrelationships between entities, domain vocabulary, and factual knowledge.

Semantics: The purpose of semantics is to assign a meaning to syntactical elements. For Web services, it is the agreed upon meaning of data, functions, QoS, etc., exchanged between two or more services.

UDDI: UDDI (Universal Description, Discovery, and Integration) is a registry for businesses to list themselves on the Internet. Its goal is to facilitate online transactions by enabling companies to find one another on the Web and make their systems interoperable for e-commerce. UDDI is often compared to a telephone book's white, yellow, and green pages.

Web Process: A Web process describes the logic to control and coordinate Web services participating in a process flow to carry out a specific goal. It directly addresses business process challenges such as control flow, data flow between Web services, long-running nested units of work, faults and compensation.

Web Service: A Web service describes a standardized way of integrating Web-based applications using open standards. A Web service is defined as a remotely callable function or procedure which communicates via the HTTP (HyperText Transfer Protocol) using standardized protocols.

WSDL: WSDL stands for Web Services Description Language. It is written in XML and it is used to describe and locate Web services.

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Semi-Automated Seeding of Personal Privacy Policies in E-Services

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INTRODUCTION

The rapid growth of the Internet has been accompanied by a proliferation of e-services targeting consumers. E-services are available for banking, shopping, learning, government online, and healthcare. However, each of these services requires a consumer's personally identifiable information (PII) in one form or another. This leads to concerns over privacy.

In order for e-services to be successful, privacy must be protected (Ackerman, Cranor, & Reagle, 1999). An effective and flexible way of handling privacy is management via privacy policies. In this approach, a consumer of an e-service has a personal privacy policy that describes what private information the consumer is willing to give up to the e-service, with which parties the provider of the e-service may share the private information, and how long the private information may be kept by the provider. The provider likewise has a provider privacy policy describing similar privacy constraints as in the consumer's policy, but from the viewpoint of the provider, (i.e., the nature of the private information and the disclosure/retention requirements that are needed by the e-service). Before the consumer engages the e-service, the provider's privacy policy must match with the consumer's privacy policy. In this way, the consumer's privacy is protected, assuming that the provider complies with the consumer's privacy policy. Note that policy compliance is outside the scope of this work but see Yee and Korba (July, 2004).

Initial attempts at conserving consumer privacy for e-services over the last few years have focused on the use of Web site privacy policies that state the privacy rules or preferences of the Web site or service provider. Some of these policies are merely statements in plain English and it is up to the consumer to read it. This has the drawback that very few consumers take the trouble to read it. Even when they do take the time to look at it, online privacy policies have been far too complicated for consumers to understand and suffer from other deficiencies (Lichtenstein, Swatman, & Babu, 2003; Jensen & Potts, 2004). Still other privacy policies are specified using P3P (W3C) that allows a consumer's browser to automatically check the privacy policy via a browser plug-in. This, of course, is better than plain English policies but a major drawback is that it is a "take-it-or-leave-it" approach. There is no recourse for the consumer who has a conflict with the Web site's P3P policy, except to try another Web site. In this case, we have advocated a negotiations approach to resolve the conflict (Yee & Korba, Jan., May, 2003). However, this requires a machine-processable personal privacy policy for the consumer.

We assume that providers in general have sufficient resources to generate their privacy policies. Certainly, the literature is full of works relating to enterprise privacy policies and models (e.g., Barth & Mitchell, 2005; Karjoth & Schunter 2002). Consumers, on the other hand, need help in formulating machine-processable privacy policies. In addition, the creation of such policies needs to be as easy as possible or consumers would simply avoid using them. Existing privacy specification languages such as P3P, APPEL (W3C; W3C, 2002), and EPAL (IBM) are far too complicated for the average internet user to understand. Understanding or changing a privacy policy expressed in these languages effectively requires knowing how to program. Moreover, most of these languages suffer from inadequate expressiveness (Stufflebeam, Anton, He, & Jain, 2004). What is needed is an easy, semi-automated way of seeding a personal privacy policy with a consumer's privacy preferences. In this work, we present two semi-automated approaches for obtaining consumer personal privacy policies for e-services through seeding. This article is based on our work in Yee and Korba (2004).

The section "Background" examines related work and the content of personal privacy policies. The section "Semi-Automated Seeding of Personal Privacy Policies" shows how personal privacy policies can be semi-automatically seeded or generated. The section "Future Trends" identifies some of the developments we see in this area over the next few years. We end with "Conclusion".

BACKGROUND

We have been able to find only two other authors who have written on the derivation of personal privacy policies. Dreyer and Olivier (1998) describe a tool called the "Privacy Workbench" for creating and analyzing privacy policies. However, it is not clear from their article how one comes up with the privacy policy in the first place, as it seems to just appear followed by a description of how the tool can perform conflict analysis. It is a model-based rules inference approach for validating an existing privacy policy. More importantly, Privacy Workbench is a tool for a programmer, as it is far too complex for the average consumer to understand and use. Snekkenes (Snekkenes, 2001) wrote about the derivation of personal location privacy policies for use with a location-based service, (e.g., E911 emergency location service in the United States). Snekkenes' view is that "individuals should be equipped with tools to become in the position to formulate their own personal location privacy policies". This author provided concepts as well as fragments of a language for formulating personal location privacy policies. Unfortunately, the language presented can only be understood by programmers and not the average consumer. Our approaches for generating personal privacy policies are not model-driven or service specific and have been designed for ease-of-use by the average consumer.

Privacy Legislation and Directives

Before we can consider how to seed a personal privacy policy, we need to know what such a policy should contain in terms of privacy provisions. We use privacy legislation to obtain what must be specified in a personal privacy policy. Therefore, this gives a minimum policy in the sense that all elements required by law have been specified, but additional provisions can be included at the discretion of the consumer.

In Canada, privacy legislation is enacted in the *Personal Information Protection and Electronic Documents Act* (Department of Justice, 2005; Government of Canada) and is based on the Canadian Standards Association's Model Code for the Protection of Personal Information *(Canadian Standards Association)* recognized as a national standard in 1996. This Code consists of ten Privacy Principles *(Canadian Standards Association)* that for convenience, we label as CSAPP. Data privacy in the European Union is governed by a comprehensive set of regulations called the Data Protection Directive (Euro-

Figure 1. Example consumer personal privacy policies

Policy Use: *E-learning* Owner: *Alice Consumer* Proxy: *No* Valid: *unlimited*	Policy Use: *Bookseller* **Owner:** *Alice Consumer* Proxy: *No* Valid: *June 2003*	Policy Use: *Medical Help* **Owner:** *Alice Consumer* Proxy: *No* Valid: *July 2003*
Collector: Any *What:* name, address, tel *Purposes:* identification *Retention Time:* unlimited *Disclose-To*: none *Collector:* Any *What:* Course Marks *Purposes:* Records *Retention Time:* 2 years *Disclose-To*: none	*Collector:* Any *What:* name, address, tel *Purposes:* identification *Retention Time:* unlimited *Disclose-To*: none	*Collector:* Any *What:* name, address, tel *Purposes:* contact *Retention Time:* unlimited *Disclose-To*: pharmacy *Collector:* Dr. A. Smith *What:* medical condition *Purposes:* treatment *Retention Time:* unlimited *Disclose-To*: pharmacy

pean Union). In the United States, privacy protection is achieved through a patchwork of legislation at the federal and state levels. However, privacy has been recognized as a constitutional right and there exists a highly developed system of privacy protection under tort law for the past century (Industry Canada).

We seek attributes of private information collection using CSAPP as a guide. We use CSAPP because it is representative of privacy legislation in other countries and has withstood the test of time, originating from 1996. We will then apply these attributes to the specification of privacy policy contents.

Personal Privacy Policy Content Based on Legislation

Based on an exploration of CSAPP (Yee & Korba, 2004, 2005), the contents of a privacy policy should, for each item of PII, identify (a) collector—who wishes to collect the information (for consumer policies only), (b) what—the nature of the information, (c) purposes—the purposes for which the information is being collected, (d) retention time—the amount of time for the provider to keep the information, and (e) disclose-to—the parties to whom the information will be disclosed. Figure 1 gives 3 examples of consumer personal privacy policies for use with an e-learning provider, an online bookseller, and an online medical help clinic. The first item in a policy indicates the type of online service for which the policy will be used. Since a privacy policy may change over time, we have a *valid* field to hold the time period during which the policy is valid. For a consumer policy, the proxy field holds the name of the proxy if a proxy is employed to provide the information. Otherwise, this field has the default value of "no". For a provider policy, the proxy field has a default value of "yes" indicating that the consumer can use a proxy to provide the information. Otherwise, this field has the value "no".

A personal privacy policy thus consists of "header" information (policy use, owner, proxy, valid) together with 5-tuples or privacy rules

<collector, what, purposes, retention time, disclose-to>

where each 5-tuple or rule represents an item of private information and the conditions under which the information may be shared. A personal privacy policy therefore consists of a header plus one or more privacy rules.

SEMI-AUTOMATED SEEDING OF PERSONAL PRIVACY POLICIES

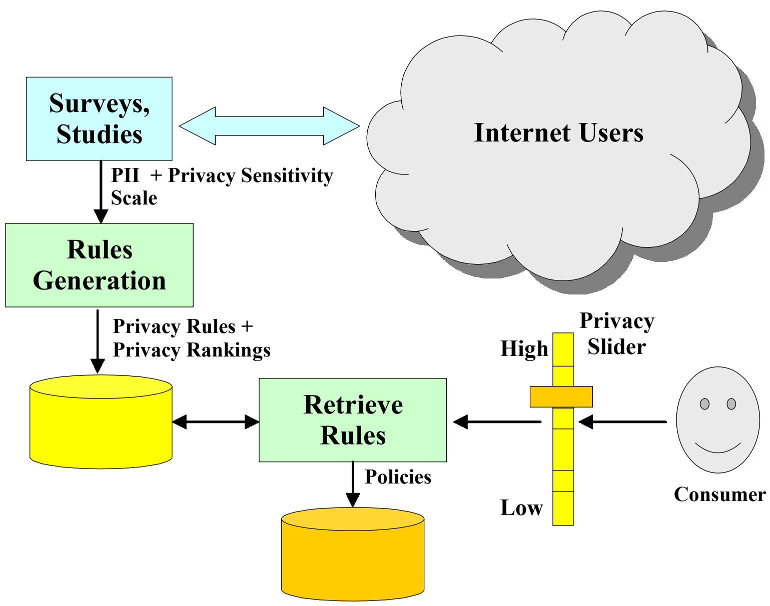
A semi-automated seeding (or derivation) of a personal privacy policy is the use of mechanisms (described in the following paragraph) that may be semi-automated to obtain a set of privacy rules for a particular use (see previous paragraph). We present two approaches for such derivations. The first approach relies on third party surveys of user perceptions of data privacy. The second approach is based on retrieval from a community of peers.

Seeding through Third Party Surveys

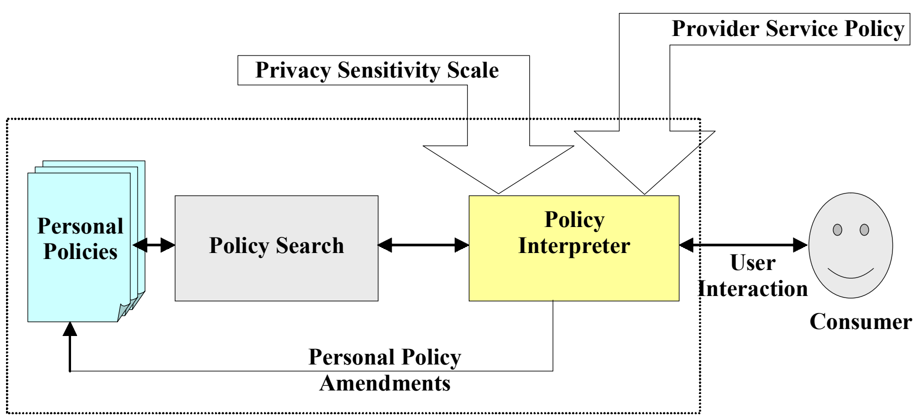
1. A policy provider makes use of third party surveys performed on a regular basis as well as those published in research literature to obtain user perceptions of the level of privacy for various sets of PII separated according to their uses. This gives a sensitivity or range of privacy levels for different PII in different situations.
2. Corresponding to a provider's privacy policy (which specifies what PII is required), the policy provider or a software application constructs and ranks the privacy rules for each use using the PII in number 1 above, according to their sensitivity levels, such that the rules are selectable by a single value privacy level from a "privacy slider". The outcome of this process is a set of consumer privacy rules, ranked by PII sensitivity, for different providers. The policy provider would express the resulting privacy rules in a policy language such as APPEL. There are different ways to do this ranking. One way is to assign a privacy rule the median of its sensitivity range as its privacy level (illustrated below).
3. Consumers obtain online from the policy provider the privacy rules that make up whole policies. They do this by specifying the use for the rules, the provider for which a consumer privacy policy is required, and the level of privacy required using the privacy slider. The consumer then completes each privacy policy by adding the rest of the header information. This can be done through a human computer interface that shelters the user from the complexity of the policy language. In this way, large populations of consumers may quickly obtain privacy policies for many service providers

Figure 2. Derivation of personal privacy policies through surveys

(a) Derivation of personal privacy policies from surveys



(b) Adapting personal privacy policies to the service provider



that reflect the privacy sensitivities of the communities surveyed.

4. Consumers may interactively adapt their privacy policies for different service providers based on their current policies, the sensitivities of the privacy rules, and the policy of the service provider. This assumes the availability of an easy to understand interface for the interaction as well as software to reflect the changes back into the policy language.

This approach requires trust in the policy provider. Effectively the policy provider becomes a trusted third party. A certification process for the policy provider is probably required. For instance, in Canada, the offices for the provincial and federal privacy commissioners could be this certification body. They could also provide this policy creation service.

A notification process should be used during the policy exchange phase between a consumer and a service provider to let the consumer know when "sensitive data" is exchanged. The degree of consumer sensitivity to different PII for different situations would also be available from the policy provider. This information could be updated regularly by the policy provider, or updated through a short online survey. The sensitivities would either modulate the base policy or set a trigger level for user warnings during policy exchange. During the warning, the user is presented with options that may allow the "degradation" or shoring up of the privacy policy. Figure 2 illustrates this approach.

Example

Suppose the item of PII for which we wish to derive a privacy rule is "course marks retention time" from the e-learning privacy policy in Figure 1.

Then the previous steps are implemented as follows:

1. The third party survey generates the following results for course marks retention time (the higher the privacy level, the higher the privacy; the highest level is 5, the lowest level is 1). Note that CMRT stands for "Course Marks Retention Time".

PII	Privacy Level
CMRT: 6 months	3
CMRT: 6 months	4
CMRT: 6 months	4
CMRT: 6 months	5
CMRT: 12 months	1
CMRT: 12 months	1
CMRT: 12 months	2
CMRT: 12 months	3

CMRT = Course Marks Retention Time

Note that the other parameters in a privacy rule may change too, not just retention time. We change retention time only to keep the example simple. Actually, each different combination of parameters represents a different privacy level. The privacy level is inversely proportional to the retention time of the marks. The different privacy levels obtained for the same PII constitute one part of the privacy sensitivity scale.

2. In this step, the policy provider constructs privacy rules from the PII in number 1 and ranks them using the median value from the corresponding sensitivity range. Thus for the 4 course mark retention times of 6 months, the lowest value is 3, the highest value is 5, and the median is 4. Therefore the rule < any, course marks, records, 6 months, none > is ranked with privacy level 4. Similarly, the rule < any, course marks, records, 12 months, none > is ranked with privacy level 2.
3. To obtain his or her privacy rules, the consumer specifies the use as e-learning and a privacy slider value of four (for example). He or she then obtains the rule

   < any, course marks, records, 6 months, none >

   and proceeds to complete the policy by adding header values for *owner*, *proxy*, and *valid*.

Retrieval from a Community of Peers

This approach assumes an existing community of peers already possessing specific use privacy policies with rules according to desired levels of privacy. A new consumer joining the community searches for personal privacy rules or whole personal privacy policies (sets of rules). The existing personal privacy policies may have been derived using the third party surveys as above. The privacy policy rules are each stored along with its privacy level so that it may be selected according to this level. Where a rule has been adapted or modified by the owner, it is the owner's responsibility to ensure that the slider privacy value of the modified rule is consistent with the privacy sensitivity scale from surveys.

1. All online users are peers and everyone has a privacy slider. The new consumer broadcasts a request for privacy rules to the community, specifying use and slider value. This is essentially a peer-to-peer search over all peers.

2. The community responds by forwarding matching (in terms of use and slider value) rules to the consumer. This match may be a fuzzy match as well.
3. The consumer compares the rules and selects them according to use, popularity (those that are from the greater number of peers), and best fit in terms of privacy. After obtaining the rules, the consumer completes the privacy policies by completing the headers as in the above derivation from surveys approach.
4. Consumers may adapt their privacy policies for different service providers as in the derivation by surveys approach.

There is a challenge here regarding how to carry out this approach in a timely fashion. Efficient peer-to-peer search techniques will collect the policies in a timely manner, but the amount of information collected by the requester may be quite large. As well, since the various policies collected will probably differ from each other, the requestor will have to compare them to determine which one to select. Quick comparison so as to reduce the amount of data collected would be through a peer-to-peer policy search that employs a policy hash array, containing hashed values for different portions of the policy for more rapid comparison.

FUTURE TRENDS

We expect that over the next few years, consumers will become increasingly aware of their privacy rights. This is already happening as consumers are faced with the practical implications of privacy legislation. In Canada, this has meant that consumers are being asked for permission before their private data is collected every time they walk into a dentist's office or visit an optician for glasses. To ensure that their privacy rights are respected, consumers will need to express their privacy preferences in personal privacy policies. Hence the need for consumers to be able to create their personal privacy policies easily will grow. In response to this need, researchers will discover more ways for them to do so easily. In addition, there will be a need for technologies that are associated with personal privacy policies, such as policy negotiation, policy compliance, and trustable interfaces for interfacing the consumer to the provider for the purpose of privacy policy management (see "Introduction" for policy negotiation and compliance). Consumer privacy will only be truly protected once these technologies are available and used.

CONCLUSION

The protection of personal privacy is paramount if e-services are to be successful. A privacy policy approach to privacy protection seems best for e-services. However, for this approach to work, consumers must be able to seed their personal privacy policies easily. We have presented two semi-automated approaches for seeding the policies: one based on third party surveys of consumer perceptions of privacy, the other based on retrieval from a peer community. Both approaches reflect the privacy sensitivities of the community, giving the consumer confidence that his/her privacy preferences are interpreted with the best information available. As well, they might be effectively combined.

Clearly, the notion of a trusted third party as a personal policy provider may be controversial to some. Any error made by the policy provider could affect PII for many hundreds or thousands of people. Having privacy commissioners' offices take responsibility for this process seems to be a natural fit, given their mandate as privacy watchdog for the consumer. However, the process would have a cost. Costs might be recovered via micro-charges to the consumer, or the service provider for the policies provided. Aggregated information from the PII surveys might be sold to service providers.

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KEY TERMS

Community of Peers: A grouping of peers having something in common or considered grouped for a specific purpose, (e.g., having particular types of privacy policies as discussed above).

Consumer: Of an e-service is a user of the service, possibly by paying a fee.

E-Service: An electronic service accessed via a network such as the internet. Example e-services include online banking, online stock broker, online tax information, and online learning.

Peer: Another node in a network that is like every other node in the network.

Personal Information or Personally Identifiable Information (PII): Information that is personal about an individual that may be linked with the individual or identify the individual, (eg. credit card number, birth date, home address, social security number).

Personal Privacy Policy: A description of personal privacy preferences, stating what personal information or PII may be communicated to others, to whom such information may be communicated, and under what conditions the communications may occur.

Privacy: The right of an individual to determine when, how, and to what extent his or her personal information is communicated to others.

Provider: Of an e-service is a business that operates the e-service and offers it to consumers, possibly earning fees for the use of the service by consumers.

Provider Privacy Policy: A description of provider privacy preferences, stating what personal information or PII the provider requires from the consumer, and the conditions under which the information is required, in order for the provider to carry out its service.

ENDNOTE

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Sensis Search

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BACKGROUND OF THE BUSINESS

In 2002, Sensis Pty. Ltd. was launched as a new corporate brand and company name to replace the Pacific Access Pty. Ltd., a wholly owned subsidiary of Telstra Corporation, Australia's largest telecommunication company. According to the CEO of Sensis, the name of the company, Sensis, reflects the essence of today's business—keeping people in touch through appealing to the key human senses of sight, sound, and touch, using different media—print, voice, online, and wireless (Sensis, 2002). To strengthen the strategic position of Sensis in online advertising business, the company acquired CitySearch Online and BMC Media Ad Sales, adding new lines of advertising business to Sensis. After 2 years' operation driven by an aggressive-growth strategy, Sensis has developed into one of Australia's leading advertising and search companies, offering a suite of print, online, voice and wireless products designed to bring buyers and sellers together any time, anywhere. Sensis Pty. Ltd. has a team of over 3,100 employees, among which 2,300 people are directly employed by Sensis and 800 by its wholly owned subsidiary, the Trading Post Group of companies.

Sensis' products and solutions include:

- **Sensis Search (www.sensis.com.au):** An Internet search engine that utilises some of the most comprehensive and up-to-date product and service listings in Australia, with a much greater emphasis on local and national businesses. The Web site was launched in July 2004 and used by 59% of Australians with over 5 million visitors every month according to a recent Neilsen/NetRatings (Sensis, 2004a).
- **Yellow Pages®:** With over 14 million copies in circulation, the Yellow Pages® print directories are found in virtually every home and business in Australia.
- **White Pages®:** Print and online business directories.
- **City Search®:** Australia's leading online culture and lifestyle guide, offers tailored Internet solutions.
- **Whereis®:** Whereis® products and services are the location (digital mapping) and navigation brand of Sensis Search.
- **Sensis1234:** With sensis®1234, callers can find a business (and residential listings) through a single number, whether they know the business name or not.
- **MediaSmart®:** Providing consulting services on the best sites and advertising formats to reach your target market.
- **Trading Post®:** A print and online private and classified advertisements directory for goods and services.
- **JustListed.com.au:** A new commercial and residential online real estate portal currently based in Sydney, where its inventory includes over 42,000 rental and sale properties and 1,670 real estate agents. Due to the very successful performance of the portal, Sensis plans to develop it into a national, online real estate portal.

As shown above, Sensis Search (sensis.com.au) is a key component of Sensis multiple dimensions of business and plays a central hub role in the interfaces between online and print searches of information. This article focuses on exploring the experiences of sensis.com.au and identifying key issues of its operation. Data for this qualitative case study was collected mainly from two primary sources: (a) a documentary research into Sensis's business reports, online newsletters, memos, agenda, and other official publications; and (b) an in-depth interviews with a senior manager of Sensis.com.au. The case study focuses on how Sensis has been managed, how it has succeeded, and what lessons can be learned from its experience.

Description of the Business

Sensis Pty. Ltd. launched its search engine Sensis Search (sensis.com.au) in July 2004, which constitutes all the online/electronic portfolio of Sensis Pty. Ltd. including www.whitepages.com.au, www.yellowpages.com.au, www.whereis.com, and www.CitySearch.com.au (Sensis, 2004c). By doing so, Sensis Search is able to provide Australians with fully blended search results across local proprietary and global Internet content. For example, Australians can use sensis.com.au to find a local florist anywhere in Australia and can also locate and purchase a pair of shoes in New York. The search engine provides local, commercial and global searches from which customers can get blended results from local Yellow Pages®, White Pages®, CitySearch® and Whereis® data combined with global Web content. Sensis Search is the first mover in redefining Australian search market and creates a new paradigm for Internet search that delivers relevant, quality local and global results. Sensis Search represents a "world first" amongst search engines as it integrates Internet Web page content and structured content (e.g., the Yellow Pages directory) into a "one-stop shop" for searches, unlike other search engines such as Google, where these services are available, but under different URLs. As such, searches can be performed locally, nationally, globally, and throughout the Sensis sites. The strategy to develop synergies among Sensis's businesses contributes to the success of Sensis and Sensis Search. The focus on, and pursuit of Sensis Search for, relevant, local, and quality return results herald the maturity of online search services. The success of online search is no longer measured by the volume or the size of the Internet index but by the extent of meeting specific user's search needs. Moreover, Sensis Search provides Australian users with very easy access to commercial content through Internet access. Commercial content is classified under nine categories; products, services, people, places, events, jobs, cars, houses and consumer classifieds, which might include searches of Sensis directories such as the Trading Post.

Due to the initial success of Sensis Search in managing to provide the most innovative and comprehensive online search engine in Australia, Sensis management decided to expand the business further. In December 2004, Sensis acquired one of Australia's most successful mapping and street directory businesses, Universal Publishers Pty. Ltd. The acquisition has significantly strengthened the market share and position of Sensis Search which now boasts the largest and most up-to-date database of navigable mapping content in Australia. Unlike its competitors, as one line of its business, Sensis Search provides nearly 100% geographic coverage of Australia and "its contents covers everything from urban streets, to points of interest, four-wheel drive tracks in the remote outback and smaller roads you'd never see on a normal map" (Sensis, 2004a, p. 1) said, the CEO of Sensis Pty. Ltd.. This aggressive growth strategy of Sensis through acquisition aims to accommodate the increasing demand of Australia's local consumers for localised advertising and map-based search to find local businesses, products and services. Sensis Search's digital mapping business now serves more than 18 million digital maps online every month through its Whereis® brand on the www.sensis.com.au site (Sensis, 2004a).

To survive and succeed in today's fierce competition in the search engine industry, Sensis Search pursues two complementary lines of businesses—online advertising and online search. The market share of Sensis Search online advertising has now exceeded 23% of online advertising in Australia, and meanwhile, it has seized approximately 70% of the combined search and directories market in Australia (Sensis, 2004b). In the light of the Online Advertising Expenditure Report issued by the Audit Bureau of Verification Services, the revenues from online advertising grew by 58% to AU$300 million in the 2003/2004 financial year in Australia. The stellar growth in online advertising is both an opportunity and a challenge to Sensis Search. The company develops its corporate strategy and direction focusing on local online search within Australia, thus becoming the major player in local Australia's search through providing relevant and complete, localised business information. The success in providing relevant and quality search results to meet specific user searches helps boost the online advertising business of Sensis Search as well as the entire business of Sensis Pty. Ltd.

Sensis Search, the online/electronic portfolio of Sensis Pty. Ltd., recorded a 40.7 growth for the year 2004 and 34% online usage growth for the same year (Sensis, 2004b), although Sensis's print business grew by 5.6% only compared with the previous financial year (Sensis, 2004d).

Lessons Learned

Sensis Search's experience presents several fundamental management lessons for the business operations and development of today's dot-coms and e-businesses. This section examines and explores these lessons.

First, the success of Sensis Search is one of combined innovation and entrepreneurship in the e-business world (thus called *e-innovation* and *e-entrepreneurship*). Today's e-business operates in a highly competitive marketplace where sustainable competitive advantage is almost impossible as there are minimal barriers to new entrants and competitors in the marketplace. Innovation faces constant challenges of imitation and erosion. There have been different views in the literature about the benefits of first movers in e-business marketplace. Mellahi and Johnson (2000, p. 445) asked the question "does it pay to be first to market or should e-commerce firms wait for first movers to make an investment and then cannibalize the idea with lower entry cost?" The cause of the concerns are raised by a general belief that it is safer and less expensive to imitate the first mover in the e-business environment, where there is a higher level of technical uncertainties and rapid rate of technological innovation. For instance, many new dotcoms rushed to build an e-marketplace and chose imitation as a business strategy rather than innovation. This author argues that it is the lack of a combination of innovation and entrepreneurship capacity that has caused the demise of many imitators in the dot-com industry. The essence of innovation and entrepreneurship is taking a new idea to market, not imitating a new idea without taking into account the special needs of local markets, and being innovatively and proactively responsive to environmental changes by introducing a new product, process, service or implementing a distinctive business model. Sense Search's success has clearly been contributed by the first mover advantage (being the first company in the world that took its directory products online).

Both empirical and theoretical studies show that innovation interacts with entrepreneurship to achieve business success (Kanungo, 1999; Drucker, 1994; Zhao, 2005). The key elements of entrepreneurship include risk-taking, proactivity, and innovation (Miller, 1983). However, Slevin and Covin (1990) argued that the three elements are not sufficient to ensure organisational success. They maintained that "a successful firm not only engages in entrepreneurial managerial behaviour, but also has the appropriate culture and organisational structure to support such behaviour" (p. 43). Thus, there is clearly overlapping and interdependence between entrepreneurship and innovation. Both are needed for firms to be successful and sustainable. Furthermore, entrepreneurship is related to the development of new products and services. Innovation is sometimes not necessarily related to new products but concerns doing something differently and better. Although entrepreneurship is related to working with new products and services, it is not necessarily about doing things better. Innovation however, is about doing something better by doing it differently. As such, entrepreneurship carries extra financial and risk issues because of the newness of the venture. According to the experience of the company's senior manager interviewed for the present study, there are no conceptual and/or practical differences in terms of online and offline entrepreneurship and innovation. The approach is the same, regardless of the online or offline environment, although the skill set required is obviously different. The company believes that entrepreneurship and innovation are crucial to their success and innovation should be inculcated into the organisational culture, and is developed internally. It includes encouraging staff to interact with customers, and undertake research and development. Sensis Search is not only an entrepreneurial company in terms of its aggressive growth strategy but also a pioneer of innovation. Sensis has claimed to be the first company in the world that took its directory products online. Sensis Search has identified seven factors, which it believes drive innovation, and which it has subsequently applied to all new product areas:

1. clear vision communicated throughout the company;
2. development of a culture of innovation—through rewarding people and taking calculated risks;
3. an organic organisational structure—rather than having a central group of IT managers, producers and product managers, each product unit employs their own staff with their own responsibilities and P&L statements;
4. job role clarity;
5. accountability and responsibility;
6. clear key performance indicators (KPIs); and
7. sufficient funding, realistic revenue expectations and people positively motivated.

The entrepreneurship strategy that Sensis Pty. has taken is actually that of an intrapreneurship, that is, entrepreneurship within an organization. Sensis's story indicates that development of entrepreneurship and innovation should be dependent on the size of the company. For instance, the Sensis group includes large, established companies such as Yellow Pages®, and the much younger and relatively smaller Sensis Search. Yellow Pages® is built on an established, traditional business model, whereas the Sensis Search approach is entirely different. As such, there is a need to separate the companies, and to allow new business units within the group to "quarantine space," where they can grow (within set timeframes), using different people, with different rewards, finances etc., rather than trying to fit in with the old models.

Second, Sensis Search can be viewed as a successful start up of a new generation of dot-coms that are more mature in terms of business models and information technologies, focusing more on justification and accountability of business processes and outcomes than on a "can-do" mentality only. The post-2000 e-business successes generally tended to be those that were first to market, and which were sufficiently funded to weather the crash. These companies also managed to maintain their people and stay sufficiently focused on their core strategies, rather than diversifying too greatly. Therefore, they have distinctive features from their counterparts in the earlier days of e-commerce. In hindsight, e-commerce failures tended to be the Me2 brands, which were merely copying existing, successful e-commerce models under the premise of "build it and customers will come," wholly failing to recognise the power of established branding.

Sensis Search is Australian-based, but competes against global giants such as Microsoft, Yahoo, and Google. As such, they have identified two ways by which they can be competitive. The first is by providing a higher amount of business and commercial content and the second is by having good relationships with global partners in order to deliver their solutions in the most efficient and cost effective manner. For instance, Sensis Search has partnered with Fast, a Norwegian company specialising in algorithmic search technology which powers the Sensis Search engine. It has continued to achieve strong growth and to develop leading edge online search solutions for Australians. It offers its advertisers the opportunity to put their companies' existing print content online at little or no additional cost. For example, businesses do not need to have a Web site to be found on sensis.com.au but simply be listed on the Sensis's Yellow Pages® Online site.

Third, successful dotcoms require sufficient funds and people skills, as well as adherence to the seven-step innovation model cited above. Sensis Pty has made significant investment in developing its online/electronic dimension of its business as a long-term corporate strategy. Generally speaking, there appears to be a shortfall in people with specific expertise in e-commerce in Australia. This may be because international demand is high and it takes time for the right skills to be taught in universities. The shortage in human resources and skills remains a significant barrier to online entrepreneurship and innovation in Australia. Sensis believes that retention of staff is a very significant driver of innovation and as such they have developed reward systems which will commit their people to the company, and offer them recognition, training and opportunities. The company has also developed relationships with universities, and regularly engages speakers to address staff.

Other lessons learned from Sensis Search are also fundamental. According to the Sensis's CEO, the key factors contributing to the company's success are Sensis's continued focus and commitment to its people and customers. Survey data showed that its customer satisfaction improved 10% in 2004 and its employee satisfaction has continued to rate up to 10% higher than the Australian average with regard to key satisfaction measures (Sensis, 2004d). In addition, there is a need to be realistic (particularly if the company is competing against established players), and to identify what differentiates the company from its competitors, and the sustainability of that differentiation. Further, companies should also have firm milestones, which can be derived from a user point of view, customers, brand recognition or advertising, with which to gauge the progress of their investment. Finally, a calculated risk assessment is crucial to an online business. Companies should know when to let go, or substantially change their model or sell it to others in order to go to the next level.

The overall improvement of economic conditions worldwide in 2003 and 2004, and the recovery of investors' confidence in high-tech and e-business industries have refuelled the growth of e-businesses. Indeed, the public interest in Google's IPO launched in August 2004 is an indicator of the recovery. After two days trading, Google's share price jumped 27% and the company's value (around US$29 billion) equalled that of the Ford Motor Company (Wood, 2004). According to the projection made by Forrester Research, online sales will grow at a year-over-year pace of 19% to US$225.9 billion in 2008 in the United States. Further, the number of online shoppers will also increase significantly and nearly 5 million new United States households will shop online every year (*TechWeb News*, 2003). The mega economic environment entails a positive and promising future for e-business although there are many challenges and hurdles that need to be surmounted. There is clear evidence as provided by companies like Google, Yahoo, and Amazon as well as the case company of this study that e-innovation is alive and well. Consumer behaviour has changed, and people are more likely to accept new Internet technology than 5 years ago. E-entrepreneurship and e-innovation will help an e-business get to the stage where they are profitable and sustainable.

However, dotcoms are also facing greater challenges than ever. First, dot-com industries need to achieve sustainability, due to a more uncertain economic environment and the increasing complexities of new technologies and a more globalised economy. Second, the business success and fast expansion of Amazon.com, Dell, travel.com and the like through e-business partnerships reinforce the value of strategic alliances. Corporate e-partnerships will be a crucial factor and play a key role in the future development of e-business activities. In the frenetically changing competitive landscape of today's business world, few organizations can rely only on their internal strengths to gain a competitive advantage in national and/or international markets. Continued expansion to global markets will push more international dotcoms to form strategic alliances in e-business. Yahoo!, Google, eBay, and E*trade provide good examples of global expansion using alliances with local e-businesses worldwide for smaller players who will follow the trend to go global. Finally, the key principles of total quality management will be the fundamental cornerstone to e-business success, which include customer focus; and continuous improvement and measurement to achieve customer satisfaction. The failure of many e-businesses and the dotcom crash have on the whole been caused by poor quality customer services and support, problems with Web site security and technologies, and weaker change management (Janenko, 2003).

Future research could focus on

- the complex, dynamic, and sophisticated structures under which e-business can operate;

- identification of the e-business networks and relationships that are most likely to succeed, and how they succeed;
- the specific nature and characteristics of the operations of dotcoms in different industry sectors and in different country settings;
- the impact of specific e-business technological innovations on specific functional areas of e-businesses; and
- the effectiveness of the current technological trend of "one size fits all" e-business solutions built on 'industry best practices' for e-business.

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Category: Concepts, Trends, and Challenges

Service–Oriented Architecture

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INTRODUCTION

The established global business environment is under intense pressure from Asian countries such as Korea, China, and India. This forces businesses to concentrate on their core competencies and adopt leaner management structures. The coordination of activities both within companies and with suppliers and customers has become a crucial competitive advantage. At the same time, the Internet has transformed the way in which businesses run. As the Internet becomes a cheap and effective communication channel, businesses are quick to adopt the Web for integrating their systems together and linking them with their suppliers and customers. Current enterprise computing using J2EE (Java 2 Platform, Enterprise Edition) has yielded systems in which the coupling between various components in them are too tight to be effective for ubiquitous B2B (business-to-business) and B2C (business-to-consumer) e-business over the Internet. This approach requires too much agreement and shared context between business systems from different organizations. There is a need to move away from tightly coupled, monolithic systems and toward systems of loosely coupled, dynamically bound components. The emerging technology, Web services, provides the tools to accomplish this integration, but this approach presents many new challenges and problems that must be overcome. In this article, we will discuss the current approaches in enterprise application integration (EAI) and the limitations. There is also a need for service-oriented applications, that is, Web services. Finally, the challenges in implementing Web services are outlined.

BACKGROUND

The advancement of computing in the past decade results in enterprise computing being distributed in a heterogeneous environment: computers ranging from mainframes to PCs (personal computers; including top-of-the-line 64-bit processors and outdated 386s) and running two or three different operating systems, database software from different vendors, and a variety of servers. On the other hand, the Internet changes the way that businesses run. The converging mobile and wireless technologies enable mobile users to access the Internet anywhere with broadband. The Internet becomes an indispensable and cheap communication medium and the backbone for enterprise application integration.

Developers have to put a lot of effort and resources in integrating new applications with existing ones, as well as getting existing applications to communicate with one another while keeping the number of changes to these applications to a minimum. Typically, this kind of integration is called EAI. The Java 2 Platform, Enterprise Edition and Microsoft .NET both address the need for making existing applications and business processes available on the Web in a robust, secure, and distributed transactional way. J2EE is platform independent while .NET is limited to Windows-based platforms. In addition, J2EE provides a connector, Java 2 Connector, to integrate with legacy systems such as IBM CICS (Customer Information Control System) for mission-critical applications. However, the choice really depends on the existing infrastructure of a company: Windows-based or multiple platforms. Here, J2EE is used to illustrate the operations and the limitations.

J2EE has a number of applications models (Graham et al., 2005).

- Thin client-browser-based applications use servlets and Java server pages in the Internet environment.
- Thick managed application clients use RMI-IIOP (remote method invocation run over Internet inter-orb protocol) to communicate with server-based

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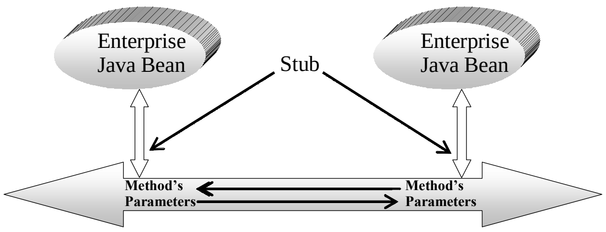
Figure 1. Java RMI architecture



EJBs (Enterprise Java Beans) components. This is applied in the intranet, which provides the extra infrastructure that allows Java programs to directly access EJBs within the intranet domain.

- Messaging applications use the Java message services to act on messages in queues or from subscriptions.

The first two models require a tight coupling between applications. Coupling is the strength of interconnection between two software modules: The higher the strength of interconnection, the higher the coupling (Wijegunaratne & Fernandez, 1998). Loosely coupled systems make it easier for the developer to modify as he or she can maintain one module without having to know very much about any other module in the system. If two modules are highly coupled, then there is a high probability that a programmer trying to modify one of them will have to change the other. The tight coupling in J2EE is due to the stubs. Figure 1 shows the Java RMI middleware. A Java application is composed of a number of components, called Java Beans, distributed across a network. The stub is used to connect to the middleware and transfer activation parameters from the component to the network. In such a way, components can be exchanged for other components, and this allows code mobility. However, any change in the application will be done in the stub in each component due to the tight coupling.

The third model is based on messaging called message-oriented middleware (MOM) and is asynchronous by nature (Serian, 2002). MOM sends messages from one application to another using a queue as a temporary storage area. The queues reside in the middleware layer and do not require a direct connection to the retrieving applications. Furthermore, applications can retrieve the message from the message queue at anytime and in any order. Figure 2 shows message-oriented middleware's architecture. The implementation involves the communication code only and reduces the involvement with the *complexity* of the distributed mechanism. Since the application code is not involved, each application code is independent of each other; that is, there is a decoupling. Conclusively, J2EE is not applicable for dynamic e-business environments where services are called on demand.

THE NEED FOR A SERVICE-ORIENTED ARCHITECTURE

Businesses are under intense pressure. First, customers are like butterflies. As they are well informed in the digital era, they are smart in shopping around and their preferences are changing. Customers are no longer loyal to the same business. Second, the emerging industrial nations in Asia such as Korea, China, and India are posing a threat.

Figure 2. The message-oriented middleware's architecture

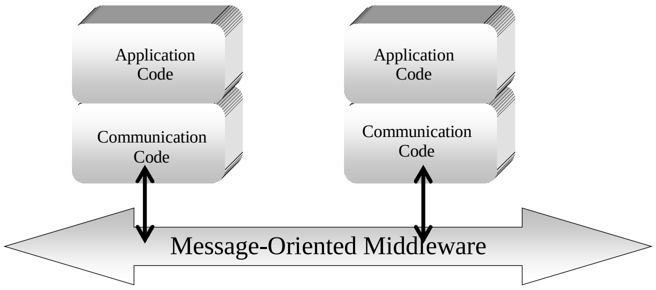


Figure 3. The coordination activities of business

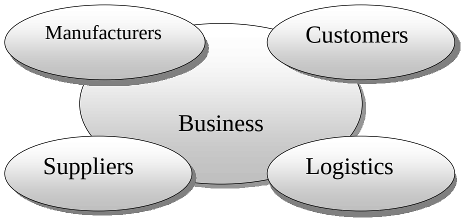
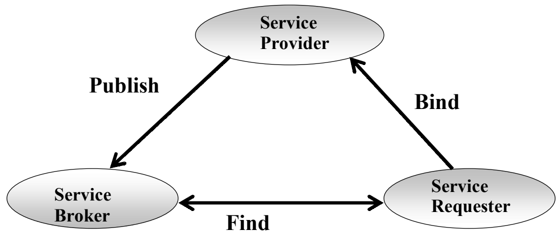


Figure 4. Service-oriented architecture



Businesses have to compete dynamically. This forces businesses to concentrate on their core competencies and adopt leaner management structures. Businesses have to coordinate the activities of suppliers, manufacturers, and customers in a global environment (Figure 3). Partners come and go dynamically. From the discovery of new partners to the integration of other entities, dynamic e-business has evolved from human-to-application (H2A) to application-to-application (A2A) exchanges (Zimmermann, Tomlinson, & Peuser, 2003) in which there is no human involvement. A service-oriented architecture (SOA) provides the framework for dynamic e-business with the following characteristics:

- Quick response time to customers, suppliers, and business partners;
- Redefinition of operations dynamically according to the changing business environment; and
- Automatic discovery of service interfaces and implementations.

To achieve SOA, the integration layer must be independent of any specific implementation languages, the transport protocol, the operating system, and the platform, and has to be supported by open standards. Furthermore, no human is involved at run time. It is programmed automatically, not manually. The current approaches in EAI using J2EE and .NET are made up of tightly coupled applications and subsystems. A change to any one subsystem can cause breakage in a variety of dependent applications.

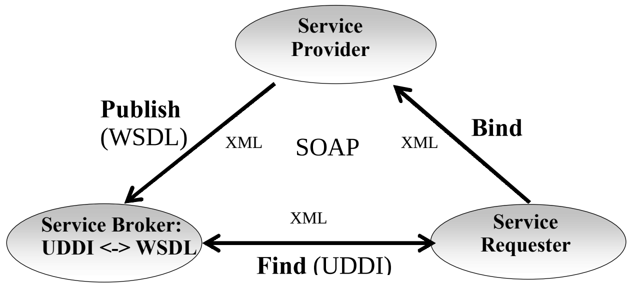
SOA is based on the assumption that an application can be partitioned into fragments of business processes, called services. Each service exposes a well-defined interface, which is accessible over the network (Figure 4). Hence, SOA applications are much more flexible, easier to integrate with, and simpler to maintain than classic monolithic applications such as EAI using J2EE or .NET. Web services provide a simple interoperability platform for SOA and a formal way to describe service interfaces (Pezzini, 2004). The Web-services technology meets the overall requirements.

A Web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically, WSDL [Web services description language]). Other systems interact with the Web service in a manner prescribed by its description using SOAP (simple object access protocol) messages, typically conveyed using HTTP (hypertext transfer protocol) with an XML (extensible markup language) serialization in conjunction with other Web-related standards (Booth et al., 2003). Hence, Web services are architectural and a technology solution for connecting distributed applications in SOA. Web services make use of several standards such as the following (Gisolfi, 2001).

- **XML:** The extensible markup language is used as a language for defining data-descriptive languages, such as markup grammars or vocabularies, and interchange formats and messaging protocols.
- **SOAP:** The simple object access protocol is an XML-based lightweight protocol for the exchange of information in a decentralized, distributed environment.
- **WSDL:** The Web services description language defines the characteristics of the service including the location of the service and how to access it. The service provider publishes its interface contract in the form of a WSDL document.
- **UDDI:** The universal description, discovery, and integration specification provides a common set of SOAP APIs that enable the implementation of a service broker.

Figure 5 shows the implementation of SOA with Web services. The service provider publishes its interface contract in the form of a WSDL document. Service requestors locate services by using a service registry, UDDI. The UDDI server contains the database of service descriptions and provides them to the service requestor's application. The requestor uses the WSDL document to

Figure 5. The implementation of SOA with Web services



understand the interface contract with the Web service. Using the information in the WSDL document, the requestor will understand how to access the service, what methods it has, and what parameters need to be sent, among other things. Web services simplify the business process without the involvement of humans. For example, when an employee books a flight, he or she fills in the desired flight time. Then a personnel staff will surf the airline-flight Web server and book the ticket as there is no integration between the company's travel request and the airline's flight reservation. Through the Web service, the two services are integrated and the process is automated.

THE CHALLENGES OF WEB SERVICES

Web services are a simple, programming-language-neutral, and interoperable communication technology. Web services are available today at low initial costs and minimal risk. Many business scenarios such as EAI, B2B, and common services can be supported as comprehensive and mature tool support is available; huge productivity gains can be realized (Zimmermann et al., 2003). However, since the introduction of Web services in 2001, the deployment rate is poor. First, security is a critical issue. In transforming EAI built by J2EE to Web services, a developer has to move the stubs written in Java, which act as glue among applications to XML. XML forms the basis for distributed system protocols to integrate applications across the Internet. XML languages are text based and provide a structured way to add context to data so that they can be shared among different applications. XML is primarily for Internet-based communications; thus, it provides the opportunity for others to sniff or spoof information. Integrating more applications and resources implies an increased degree of exposure to access that has not been possible (Brose, 2003). Furthermore, standard security functionalities such as authentication, authorization, privacy, and nonrepudiation are mostly incomplete.

Second, the interaction among applications in Web services is automatically generated. If things go wrong, it is hard to debug. Third, Web services are emerging standards that are still under development. The specifications are being developed by different standards bodies without a unifying authority. While there was a good deal of agreement in the first phase of basic Web-services protocols, there is a significant rift between backers of different reliable messaging proposals, pitting IBM, Microsoft, BEA Systems, and their technical partners against Oracle, Sun Microsystems, Hitachi, and others. Tim Bray, coinventor of XML and director of Web technologies at Sun Microsystems, said recently that Web-services standards have become bloated, opaque, and insanely complex (LaMonica, 2004). Businesses have to be cautious when embracing Web-services technology and the standardization process. IT industries must reconcile their differences to achieve unified standards in Web services.

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KEY TERMS

Coupling: Used to measure the extent to which interdependencies exist between software modules: The higher the interdependencies, the higher the coupling. It implies that if you want to reuse one component, you will also have to import all the ones with which it is coupled.

Enterprise Java Beans (EJBs): Components of distributed transaction-oriented enterprise applications. EJBs execute within an *EJB container,* which in turn executes within an *EJB server.* The EJB container is where the EJB component resides. The EJB container provides services such as transaction and resource management, versioning, scalability, mobility, persistence, and security to the EJB components it contains. Since the EJB container handles all of these functions, the EJB-component developer can concentrate on business rules, and leave database manipulation and other such fine details to the container. It automatically stores the contexts of the calls made by the user and can make the connection between several calls coming from the same user (Johnson, 1998).

Extensible Markup Language (XML): Describes a class of data objects called XML documents and partially describes the behavior of computer programs that process them (Bray et al., 2004).

Message-Oriented Middleware (MOM): Asynchronous by nature. MOM sends messages from one application to another using a queue as a temporary storage area, like e-mail.

Middleware: The wide range of services layered between the applications and operating systems that provide specialized services and interoperability between distributed applications. The services consist of transaction-processing monitors, remote procedure calls, message-oriented middleware, and object request brokers.

Remote Method Invocation run over Internet Inter-Orb Protocol (RMI-IIOP): Like CORBA (common object request broker architecture), RMI over IIOP is based on open standards defined by the Object Management Group and uses IIOP as its communication protocol. IIOP eases legacy application and platform integration by allowing application components written in C++, Smalltalk, and other CORBA-supported languages to communicate with components running on the Java platform (Sun Microsystems, 2004).

Service-Oriented Architecture: Essentially a collection of services. These services communicate with each other. The communication can involve either simple data passing or it could involve two or more services coordinating some activity. Some means of connecting services to each other is needed.

Stub: Used to connect to the middleware and transfer activation parameters from the component to the network. For instance, the client stub marshals the parameters and packs them up with the procedure identifier to a message, sends the message to the server, and then awaits the reply message, unmarshals it, and returns the results (Coulouris, Dollimore, & Kindberg, 1999).

Web Services: Web-based enterprise applications that use open, XML-based standards and transport protocols to exchange data with calling clients.

Service–Oriented Architectures and Virtual Enterprises

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INTRODUCTION

This article presents some trends in e-commerce technology and more specifically the service-oriented architectures (SOA) and its interoperability promise applied to innovative organization schemes such as virtual enterprises (VE). The evolution of software architectures from traditional to SOA is presented through comparison of characteristics, advantages and disadvantages, and problems and difficulties in applying the SOA, while also focusing on the compatibility between SOA and modern organizational structures. The main focus is on the SOA technology trends of modern organizational structures with regards their formation and integration. The comparison between SOA and traditional Architectures provides a clear path to their adoption in various cases.

BACKGROUND

Service-oriented architecture was first introduced by Gartner, Inc. (1996) as:

> *...a software architecture that starts with an interface definition and builds the entire application topology as a topology of interfaces, interface implementations and interface calls. SOA would be better named* interface-oriented architecture*. SOA is a relationship of services and service consumers, both software modules large enough to represent a complete business function. Services are software modules that are accessed by name via an interface typically in a request-reply mode. Service consumers are software that embeds a service interface proxy (the client representation of the interface).*

SOA has since excited many software architects and developers but only recently with the advent of Web services, SOA has found its route to real applications. Other technologies have been tried in the mean time but undoubtedly Web services is the most prominent technology that forms a solid base to develop robust SOA applications. Web services are defined by Gartner (Plummer, Blosch, & Woolfe, 2002) as: "modular business services with each module fully implemented in software and delivered over the Internet. The modules can be combined, can come from any source, and can eventually be acquired dynamically and without human intervention when needed."

Web services and SOA are complimentary technologies that represent the most recent step in the evolution scale, which started with distributed programming and object distribution technologies like CORBA, COM/DCOM, DCE and more recently J2EE. Web services represent a technology specification—meaning that an application must use its standards like Web services description language (WSDL), simple object access protocol (SOAP) or Universal Description, Discovery and Integration (UDDI) to be considered as Web services. SOA on the other hand is more considered as a design principle (Natis, 2005) meaning that Web services interfaces like WSDL (WSDL) and SOAP are suitable interface definition standards (UDDI, 2001; WSDL, 2001; SOAP, 2001; Atkinson, 2002; IBM, 2001).

SOA has an inherent ability to apply itself efficiently across enterprises, being the most promising technology to form and operate virtual enterprises where different economic organizations are combining their strengths (and thus minimizing their weaknesses) to provide a specific service traditionally provided by a single enterprise. Such a development will offer, in the long term, immense influence on the economy and enterprise development strategies. The availability, through SOA on the Internet, of standardized SME information, relevant for participating in virtual enterprises, will dramatically multiply the number of business opportunities transformed into successful business ventures. The most important requirements for virtuality in virtual enterprises are (Protogeros, 2005):

1. **Visibility Across the Virtual Enterprise:** There is a need to have an overall visibility on the entire life cycle of the products and/or services produced, starting from its development to its launch into the market. Such a visibility must be permitted to all the companies' personnel involved in the virtual enterprise operation and in particular to the Project Managers that often, in the traditional supply chain, cannot adequately follow the development of im-

portant sub-systems, which are supplied by a sub contractor.

2. **Consistent and Uniform Business Model:** Gou, Huang, Liu, and Xiu (2003) define a business process of a virtual enterprise as a set of linked activities that are distributed at member enterprises of the virtual enterprise and collectively realize its common business goal. A uniform business model is very important for the viability of the virtual enterprise. It should support the evolution of the product, process and organization according to the increasing detail of the attributes representing the same concept (e.g., the status of an order, the categorization of the order, the customer contact information, the customer account representation, etc.) in a consistent manner.
3. **Consistent Co-Operative Process and Data Model:** The data model of the companies can capture various behavioral semantics of the business entities. Thus it is not sufficient to have just a consistent conceptual business model of the business entities for smooth operation (Setrag, 2002). Data semantics and operational behavior must also be represented and applied consistently.
4. **Uniform Organizational Model:** The organizational view of enterprises captures information about departments, roles, employees, partners and entire organizations. The organizational model of the virtual enterprise should encompass ownership, privileges and responsibility of messages, documents, and activities that are involved in the processes of the virtual enterprise. It also has to involve extensive security as well as personalization requirements. Virtual enterprises can be thought of as an aggregation of processes. Thus processes use information, operations, roles, and sequencing of tasks to carry out specific objectives in the virtual enterprise.
5. The large diversity in business practices reflected in the plethora of monolithic and legacy applications, along with the huge gaps in business scope and differences in working standards between the large enterprises and the SMEs make the integration process for virtual enterprises a real headache for analysts and developers. SMEs significantly contribute to the value chain by supplying to large enterprises the equipment and subsystems required. In Europe, for example, where a large number of SMEs exist, the need for harmonizing the large and small/medium enterprises business approach and practices has been pointed out several times at European Community level. Technology should support the four main phases of a virtual enterprise life cycle [200], which are: creation/configuration, operation, evolution and dissolution. By now a large number of projects are addressing various aspects of infrastructures for virtual enterprises including NIIIP (NIIIP), PRODNET II (Camarinha-Matos & Cardoso, 1999), VIRTEC (Bremer, 1999), Co-OPERATE (Azevedo, Torscano, & Sousa, 2002), and BIDSAVER (Protogeros, 2005). Some of them are developing Service based reference architectures for example the NIIIP.

SOA TECHNOLOGY AND STANDARDS

In recent years a new trend has appeared related to the reuse of old applications in new type user-transactions. This style, being an alternative to the development of purely new applications, is known as composite development. In 2003 the majority of new business applications developed were composite applications (Natis, 2005). In taking that approach, wrappers are developed around legacy or other functionality that assemble those components into heterogeneous composite transactions. SOA is the natural place were these types of composite components fit together. From an industry and standards perspective, SOA technologies are quite advanced. All major software vendors have at least some level of support for Web services in their products, providing Web service technologies broad industry support. On the other hand, the baseline standards underlying Web services—XML, SOAP, and WSDL—are stable and mature since they have been used for many years now (since 1998, 2000, and 2001 respectively). According to Gartner Group, these standards have reached the “plateau of productivity,” a term Gartner applies to technologies whose value is demonstrated and accepted.

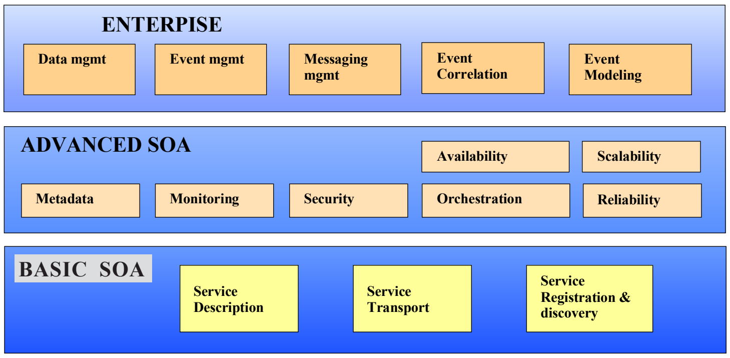
An important step towards interoperability in SOA is the formation of the WS-I—the Web Services Interoperability Organization—an organization driven by vendors. This organization’s role is to assure that the “common language” of Web services (and the entire supporting infrastructure around it) is interoperable among implementations.

The WS-I has published a “basic profile” which describes how to build and use the base Web services standards to ensure interoperability. In addition, a version of the “security profile” has also been published.

Can SOA Be the Key Driver of Virtual Enterprise Integration?

Ashkenas, Ulrich, Jick, and Kerr (2002) described the emergence of the “Boundaryless Organization” that in-

Figure 1. Functional elements of service-oriented architecture



creasingly requires organizations to consider four boundaries; vertical, horizontal, external, and geographic, in determining the shape of their enterprise. Web service environments can support horizontal integration by delivering the standardized technological infrastructure that will enable organizations to more effectively share knowledge and collaborate within and beyond organizational boundaries (Estrem, 2003). Typical benefits that SOA brings to virtual enterprise IT are:

1. **Interoperability:** Through the addition of a thin and transparent layer to existing software, Web service–enabled components can communicate with each other via a platform-independent messaging protocol. This ability completed by a semantic interoperability, will enable two Web services to interact with each other despite their semantic differences. Only with semantic interoperability could different applications in members of a virtual enterprise build a composite application that exchanges data with each other's business systems.
2. Web services can provide the infrastructure that would support virtual enterprise relationships (Estrem, 2003). This would provide the flexibility and agility that could support manufacturing approaches by reducing the complexity and driving down the transaction costs associated with outsourcing and extended value chain operations between principals and their agents. The ability to dynamically integrate functions that are spread across the value chain would reduce the time, cost, and complexity associated with establishing the relationships needed to support virtual business processes.
3. **Incremental and Flexible Development and Deployment:** Conventional monolithic IT systems apply many technologies and exchange data and requests via multiple connections. The resulting dependencies between systems are so numerous that system reconfigurations—for example, to support a new business requirement—are often extremely time consuming. Tight coupling between applications may render conventional architectures so fragile that changes become prohibitively complex. SOA, in contrast, is much more flexible. Web services present many new potential opportunities to significantly reduce the complexity and costs of enterprise computing for developing and maintaining e-business applications (Huang & Chung 2003)
4. **Low-Cost Development of New Business Processes:** In the traditional software development process, translating requirements into working distributed systems is both time-consuming and difficult, requiring several stages of manual development and deployment. This complex, error-prone task can be effectively streamlined using a higher-level, component-based SOA architecture. SOA's components ease of development considerably lowers total development costs. Development of new business solutions for the virtual enterprise is reduced to an assembly of service components that do not require the in-depth technical skills when coding solutions from scratch.
5. **Easier Version Control and Dynamic Configuration Management:** SOA permits fine-grained control over deployments across the virtual enterprise. Components within a process can be easily replaced by new or updated components, further reducing the time taken to modify or change an existing process in response to business requirements.
6. **Clarity of Application Alignment:** Traditional application design bound by conventional architectures has pursued a technology-driven approach to the automation of the enterprise's business

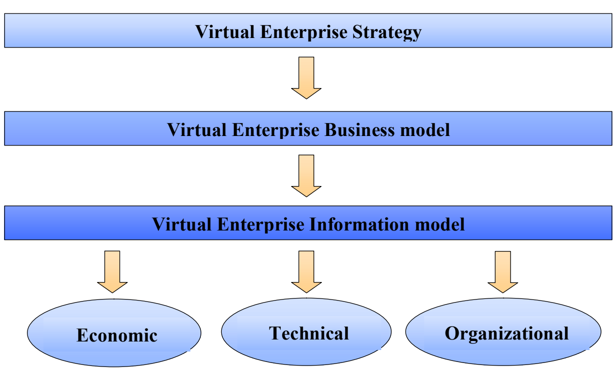
processes. Under SOA the emphasis is given to a business solution–driven approach where created services are more meaningful and hence more accessible to business users. This approach shifts effort to a much closer alignment between the IT function and virtual enterprise member companies' business units.

Interoperability is the key issue for virtual enterprise operation but the use of Web services is not a panacea. A lot of management and security challenges come up when dividing up monolithic applications into collections of distributed services. As many early adopters have discovered (Actional Corporation, 2004), XML firewalls and Web services management products are necessary to preserve anticipated return of investment (ROI) and resolve the many infrastructure issues appearing such as security, routing, versioning, provisioning, and transformation of Web services. The most important challenges fit into three contexts which are: economic, technological, and organizational (Estrem, 2003) Figure 2.

Standards do not guarantee interoperability. This is particularly true in software development and SOA where standards are designed to support many different uses across many different types of organizations. In the security standards for example, many different types of credentials are allowed related to the way a user is identified (e-mail, username, digital certificate, etc.) If both the sender and receiver do not understand the same types of credentials then they cannot communicate. Thus there is an obvious need to agree on specific subsets of standards narrowing down the available options via policies and procedures.

SOA components can be developed by different teams of developers, each of which focus only on their specific functions. In such a development model none has visibility into all of the moving parts that make up their overall application. This scenario is even worse in virtual enterprise integration development where services are owned by different companies. This has a number of implications. For example, how does an application team ensure visibility across the services owned by various enterprises across a virtual enterprise and how in that case can they ensure that their overall application is secure? If their application will be exposed to partners and customers via the internet, how do they ensure that the services they use are not vulnerable to malicious attacks aimed at stealing or corrupting information? Further, who has a truly global view of all the interrelated services that are driving the member's applications overall? Who dictates security and business policy as it relates to shared services?

Figure 2. Virtual enterprise framework



Economical Context

The valuation of Web services in the virtual environment is a multidimensional problem. While the analysis must include economic and financial factors, other factors must be considered as well. In recent years, strategic cost management methods such as total cost of ownership (TCO) have been employed as a means of evaluating information technology investment alternatives (Ellram & Siferd, 1998). However, Daghfous and White (1994) have showed that making decisions solely based on narrow differences in financial measures such as ROI, TCO, or payback period, could result in erroneous decisions. Instead, they suggested that an innovative technological concept, such as Web services, be evaluated in four dimensions: inventive concept, embodiment merit, operational practice, and market dynamics.

With traditional business applications or SOA development for internal use to the organization, it is easy to estimate the initial implementation cost and ongoing operational and maintenance costs and thus the pricing policy. However, who pays for a service shared by many applications in various organizations participating in a virtual enterprise? A possible payment scheme would be that each line of business pay proportional to their use—those who use it most should pay the most. Essentially this is a transfer pricing model. However the problem in such a case is how to track usage by each line of business—if you cannot measure usage, how can you charge for it!

Organizational Context

Web services are easier than previous generations of distributed computing innovations (Estrem, 2003). However, the dimensions of transformation and exploitation will be more challenging. According to Zahra and George (2002), transformation relates to the organization's capability to harvest and incorporate knowledge into its operations, combining the newly acquired and assimilated innovation with existing organizational knowledge. Organizations that can successfully exploit Web services to transform their business processes could achieve significant competitive advantage. However, this process will require significant organizational learning and change. In order to provide more functional frameworks, researchers have found that Web services can be combined with agent technology. Hao, Shen, and Wang, (2005) propose a virtual enterprise framework which permits VE operation in a more flexible, scalable, and interoperable way. This framework is based on Web services and agent technologies which are combined to provide an integrative solution for enterprise collaboration.

FUTURE TRENDS

Virtual enterprise integration and operation will greatly depend on Web services and SOA standards adoption from a corporate perspective. How is corporate adoption progressing? An IDC's study from 2003 (just a few years after the SOA standards appeared) shows that among large organizations (those with more than 1000 employees), 96% were actively pursuing Web services technologies. Of these organizations, 50% already had at least one Web service project in production, while the remaining 50% were either evaluating or running pilots with the technologies. Of the organizations with Web services in production, 81% had more than one Web service project in production.

Given that trend, it is safe to assume that the adoption of Web services and SOA has progressed even further than these figures indicate. Organizations are embracing these standards (Ziff Davis Media Custom Publishing, 2004) and deploying Web services for many internal projects and sometimes modern organisation schemes like virtual enterprises. However, most organizations and specifically SMEs have yet to fully capture the value available to them through a strategic use and reuse of services through a service-oriented architecture. SOA's true value escalates when organizations harness the economies of scale of consolidation and reuse. When an organization moves from ad hoc use of collections of Web services to a more formalized SOA, the value of those services rises dramatically (Actional Corporation, 2004).

CONCLUSION

Clearly, projects deployed with Web services and SOA can achieve an important level of business process abstraction. The interoperability and integration issues can successfully be addressed through SOA. The experience on projects addressing the interoperability issue between organizations is very positive according to Gartner and IDC research.

However, there is work to do, specifically to the wider standards adoptions between medium and small enterprises. The lack of custom tools drives developers to manually recode services or provide "glue code" so that they can interconnect with one another. Such painstaking labor deprives SOAs of much of their virtue—namely, rapid integration and composite application.

Wider virtual enterprise models acceptance tightly connects with the ease of integration at the business process level, and this in turn relates closely with SOA acceptance and adoption. This cohesion makes us more optimistic about the future of virtual enterprises.

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KEY TERMS

Business Process (of a Virtual Enterprise): A set of linked activities that are distributed at member enterprises of the virtual enterprise and collectively realize its common business goal.

Service-Oriented Architecture: A software architecture that starts with an interface definition and builds the entire application topology as a topology of interfaces, interface implementations and interface calls

Service Consumers: Software that embeds a service interface proxy (the client representation of the interface).

Services: Software modules that are accessed by name via an interface typically in a request-reply mode.

Software Agents: Pieces of code that present some unique characteristics like autonomy, collaboration and learning.

Virtual Enterprise: Set of economic actors, mainly enterprises, that combine their strengths to provide a specific service traditionally provided by a single enterprise.

Web Services: Modular business services with each module fully implemented in software and delivered over the Internet. The modules can be combined, can come from any source, and can eventually be acquired dynamically and without human intervention when needed.

Simulation Technologies for Enhancing Citizen Participation

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INTRODUCTION

In the first decade of the 21st century, citizenship is increasingly channeled into and organized through digital communications and experiences (Center for Technology in Government, 1999; Fountain, 2001; Larsen & Rainie, 2002). This article presents an overview of a set of new information technologies—online modeling, simulation, and decision-support technologies that have the potential to transform the way citizens understand complex issues and communicate that understanding to fellow citizens and governmental decision makers.

Those who have thought deeply about democracy and technology tend to understand that new technologies often possess both beneficial and detrimental traits. These traits are also likely to occur with respect to simulation technologies for citizen participation (Shapiro, 1999; Sunstein, 2000). Whether simulation technologies will ultimately be more beneficial than detrimental will ultimately be determined by how the next generation of simulation designers do their jobs. One purpose of this article is to identify factors that these designers should consider.

What defines and makes simulation technologies unique is their ability to act as a new mode of communication. Models, simulations, and decision-support technologies communicate as much through experience as they do through any direct effort to convey a specific message. As Marshall McLuhan (1967) suggested, things are different when the medium becomes a major part of the message. In the case of models, simulations, and decision-support technologies, the medium can be much more than the video presentations that McLuhan identified as having such an impact on our culture. Specifically, these technologies can exist as entire miniature worlds of experience and can possess features that address multiple senses at one time. Moreover, simulations can be designed to specifically stimulate higher cognitive functions as well as our sense of discovery and history.

Although the terms *model, simulation,* and *decision support* are similar (see Key Terms) in that all of them involve some use of representations to help human beings understand processes, each term possesses some connotations that can be useful in different circumstances. For example, *simulations* seems to imply a greater level of experience on the part of the user when compared to models and decision-support technologies. Similarly, the term *decision-support technologies* (or *expert systems*) tend to imply a more *goal-oriented representation* of a problem. Although it is important to understand the subtle differences among these terms, for the purposes of this article I will use the term *simulation* to refer to the entire spectrum of these technologies.

Scientists and engineers have long used computer modeling, simulation, and decision support, but only recently have these technologies been employed in support of citizen participation in policy development. This article describes the uses of, the rationales for, and the trends behind the employment of these simulation technologies in this manner. Specifically, I examine three major factors that are driving the trend toward the use of simulations to promote citizen participation as well as to identify factors that will enable citizens and public managers to make better use these technologies.

BACKGROUND: INCREASING CITIZEN UNDERSTANDING OF AND ENGAGEMENT IN GOVERNMENT

Effective citizen participation is often affected by the citizens' understanding of how their dreams of the future can be realized through public-policy choices. Although many public policy choices are made based on the application of existing knowledge, some policies can only be evaluated based on how different sets of assumptions would affect the future. Specifically, simulations can be very valuable when

- *feedback loops* are too long;
- there are complicated interactions among numerous variables (Brown & Jones, 1998);
- the real-world equivalent of the simulated world is inaccessible;
- exploring numerous "what-if" scenarios in the real world would be too expensive; and
- observations are too rare in the real world.

One can observe many of the circumstances that support the use of simulations in helping citizens and public employees to better understand their world. Examples include understanding

- complex *ecological systems*;
- how different transportation policies impact different values (e.g., travel time, pollution, accessibility, beauty, etc.);
- how to respond in an emergency; and
- the complex trade-offs involved in a budget process.

In addition to overcoming limitations to using the real world as a policy test bed, simulations can also be used to help

- stakeholders recognize problems (e.g., that the flow of pollution will threaten an important water source in 15 years);
- solve computationally difficult problems faster and/or more reliably;
- stimulate new ideas (e.g., what would the neighborhood look like were the city to allow higher density development?);
- develop evidence to justify a position or to provide explanations (Kidd, 1985);
- provide advice or shape the discussion of an issue (Carroll & McKendree, 1987);
- provide a kind of accountability (e.g., experiencing a simulation prevents one from being seduced by someone's overly optimistic vision; Teicholz, 1999); and
- citizens examine trade offs (e.g., between cost and value; Jones, 1997).

There is not enough space to list the extended catalogof simulations that are being used to inform citizens about public policy. O'Looney (2003) provided descriptions of simulations that span numerous areas of public policy and civic knowledge. The number and variety of simulations being used in the planning process has, for example, become so great as to lead the Environmental Protection Agency to commission a study of strengths and weakness of various planning-support software (U.S. Environmental Protection Agency, 2000).

UNDERSTANDING AND ENGAGEMENT

If increasing citizens' *understanding* of government is the first step in enhancing citizens' participation, increasing the capacity to *engage* government officials, programs, and policy-making processes represents the next step. *Engagement-supporting technologies* tend to include communications and data aggregation capacities that help people communicate more about what they know. An engagement simulation might be one that links a simulation experience with online opportunities for communications (e.g., the city council of Kalix, Sweden, facilitated online deliberation by citizens in the redesign of the town center. After looking at renovation plans and options, citizens could give their opinions and vote online; HM Government/UK Online, 2002, p. 26).

Whereas increased understanding is an individual goal, engagement involves a group. Also, engagement tends to occur around more concrete or situation-specific events or challenges such as

- identifying the likely impacts of a land-use plan over a set period of years, and
- identifying areas that should be targeted with public funds for redevelopment.

Because engagement-focused simulations tend to address a more specific domain or problem, they are often more complex and more difficult for citizens to use in comparison to simulations for increasing understanding, which can work as simplified or "teaching model" simulations.

FACTORS LEADING TO AN ENHANCED ROLE FOR SIMULATION TECHNOLOGY IN CITIZEN PARTICIPATION

Factor 1: Citizens Demanding More Participation

As levels of education have risen, so has the desire to participate more actively in government policy making. Similarly, legislative requirements, changing professional norms, and recognition of the value of social capital are legitimizing an enhanced role for citizens in numerous areas of pubic affairs and management (Thomas, 1995). Governmental advantages of citizen involvement include increased problem-solving ability, better channels for communication, improved program implementation, and a more streamlined budget process (Norris, 2002; Thomas, 1995).

Although the benefits of citizen participation are well recognized, the actual promotion and acceptance of online technologies that enhance citizen involvement and participation has been less prevalent (O'Looney, 2000b, 2001). For citizens, online technologies that allow for more efficient participation would seem to be an ideal solution.[1] However, public managers and officials have often shown only lukewarm support for these technologies for a number of reasons, including

- their negative experiences with online technology such as e-mail (e.g., officials are often flooded with messages, leading some to stop accepting e-mail from constituents; Congress Online Project, 2004);
- the lack of experience with and substantial additional work involved in managing citizen participation;
- the uncertainty of the legal foundation for using or not using certain technologies; and
- the increased technical complexity of public policy issues that makes it more difficult to include lay citizens as equal participants and more likely that managers will depend on the advice of experts (Jasanoff, 1990).

The use of simulation technology in the general culture, the creation of a more stable legal foundation for online transactions, and increasingly positive experiences with online public technologies should help a new generation of managers become more comfortable with using technology in citizen-participation efforts. However, the lack of policy expertise (or access to or ability to purchase expertise) among ordinary citizens may be the most difficult barrier to overcome. Fortunately, simulation technology can play an important role in addressing this deficiency.

The online simulations help overcome the cost and access to expertise problems by incorporating much of the knowledge of experts into the application. This is particularly the case in decision-support technologies. Well-designed simulations can also act as jargon-free teaching tools that can begin to educate citizens so that they are more capable of participating in public decision making processes.

Simulations may also be able to help address another problem that has been noted with much of the online communications related to civic issues—its failure to promote deliberation. That is, instantly available online communications can prompt knee-jerk rather than deliberative responses (Pethokoukis, 1995). It tends to work against the slowness that is characteristic of *deliberative processes* (Barber, cited in Doheny-Farina, 1994, p. 79). Simulations can work to promote deliberation by structuring the pace at which participants to go through certain steps to match the deliberative demand of the issues (O'Looney, 2003).

Factor 2: Changes in the Way the Next Generation is Learning or Could Learn

A cursory look at the growth of simulation- or game-based learning suggests that the next generation of citizens may come to expect simulations as part of citizen outreach efforts. Schools in the last 10 years have purchased educational games and simulations by the thousands (O'Looney, 2003). Moreover, sales of commercial simulation and computer games estimated at $14 billion certainly support the idea that game-based or experiential learning is the preferred way for the next generation of citizens to learn. Moreover, whereas some computer gaming has been criticized for leading to social isolation and violence, new research indicates that moderate computer game play (e.g., 18 hours a week) is associated with higher levels of concentration and coordination, particularly in the visual mode (Subrahmanyam, Kraut, Greenfield, & Gross, 2000).

The potential for building a new learning paradigm around simulations has not been lost on the educational-technology community. Development of sophisticated simulations that are better adapted to the higher learning needs of students has occurred in areas such as consumer research, business, crisis management, science, social science, civic education, *international relations,* organizational operations, and urban and regional planning (O'Looney, 2003). Schank (2000) and other educators are calling for a major restructuring of academic courses into goal-based scenarios or simulations that get children excited about learning.

Factor 3: Building on the Science of Learning and Decision Making

Ultimately, simulations are be more likely to be adopted for citizen outreach if they can actually improve their ability to learn. Findings suggest that simulations may have a role to play in this regard . Specifically, simulations may be useful in helping to address important preconceptions, to deepen and organize knowledge, and to improve reasoning and learning strategies. For example, educational simulation can be designed to insure that students are tested for common preconceptions that could impede (or facilitate) learning. Based on efficient diagnosis of this type, the simulation can more effectively move students from their initial understanding to a grasp of new concepts (Bransford, Brown, & Cocking, 1999; Donovan, Bransford, & Pellegrino, 1999).

Bias represents a particular type of preconception. It is particularly problematic in deliberations over complex public issues. Participants may experience perceptual, social, and organizational factors that can distort their decision making. New knowledge about these decision-distorting factors suggests that simulations and decision-support technologies may have a role to play in reducing bias. O'Looney (2003) described in detail exactly how simulations can be designed to help overcome bias. For example simulations can be designed to emphasize objective quantity values rather than more subjective perceptions; for example, by more prominently displaying certain utility measures (e.g., *net benefits*) that are considered to be more relevant to good policy decisions (Kemp & Willetts, 1995; Wilkenfeld, Kraus, & Holley, 1998). Similarly, based on research on learning attitudes (Dweck & Bempechat, 1983), educational simulation designers are building learning environments that force impulsive students to work through problems step by step rather than to simply recall an answer (Hickey, 1999; Hickey, Wolfe, & Kindfield, 2001).

Simulations can also help people to deepen and organize their knowledge by making learning more meaningful from the very beginning. In traditional classrooms, students typically learn in two distinct phases. In the first phase, they learn hundreds of facts, names, and concepts. In the second phase they are challenged to wrestle with relationships and meaning. Because simulations typically allow people to observe, experience, or even manipulate complex objects and to point to or demonstrate what they mean *before* they have learned the technical names for these objects, it becomes possible for students earlier to grasp larger meanings.,Well-designed simulations can therefore help reestablish the appropriate sequencing of the "romantic" (or motivational) and "technical" phases of learning (Russell, 1961). For example, in a water management policy simulation developed at the Carl Vinson Institute of Government, players can place various types of buildings or foliage in various locations with different soil types and slopes, and they can also implement various policies (e.g., related to septic systems). Using different models of the interaction between buildings, connecting highways, soil type, slope, and impervious surface, the simulation calculates run-off coefficients and identifies the resulting levels of water pollutants. Players do not need to know the technical specifications for all the factors in order to begin to see that certain policies will have specific impacts on water quality and quantity. Simulations can also help to teach new reasoning skills such as cause–effect reasoning that are important in a number of policy areas, such as climate change, risk analysis, and health policy. Simulations accomplish this by sequencing events and tasks so as to force people to think about effects of their causes.

Finally, simulation technologies can help make people aware of their current learning strategies and to improve upon them. For example, it is common for educational simulations to track learners' responses, interpret what these mean in terms of a learning strategy, and provide relevant feedback and suggestions. This process by which learners are gradually guided from less effective to more effective learning strategies is known as *scafolding*.

FUTURE TRENDS

The prospects for using simulations effectively to address citizen engagement and understanding will depend on software creators overcoming three key barriers to development, outlined in Table 1.

CONCLUSION

How far governments are willing to support the development of simulations for citizen participation will depend on factors such as (a) whether the results are worth the resources spent on development or the time needed for a simulation player to reach exemplary performance and (b) whether simulation participants are challenged to think at a higher cognitive level (Miller & Singleton, 1997).

Similarly, the worth and effectiveness of simulations will involve the following factors:

- Fitting simulations within the larger array of techniques such as media campaigns for enhancing citizen understanding (City of Denton, 2000; Davis, 1997; McKeever, Hanson, Thomas, & Snyder, 1999).
- Correctly orienting simulation experiences within the spectrum from gamelike to serious experiences. Although "gamers" may increase tacit knowledge (e.g., of how a simulated world works), they may not necessarily gain in conscious understanding or an ability to apply knowledge to other fields (Rieber, 1996; Rieber & Noah, 1997; Rieber et al., 1996).
- Ensuring that the context for use is appropriate (e.g., will not result in detachment or act as a substitute for needed face-to-face interactions; Turkle, 1997).
- Ensuring that the simulation offers opportunities to explore different perspectives and deliberation (Judge, 1997).
- Identifying the appropriate role of government in developing simulations. Software such as SimCity is frequently criticized for policy biases (e.g., "tax too much and you lose") and the lack of transparency. Government may need to play a role in supporting development of unbiased and transparent simulations (Turkle, 1997).

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Table 1.

Barrier	Possible Response
Simulations not designed with citizens in mind	Design simulations that build on the user's prior knowledge and are attentive to individual needs and learning styles. Design simulations that are specialized enough to help citizens understand a specific set of public policy tools, but general enough to allow a layperson to approach the subject without undue trepidation Create user-friendly interfaces to existing complex simulations, (e.g., PriceWaterhouseCoopers new interface to Transims built by Los Alamos National Labs (Kulisch, 2001)
Lack of Effective Funding Strategies	Support initiatives such as the Digital Promise project of the Century Foundation designed to create new training materials for civic engagement by using techniques such as modeling, simulation, and advanced information visualization techniques. (Weber, 2001). Follow the European Commission's Information Society Technologies (IST) Program funding model in which funded programs must be both commercially viable and provide a means for citizen access to products, information, and services. (European Commission, 2001).
Lack of support from Public Managers with concerns about cost or accuracy	Provide funding to off-set the cost of transforming a simulation developed for a policy study into a more generalized simulation for use by citizens and other governments. Insure that designers put time limits or warnings on their applications when there is a potential for inaccuracy in the simulations due to time-sensitive data (O'Donoghue , 1998). Include disclaimers related to use of simulations to demonstrate the advantages of policies different from current government policy.

Finally, although one can and should ask for transparency in simulations for civic education, one may also need to recognize that people regularly use computers in the real world to perform tasks where the underlying workings of the computer remain obscure. As the sociologist Paul Starr (1994) pointed out, "policymaking inevitably relies on imperfect models and simplifying assumptions that the media, the public and even policymakers themselves do not understand." Obviously, the development of simulations for citizen use will involve similar trade-offs.

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KEY TERMS

Decision-Support (or Expert) System: A type of application program that makes decisions or solves problems in a particular field by using knowledge and analytical rules defined by experts in the field (PC AI, 2005).

Deliberative Processes: A careful discussion, pondering, and weighing of facts.

Ecological Systems: The organization and interactions of communities of living things, together with the chemical and physical factors in their environment.

Engagement-Supporting Technologies: Technologies that enable people to learn and communicate with fellow citizens about a specific policy-related event or challenge.

Feedback Loops: A self-perpetuating mechanism of change.

Goal-Oriented Representation: An application designed to solve rather than simply describe a problem or process.

Model: A representation of reality used to simulate a process, understand a situation, predict an outcome, or analyze a problem. A model is structured as a set of rules and procedures (U.S. Environmental Protection Agency, 2005).

Net Benefit: Benefits that remain after costs are subtracted.

Scaffolding: The process by which learners are gradually guided from less-effective to more-effective learning strategies.

Simulation: A software package that recreates or simulates, albeit in a simplified manner, a complex phenomena, environment, or experience (Schumaker, 1999).

ENDNOTE

[1] It should be recognized that online services may not always promote greater citizen participation or satisfaction.

Small Business and Regional Portals in Australia

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BACKGROUND

A portal is a special Web site designed to act as a *gateway* to give access to other related sites (Tatnall 2005b). It is often used as a base site that users will keep returning to after accessing other sites, and is often seen as a starting point for specific groups of users when they access the Web. What is unique about Web portals is the way that these special sites are now being used to facilitate access to other sites that may be closely related, in the case of special purpose portals, or quite diverse in the case of general portals (Internet.com, 1999).

There are many differences in the ways in that small businesses adopt and use information technology (IT) by comparison with larger businesses. Small businesses are constrained by a lack of resources (time, money and expertise) and the strategic, longer-term focus necessary to plan effective use of IT. These differences extend to the adoption and use of the Internet and electronic commerce. This article considers the still evolving concept of *portals* and the potential use of community and regional portals by small businesses. Benefits that portals can provide to small businesses are discussed here, and two Australian regional portals are contrasted against the more generic e-mall to illustrate the benefits that portals can provide for small businesses.

The term *Web portal* is overused and difficult to define precisely. There is no definitive categorisation of the types of portal, but Tatnall (2005a) offers the following:

1. **General Portals:** Portals can aim to provide links to sites that can be either closely related or quite diverse. General portals provide links to all sorts of different sites of the user's choosing, many having developed from being simple search tools (such as Yahoo), Internet service providers (such as AOL), and e-mail services (such as Hotmail).
2. **Vertical Industry Portals:** Usually based around specific industries and aggregate information relevant to particular groups, or 'on-line trade communities' of closely related industries. They aim to facilitate the exchange of goods and services in a particular market as part of a value chain.
3. **Horizontal Industry Portals:** A portal is described as *horizontal* when it is utilised by a broad base of users across a horizontal market. Horizontal industry portals are typically based around a group of industries, or a local area.
4. **Community Portals:** Often set up by community groups, or are sometimes based around special group interests. They attempt to foster virtual communities where users share a common location or interest, and provide many different services. Sometimes community portals represent specific regional areas (and are thus called *regional portals*).
5. **Enterprise Information Portal:** The term enterprise (or corporate) information portal is often applied to the gateways to the corporate intranets that are used to manage the knowledge within an organisation.
6. **E-Marketplace Portals:** These extended enterprise portals often offer access to a company's extranet services and are useful for business-to-business processes such as ordering, tendering and supply of goods.
7. **Personal/Mobile Portals:** Following the trends towards mobile (or pervasive) computing personal/mobile portals are increasingly being embedded into mobile phones wireless PDAs and similar devices.
8. **Information Portals:** These can be viewed as a category in their own right as portals whose *prime* aim is to provide a specific type of information.
9. **Specialised/Niche Portals** are portals designed *primarily* to satisfy specific niche markets, but often could also be classified as Information Portals.

Eduard (2001) refered to portal Web sites as being the *fourth* stage of development of a business Web sites. The earlier stages are:

1. Dumb Web site,
2. Simple interactive Web site, and
3. Transactional interactive Web site.

The fourth stage of Web sites development, according to Eisenmann (2002), is where the business attempts to become a focus of attention for customers (and perhaps suppliers). It becomes the first "port of call" for that group for many of their needs, perhaps linking through to other businesses. This opens up options for other forms of revenue, such as advertising or sales commissions.

PORTALS AND SMALL BUSINESS IN AUSTRALIA

Internet business use is well known for new, evolving, and interchangeable terminologies. A few years ago what we now know as portals were generally known as e-malls, either generic or specialised, especially in the retail industry. More recently, portals also include a very narrow vertical structure such as www.rmit.edu.au/ebusiness/, which is aimed at a small community with specific information. Many small businesses involved with portals usually do so as a *user* rather than setting up the portal themselves (Eduard, 2001). One of the best mechanisms by which small businesses can become involved is through regional and community portals.

A number of regional and community portals, whose primary function is to service the needs of small businesses, exist in Australia. In the remainder of this article two typical small business regional portals are contrasted against the more generic e-mall. In each instance, the portals are examined to see whether they provide the benefits indicated. For the first regional portal and the e-malls, the authors gathered details via observation of the actual portals themselves. For the second regional portal, details were gained from a series of interviews with various stakeholders. While not atypical, the authors do not claim that these portals are representative of all portals in Australia.

THE EBIZNET PORTAL

Background of Organisation

Ebiznet (www.ebiznet.com.au) was set up in 1997 by a number of regional development boards in South Australia for the purpose of increasing awareness and use of communication technologies in the regions to boost economic development and employment growth (Ebiznet, 1999a). A number of separate Web sites were set up within the project, including the Adelaide Hills Regional Portal (www.adelaide-hills.com.au), Information about the operation of the Web sites was extracted from the Web sites by the authors in October 2002. The Adelaide Hills Regional Portal offers a number of services (Ebiznet, 2000):

- **Come Visit:** Links to accommodation, dining, events and shopping information, as well as details about local attractions and location maps.
- **Go Shopping:** Links to regional businesses that have successfully taken their business online and are utilising e-commerce.
- **Do Business:** Links to information Web sites on government and other business services.
- **Live Here:** This section is more for individuals and families.

Description of E-Commerce Using the Portal

Small businesses were primarily interested in the Go Shopping and Do Business links. To set up the project, IT personnel in the regions formed part of a project team that went through a series of interrelated development stages aimed at providing awareness of the Internet and its business applications. The main emphasis was on e-commerce. Work began with the development of cost effective e-commerce applications and establishment of a range of demonstration Web sites with e-commerce capacities, including shopping carts. Training in IT business applications and use of the Internet was also provided. The project was specifically targeted to regional small businesses. In particular it aimed to facilitate e-commerce solutions for small businesses that were judged unlikely to otherwise acquire the necessary skills (Ebiznet, 1999a).

Functions provided by local Web service providers were project management, strategic planning, Web design, hosting, e-commerce, Web marketing, Web maintenance, and training (Ebiznet 1999b). Initially, information seminars were run for small businesses, but these were not well attended. It was felt that this was because of a lack of advertising dollars and effort. Those that did attend found the seminars to be very useful and were particularly interested in the e-commerce applications. Training courses were subsidised and were oversubscribed, with extra courses being run. It was felt that *local* examples were most important to the success of the courses (Ebiznet, 1999a).

Impact of the Portal on Small Business

A number of the businesses operated using secure online payments on the Adelaide Hills Web site. These ranged from accommodation to provision of food and wine, a general store and an online recruitment agency. Other community portal sites within Ebiznet offered a similar structure to Adelaide Hills. A total of 26 businesses were part of the secure online shopping area of the Ebiznet sites.

The benefits to small businesses that became involved in Ebiznet (2000) were the opportunity to receive subsidised training, the technology itself and secure payment processes set up and available to use. They also had the chance of traffic heading to their own Web sites through the portal and there was the opportunity to support the local region. Unfortunately this portal recently ceased operation.

THE BIZEWEST PORTAL

Background of Organisation

In June 2000, the Western Region Economic Development Organisation (WREDO), a not-for-profit organisation sponsored by the six municipalities that make up the western region of Melbourne, Australia, received a government grant for a project to set up a business-to-business portal. The project was to create a horizontal portal—*Bizewest*, that would enable small businesses in Melbourne's west to engage in an increased number of e-commerce transactions with each other. In setting up the Bizewest Portal it was noted that the majority of e-commerce activity currently occurs on a business-to-business level (Department of Industry Science and Tourism, 1998). It is estimated that transactions of this type comprises 80% of all electronic commerce (Conhaim, 1999) and that this is likely to remain the case in the near future (Straub, 1998).

Description of E-Commerce Using the Portal

The main objective of the Bizewest Portal project, in its initial stages, was to encourage small to medium enterprises in Melbourne's west to be more aggressive in their up-take of e-commerce business opportunities, and to encourage them to work with other local enterprises in the region also using the Portal (Pliaskin & Tatnall, 2005; Tatnall & Burgess, 2002). The project was to create a true business-to-business portal on which online trading was to occur. The initial plan was to gain the participation of about three hundred SMEs from the local region in the use of the portal to facilitate their business-to-business and business to local government interactions. Another important project goal was youth involvement and students from the local high schools and colleges who were studying IT-related subjects, were to be given the opportunity to 'consult' with SMEs on a one-to-one basis in the development of their Web pages for the portal. When the Portal was launched, a payment gateway was not initially included, meaning that orders could be placed but that full transaction processing functionality was not initially available. It was always intended that a payment gateway be added to the Portal as soon as this was possible. After some initial delays the Bizewest Portal went online in June 2001.

Once the portal was operational, getting local business online was the next step and this involved two parts: convincing regional SMEs to adopt the portal, and providing them with suitable Web sites to link to the portal.

Impact of the Portal on Small Business

An important group in local adoption of the portal were the five companies designated by WREDO as business champions for this project. One of the business champions was a medium-sized Melbourne company, with about 100 employees, that stores frozen food and transports it to supermarkets and other locations around the country. A major reason that this company adopted the portal was the hope that it would provide a better opportunity to deal with people in the local region (Tatnall & Burgess, 2004). A firm of solicitors had also just started making use of the portal and were trying to work out the best ways to utilise it to advantage. Their primary goal was to use the portal to increase their visibility. Another business champion was a small printer with 15 employees that had just begun using the portal. They saw the portal as having "fantastic possibilities," but there were some problems in difficulty with customers being able to contact them via the portal. Finally, a textile company just outside the metropolitan area were using the portal mainly for promoting their image but did intend to move to B-B operations in the future. One of the problems that this company faced was lack of computing expertise, which is a common problem in small business (Burgess, 2002). Despite some successes, however, in early 2003 the WREDO Board decided that Bizewest was costing too much in relation to the benefits it was providing, and reluctantly closed the portal down.

There is a distinct contrast between the 'usefulness' to small business as reported on the Web site of Ebiznet and that resulting from actual interviews with small businesses participating in Bizewest. The interviews indicated that there were some less obvious reasons for linking with the community portal – such as "it seemed like a good idea" and "we didn't want to be left behind."

E-MALLS

Background

An e-mall consists of a number of e-shops, and serves as a gateway through which a visitor can access other e-shops. An e-mall may be generalised or specialised depending on the products offered by the e-shops it hosts. Revenues for e-mall operators include membership fees from participating e-shops and customers, advertising, and possibly a fee on each transaction if the e-mall operator also processes payments. E-shops, on the other hand, benefit from brand reinforcement and increased traffic as visiting one shop on the e-mall often leads to visits to neighbouring shops.

Description of E-Commerce Using the E-Mall

Visitors to e-malls benefit from the convenience of easy access to other e-shops and ease of use through a common interface (Farhoomand & Lovelock, 2001).One example is Internet Marketing (http://www.e-mall.com.au/index.htm), which is a community directory that lists local businesses and community services in the area of Sydney's west. The e-mall Web site promotes itself as offering solutions from Web site development to listings in local business directories, allowing the move to a Web presence to be "cheap and easy." The Australian Internet Shopping Mall (http://dkd.net/mall/holesale.html) offers a range of services, including a national presence and regional divisions. Both of these enterprises have therefore recognised the value of regional or local influences on their participants.

Impact of the E-Mall on Small Business

E-malls enable small businesses to promote their business, tap into infrastructure for online business already set up for transactions, expand market reach by acquiring new users and to be listed on search engines. They also allow these businesses to participate in community building, supplement their hardware sales with revenues from online services, partner with other providers and increase the value of their products and services, retain traffic to their Web sites, invest in marketing activities at reduced costs, and remain innovative. Where they have differed from regional portals is that, although there are benefits in relation to cost efficiencies and possible market expansion, they have not tapped into community relations, but this may be changing.

DISCUSSION

Do the portals examined provide significant benefits to small businesses? Table 1 summarises the findings of the authors in this respect.

The two regional portals investigated here offer services, a consistent infrastructure and search and directory services to allow businesses and consumers to find the products and services they are after. E-malls offer some of these services (depending upon the mall), with the added advantage of having access to a wider market—*if* that is what the small business desires. In the end, the small business must balance the benefits of regionality against what an e-mall may offer. It still seems, however, that there is potential for the regional portals we have examined to develop further, especially in the areas of

Figure 1. Australian Internet shopping mall

Figure 2. E-mall Internet marketing

Table 1. Benefits of example portals

Potential Benefits	Ebiznet	Bizewest	E-Malls
A Secure Environment	Secure catalogue, order and payment facility provided.	Secure environment developed after initial launch.	Not all e-malls offer ordering and purchasing. Some just offer links to business Web sites (cheapest solution). Others offer full service.
Search and Directory Services	Directory, but no search provided.	Search and Directory options are provided.	Search and Directory options are provided.
New Partnerships	No service for 'bidding' for business; but training was provided.	No service for "bidding" for business; links to providers of training are provided.	Will sometimes link to printed directories.
Community Building and Regional Relationships	Community news; community notice boards; community contact details.	"Regional" services include maps; government services; youth services.	Starting to introduce "regional" categories for their services.
Strategy, Management and Business Trust	Infrastructure is identical for all participants.	Infrastructure will be identical for all participants.	Again, it depends upon the e-mall. Those that only offer links to business websites do not offer identical infrastructure for all participants.
Improved Customer Management	No "special deals" in relation to attracting customers are apparent.	No "special deals" in relation to attracting customers are apparent.	Some can provide cross-promotional opportunities.

fostering new partnerships and improving customer relationships.

CONCLUSION

With developments in the Internet, and its increased application to business in the last 10 years, portals have developed, largely from being directories and search engines to new e-business model selling and advertising goods and services. Within the e-business model, portals are generic, specific to an industry, vertical or community based. There has been considerable growth in community portals in recent years and more small businesses have capitalised on this and achieved revenue growth. Small business benefits anticipated from community portals include: increased customer loyalty, improved business relationships, enhanced trust in e-business, lower infrastructure costs, easy access to expert advice, increased market share and expanded business. Regional portals add the benefit of community participation, a very strong part of many small businesses, to the list of portal strengths (although e-malls are beginning to address this). Our investigation of portals indicates that there is scope to increase the level of benefits that they can provide to small businesses.

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KEY TERMS

Community Portals: often set up by community groups or based around special group interests, they attempt to foster the concept of a virtual community where all users share a common location or interest, and provide many different services.

Electronic Commerce: Computers, communications technologies and information systems used by people to improve the ways in which they do business.

E-Mall: A number of e-shops that serve as a gateway through which a visitor can access other e-shops.

Horizontal Industry Portals: Portals utilised by a broad base of users across a horizontal market.

Small Business: Those businesses with 1-20 employees.

Vertical Industry Portals: Usually based around specific industries, they aim to aggregate information relevant to these groups of closely related industries to facilitate the exchange of goods and services in a particular market as part of a value chain.

Web Portal: A special Internet (or intranet) site designed to act as a gateway to give access to other sites.

Category: Applications of E-Technologies

SME's Perceptions of B2B E-Commerce

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INTRODUCTION: BACKGROUND OF ORGANIZATIONS

The primary objective of this study is to examine the effects of the Internet's Web tools (the level of Web content and the level of security on the Internet) on the interorganizational relationships (IOR) between small and medium-sized enterprises (SMEs) and their loyal customers.

This article focuses on B2B electronic commerce because according to a recent report, the value of goods and services sold via B2B electronic markets will reach $2.7 trillion by the year 2004 (Gartner Group, 2000). While these figures give the impression that B2B electronic commerce is expanding fast, the fact remains that many SMEs are still sitting on the sidelines (Caldeira & Ward, 2002; Lam, Shankar, Erramilli, & Murthy, 2004; Teo, Wei, & Benbasat, 2003). Many SMEs that maintain IOR with their customers have difficulties achieving the benefits as suggested by media and early research (Lituchy & Rail, 2000; Poon, 2000; Tagliavini, Ravarini, & Antonelli, 2001). In addition, there is little existing research that has empirically tested the impact of the Internet's Web tools on IOR which lead to customer loyalty.

The Study Sample

The sample consists of 1700 SMEs in the USA and Canada, each having a Web site and an e-mail address. Company size is measured by number of employees (Chow and Holden, 1997). In this study, an SME is one with less than 500 employees. The senior sales representative, company executive, or president of each of the above companies was sent a cover letter through the Internet (by e-mail) along with the URL of the Web site containing the research instrument (questionnaire). As an incentive, respondents were told that a summary of the results would be sent at their request. A total of 386 SMEs responded, producing a 22.7% response rate. The response rate achieved is acceptable, given the length of the research instrument, the technical and confidential nature of the information requested and the nature of the respondents.

Characteristics of Participating SMEs

The respondents were spread across 10 different industry sectors. Seventy-four percent (74%) of the respondents were primarily involved in Manufacturing, Information Technologies Hardware/Software, and others sectors. In terms of annual sales volume, 40% of the sample had annual sales of less than $1 million, while 42% had annual sales between $1 and $10 million and 18% don't want to share that information. About 40% of the SMEs had less than 10 employees, while roughly 42% had less than 50 employees. Approximately 14% of the SMEs possess between 50 and 500 employees. Only 4% possess more than 500 employees.

Most of the participating SMEs (about 64%) have been in business for more than 10 years, while 32% have been in business between 1 and 9 years. A total of 75% of the respondents claimed to have had a company Web site in existence for 1 to 6 years, while 18% of SMEs claimed to have been online for less than one year. A total of 81% of the SMEs have 10% of their budget invested in Web site development and/or maintenance, while 7% of SMEs invested between 11 and 30% of their budget in online resources. Only 2% of SMEs invested more than 50% of their annual budget in Web site development and/or maintenance. In terms of location, 18% of SMEs are located in the western part of North America; the same percentage is located in the eastern part; while 9% does business in the southern part, and 43% in the northern part of North America. The rest of SMEs (12%) is spread across other regions.

THE THEORETICAL RESEARCH MODEL AND HYPOTHESES/ DESCRIPTION OF E-COMMERCE

The use of Internet technology to link SMEs to their customers can be demonstrated to have an effect on their loyal customer base. The Internet's Web tools, such as the level of Web content and the level of security on the internet, can support the formation and maintenance of

IOR because they facilitate the way organizations cooperate with, depend upon, and trust each other. The quality of a Web site can directly influence the type of relationships developed between SMEs and their loyal customers.

The key constructs of the research model, identified through the objective of this article, are as follows: the dependent variable will be drawn from customer loyalty construct, the independent variables will be drawn from the IOR construct and the moderating variables will be drawn from the Internet's Web tools construct.

Customer Loyalty

In this article, loyalty is defined as building and sustaining a trusted relationship with customers that leads to the customers' repeated purchases of products or services over a given period of time (Gefen, 2002; Lam et al., 2004). Customer loyalty, in general, increases profit and growth in many ways to the extent that increasing the percentage of loyal customers by as little as 5% can increase profitability by as much as 30% to 85%, depending upon the industry involved (Gefen, 2002).

IOR from SMEs Perspectives

In this study, an IOR is defined as the process whereby an SME builds long-term relationships with current customers so that both seller and buyer work toward a common set of specified goals (Evans & Laskin, 1994).

Trust is a critical factor in any IOR in which the trustor does not have direct control over the actions of a trustee, and there are possible negative consequences of one party not fulfilling its obligations (Jarvenpaa & Tractinski, 1999). IOR are built around interactions and can be characterized by a tension between autonomy and interdependence, between team loyalty and individuality, and between competition and cooperation (Nouwens & Bouwman, 1995). The primary goal of an IOR is to achieve a competitive advantage via mutual loyalty in relation to companies outside their network. Therefore an IOR is heavily dependent upon relationships based on cooperation, interdependence and trust. They are discussed in the following:

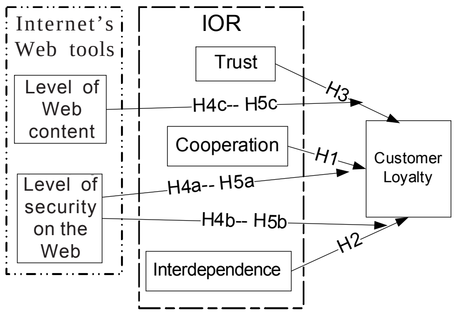
1. **Cooperation:** It is defined in this study as coordinated actions taken by parties to achieve mutual outcomes (Lewin & Johnston, 1997). Cooperation promotes effective relationship success. Cooperation is proactive because it suggests actively agreeing to advertise a partner's products.
2. **Interdependence:** Parties involved in an IOR become interdependent when there are significant switching costs associated with replacing the incumbent suppliers (Lewin & Johnston, 1997). Interdependence is an important relationship variable (Reichheld & Schefter, 2000). A loyal customer will remain with a vendor because the cost of switching to another vendor is too high (Reichheld & Schefter, 2000).
3. **Trust:** Trust is a willingness to rely on an exchange partner in whom one has confidence (Berry, 1995). Becoming a trusted partner of a customer is a key to maintaining IOR. Trust can be achieved by providing the customer with valuable information using a high quality Web site.

Internet's Web Tools

There is an existing need to investigate the tools that make a Web site effective for B2B electronic commerce. According to Dholakia and Rego (1998), the Web possesses several tools that effect the electronic commerce system, including: (1) the Web is an easy and inexpensive way to advertise, lowering the barriers to entry for SMEs; (2) the Web overturns the traditional hierarchical system of distribution channels, that is, former channel partners become competitors in the global marketplace; (3) unlike traditional means of communication, such as newspapers or television, the Web gives the customer control of choosing and processing information about the firm; (4) the breadth of the medium allows wider availability, accessibility, and selection of hard-to-find products/services (Dholakia & Rego, 1998). The Internet's Web tools range from simple associatively linked collections of static hypertext documents to interactive, integrated, customizable solutions and agent-based negotiation support (Gefen, 2002); and since the Internet's Web tools were initially developed to address the development of B2C transactions, they can also be effectively applied in B2B settings as well (Gebauer and Scharl, 1999). There are essentially two variables that encompass the construct of the Internet's Web tools: the level of Web content and the level of security on the Internet.

1. **The Level of Web Content:** The level of Web content is defined as the new Internet-based channels through which SMEs can display information about themselves and the products and services they offer or, better yet, as a dynamic interactive portal (Joseph, Cook, & Javalgi, 2001).
2. **The Level of Security on the Internet:** The level of security on the Web is defined as the risks associated with Web technology assets such as loss, disruption, and unauthorized access of information, data, and Internet resources (Cavusoglu,

Figure 1. Theoretical research model



Raghunathan, & Mishra, 2002). One of the greatest concerns about doing business on the Internet is the level of security in transactions (Cavusoglu et al., 2002). The perception of unsatisfactory security on the Internet is one of the primary hindrances of IOR. Despite advances and endeavors in Internet security mechanisms, companies are still concerned about using an impersonal transaction medium like the Internet for secure transactions (Cavusoglu et al., 2002). Although organizational acceptance of the risk of conducting transactions over the Internet is growing, it is still wavering.

The Research Model

This research model enables us to test the following hypotheses.

- **H1:** Cooperation will have a positive effect on customer loyalty.
- **H2:** Interdependence will have a positive effect on customer loyalty.
- **H3:** Trust will have a positive effect on customer loyalty.
- **H4:** The level of Web content will have a positive effect on the relation between IOR and customer loyalty.
- **H4a:** The level of Web content will have a positive effect on the relation between cooperation and customer loyalty.
- **H4b:** The level of Web content will have a positive effect on the relation between interdependence and customer loyalty.
- **H4c:** The level of Web content will have a positive effect on the relation between trust and customer loyalty.
- **H5:** The level of security on the Internet will have a positive effect on the relation between IOR and customer loyalty.

Table 1. Reliability coefficient rho

Variables	Coefficients Rho
Interdependence	0.869
Cooperation	0.754
Trust	0.726
Loyalty	0.735

- **H5a:** The level of security on the Internet will have a positive effect on the relation between cooperation and customer loyalty.
- **H5b:** The level of security on the Internet will have a positive effect on the relation between interdependence and customer loyalty.
- **H5c:** The level of security on the Internet will have a positive effect on the relation between trust and customer loyalty.

ANALYSIS AND RESULTS/IMPACT OF E-COMMERCE ON THE ORGANIZATIONS

Measures

All of the measures were selected from the survey instrument used by Lawson-Body (2003) in his study. After slight modification, the questions measuring all of the variables, except loyalty, used a scale of 1 (never) to 5 (always). The questions measuring Interdependence used a scale of 1 (disagree very strongly) to 6 (agree very strongly). The scale used to measure Loyalty was 1 (decreasing sharply) to 5 (Increasing sharply). Since the instruments have been slightly revised from the original ones, reliability coefficients have been obtained.

The test of reliability on the sample of the 386 respondents was carried out with a statistical tool named PLS-GRAPH. Table 1 presents the reliability coefficients Rho. Its first column presents the independent and dependent variables of the research model. The second column of table 1 presents the indicator of the reliability of a measure which is the Rho coefficient. Aubert, Rivard, and Patry, (1994) report that the guidelines established by Nunnally (1978) for the interpretation of Cronbach's alpha also apply to the Rho coefficient. These guidelines estimate that acceptable reliability coefficients must be higher than 0.6. It can be seen that all Rho coefficients are ranged between 0.735 and 0.869. This is considered very satisfactory.

To measure the Internet Web tools variables, the evaluation grid, mounted according to the guidelines offered by Kassarjian (1977) and found in the study of

Lawson-Body (2003) was used. Internet's Web tools such as the level of Web content and the level of security on the Internet were evaluated by two judges: the researcher and a graduate student. The inter-judges reliability coefficient is 81%. Berelson (1952; cited in Kassarjian, 1977) claimed a range located between 66% and 95% for acceptable inter-judges reliability coefficients. The ratio of 81% appeared to be satisfactory.

Procedures for Testing the Hypothesis

Gefen et al. (2000) have used PLS method to process and analyze data because of its exploratory nature and its emphasis on explaining variance (Gefen, 2002). Gefen (2002) also used PLS method to analyze the dimensionality of SERVQUAL. Finally, Aubert et al., (1994) have used PLS method to analyze the development of measures to assess dimensions of information systems operation transactions.

In this research, Partial Least Squares (PLS), a second generation multivariate method was used to process and analyze the data. The PLS method simultaneously evaluates both the measurement model and the theoretical model. It adjusts the relationships among the variables accordingly (Aubert et al., 1994). PLS was selected in this research because it presupposes no distributional form on the data.

The test of Hypothesis H1, H2, and H3 on the sample of the 386 respondents was carried out with a statistical tool named PLS-GRAPH. Table 2 shows that Student's T (t value) of impacts of interdependence (2.2856), cooperation (2.0041), and trust (1.7780) on customer loyalty are higher than 1.65 ($P<=0.05$). This first hypothesis test shows that these three variables of the IOR have a positive and direct impact on customer loyalty. In other words, customer loyalty is increased ($R^2 = .78$) by interdependence, by cooperation, and by trust, supporting H1, H2, and H3 respectively.

The coefficient of T-statistic and the weights presented in Table 3 show that only some indicators (items) contribute to the formation or creation of the variable customer loyalty and the three variables (interdependence, cooperation and trust) which have impact on customer loyalty. The indicators with (*) asterisks in table 3 bring their contribution to the creation of the variable they are connected to. According to the values of their T-statistics, some indicators contribute more than others to the formation of their variables. The indicators presented in Table 3 which do not have (*) asterisks do not play enough role in the formation of their corresponding variables.

To test the interaction effects, analysis was pursued with the three variables (interdependence, cooperation, and trust) that have a positive and direct impact on customer loyalty. The two variables of the Internet's Web tools play a moderating role. Therefore the interaction tests of Hypotheses H4, H5, and H6 were carried out with PLS-GRAPH. Table 4 presents the results of this test of the interaction effect and the size of the interaction effect, including the statistical values of the Student (T-statistic).

The results from the survey of 386 SMEs in North America concur: because of the significant value of T-statistics in the last column of table 4, the Internet's Web tools (which include the level of Web content and the level of security on the Internet) have a positive impact on the relation between cooperation and interdependence, and customer loyalty. However, that impact is debatable for trust. The path coefficient with interaction is lower for the impact of the level of Web content on the relation between trust and customer loyalty; this indicates a lower size of the interaction effect. That impact differs from the

Table 2. Path coefficient and student's T (T values)

	Loyalty (R^2 = .78)	
	Path coefficient	T-Statistic
Interdependence	0.3458	2.2856*
Cooperation	0.2273	2.0041*
Trust	0.193	1.7780*

**T-Student significant at 1.64 (P<= 0.05)*

Table 3. The coefficients of T-statistic, weights, and loadings

Items and variables	Weight	Loading	T-Statistic
Loyalty			
LOYAVE[1]	0.1888	0.3712	1.7615*
LOYREGS	0.4517	0.5702	2.2299*
LOYPERP	0.7817	0.5455	2.3671*
LOYPERT	-0.0041	0.4002	1.5039
LOYPERF	0.3652	0.5189	2.8707*
LOYPERH	0.5170	0.4520	1.8856*
LOYEXP	0.0014	0.1737	1.2700
LOYNBF	0.0147	0.2415	1.5203
LOYGEN	0.3280	0.5521	2.5801*
Interdependence			
INDCOST	0.6698	0.2244	2.4208*
INDTERM	0.3585	0.5718	1.7997*
INDDIFF	-0.4661	0.1251	0.4473
INDBENEF	1.2068	0.4113	2.8384*
Cooperation			
COOPHELP	0.2262	0.4271	2.4766*
COOPDECI	0.5961	0.8303	1.8230*
COOPOLIC	-0.2407	0.0030	0.6745
COOPRECO	0.5889	0.5543	2.0624*
Trust			
TRUSTPRO	0.0968	0.2306	1.0420
TRUSTHON	0.8102	0.6166	1.9185*
TRUSTIME	0.7682	0.6064	2.4812*
TRUSTCOU	0.7490	0.5259	1.9207*
TRUSTINT	0.3333	0.1423	1.7671*
TRUSTEXP	0.4895	0.3952	2.3651*

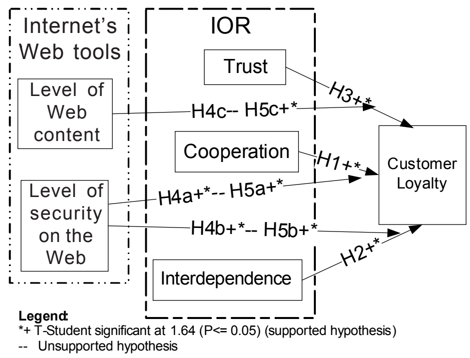
**T-Student significant at 1.64 (P<= 0.05)*

Table 4. Path coefficient and student's T (T values) for the interaction effect

	Loyalty	
	Path coefficient (Beta standardized)	T-Statistic
Interdependence	0.2364	2.7410*
Cooperation	0.3331	2.7010*
Trust	0.3104	3.1170*
Level of security on the Internet X Interdependence	0.2895	1.8902*
Level of web content X Interdependence	0.2960	1.7523*
Level of security on the Internet X Cooperation	0.3419	2.4560*
Level of web content X Cooperation	0.3459	3.1107*
Level of security on the Internet X Trust	0.3108	3.1114*
Level of web content X Trust	0.2419	1.5641

**T-Student significant at 1.64 (P<= 0.05)*

Figure 2. Results of PLS analysis



impact of the level of security on the Internet on the relation between trust and customer loyalty. For example, the beta for the impact of trust on customer loyalty is 0.3104. The interaction betas for the impact of the Internet's Web tools on the relation between trust and customer loyalty are 0.3108 and 0.2419 respectively. In consequence, the use of non-secure Web tools reduces the impact of trust on customer loyalty and the use of secure Web tools doesn't increase or decrease the impact of trust on customer loyalty. There are improvements with the interactions between the use of Web tools and interdependence, and the use of Web tools and cooperation on loyalty. The betas for the impact of interdependence on loyalty and for the impact of cooperation on loyalty are 0.2364 and 0.3331. The interaction betas for the impact of the Internet's Web tools on the relation between interdependence and loyalty are 0.2895 and 0.2960. The interaction betas for the impact of the Internet's Web tools on the relation between cooperation and loyalty are 0.3419 and 0.3459.

DISCUSSION AND CONCLUSION

We found support for eight of our nine hypotheses. More importantly, we found that the use of Web sites increases cooperation and interdependence between SMEs and their loyal customers. We also found that the impact of the use of secure Web sites on the relation between trust and customer loyalty is neutral. However, we failed to find support for the impact of the use of non-secure Web sites on the relation between trust and customer loyalty. That means, if SMEs use non secure Web sites to maintain a relationship with their customers, trust in SMEs will decrease, therefore customers will be less loyal to SMEs.

The main contribution of this study has been to provide empirical evidence on the impact of the Internet's Web tools on the relation between cooperation, interdependence, and trust and customer loyalty. In fact, business is based on trust between two parties, whether the business is conducted in person, by phone, or over a Web site. The customer can get a sense of the company and the person from face-to-face discussions or from the appearance and location of the office; but this element of trust is difficult to reconstruct in electronic transactions because all the customer knows about the supplier is what can be seen on the Web site. Therefore, creating trust via the Web depends on fostering IOR through electronic means of well-established Web tools. When SMEs treat the Web as more than just a communication tool, the trust between companies will grow, an IOR will be developed and maintained, and customer loyalty will develop.

The results of this study show that SMEs are perceived to be flexible and adaptable in terms of structure and speed of response. Therefore SMEs are perceived to promptly adopt the Internet's Web tools technologies. SMEs are set to benefit from the adoption of B2B electronic commerce because of the lower-cost Internet technologies. Some authors conclude that because the entry barriers are so low, SMEs can establish presence on the Internet, which thus helps level the playing field between small and large firms.

The findings of this research will help SMEs identify the IOR factors which they should emphasize when the Internet's Web tools are used to augment customer loyalty.

Future research is necessary because Internet technology evolves so rapidly and its evolution may likely affect in different ways the relationship between trust and customer loyalty. Additional research should also expand the range of the Internet's Web tools variables and examine their effects on the link between IOR and customer loyalty.

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ENDNOTE

[1] See APPENDIX A at the end of the article for the full definition of the items.

APPENDIX A: FULL DEFINITION OF THE ITEMS

	Loyalty
Items	Questions
LOYAVE	The average number of years during which your firm maintains business relationships with its customers
LOYREGS	Your firm maintains business relationships with its customers
LOYPERP	The percentage of sales to regular customers (customers with whom your firm maintains business relationships) out of your firm's total sales
LOYPERT	The percentage of sales from regular customers instead of one time sales
LOYPERF	The frequency of sales from your firm's regular customer
LOYPERH	The total dollar value sales from your firm's regular customer
LOYEXP	The average yearly revenue per regular customer
LOYNBF	The number of your firm's regular customers
LOYGEN	In general, your firm's customers repeat purchases of products and/or services.
	Interdependence
Items	Questions
INDCOST	In your judgment, the total costs to your firm in switching to a competitor's product line would be
INDTERM	The average length of time your firm relationship lasts with your customers
INDDIFF	Differences of opinion between your firm and its customers will probably be viewed as just a part of doing business
INDBENEF	Differences of opinion between your firm and its customers will likely results in benefits to both of them
	Cooperation
Items	Questions
COOPHELP	Your firm helps out its customers in whatever ways they ask
COOPDECI	Customers have considerable latitude in deciding how much technical support they get from your firm for their products
COOPOLIC	Your firm complies with the policies that customers establish for the marketing of their products
COOPRECO	Customers follow whatever recommendations your firm makes regarding the marketing and selling of its product line
	Trust
Items	Questions
TRUSTPRO	I have found that my firm's customers can rely on it to keep the promises that it makes
TRUSTHON	My firm is basically honest toward its customers
TRUSTIME	In my firm's relationship with its customers, it cannot be trusted at times
TRUSTCOU	In my firm's relationship with its customers, it can be counted on to do what is right
TRUSTINT	In my firm's relationship with its customers, it has high integrity
TRUSTEXP	My firm enjoys a high level of trust with its customers

Software Metrics and Measurements

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INTRODUCTION

In the past few years, a large number of e-government and e-commerce systems have been developed, thus resulting to a constantly increasing number of software developers involved in software development for such systems. To ensure the production of high quality e-government and e-commerce systems, it is important for developers to collect and analyze measurable data that guide estimation, decision making, and assessment. It is common sense that one can control and manage better what he is able to measure.

Although there are major differences between e-commerce and e-government (e.g., access, structure and accountability; Jorgenson & Cable, 2002) there are no significant differences in terms of software metrics that can be applied to both. Metrics are used in e-government and e-commerce software development to measure various factors related to software quality and can be classified as product metrics, process metrics and recourse metrics. *Product metrics* are also called software metrics. These are metrics that are directly related to the product itself, such as code statements, delivered executables, manuals, and strive to measure product quality, or attributes of the product that can be related to product quality. *Process metrics* focus on the process of software development and measure process characteristics, aiming to detect problems or to push forward successful practices. *Resource metrics* are related to the resources required for software development and their performance.

This article focuses on product metrics and on how such metrics can aid in design, prediction and assessment of the final product quality, provide data used for decision making, cost and effort estimation, fault prevention, testing time reduction, and, consequently, aid in producing better software for e-government and e-commerce systems.

BACKGROUND

Measurement is the process by which numbers or symbols are assigned to attributes of entities in the real world so as to describe such entities according to clearly defined rules (Fenton & Pfleeger, 2004). In software development, measurements are conducted by using metrics. A *metric* is an empirical assignment of a value to an entity aiming to describe a specific characteristic of this entity. Measurements have been introduced into the e-government and e-commerce software development process in order to satisfy the need to control software development and produce higher quality results.

Since the mid 1970s when the first software metrics were proposed, a large number of metrics have been proposed in the following years. The proliferation of metrics was followed by more practical proposals on how to interpret results from metrics (see Shepperd & Ince, 1990) and methods combining metrics into measurement methodologies (see Xenos, 2003).

Public or private entities involved in software development for e-gsovernment and e-commerce applications can select from a variety of applied metrics those that are more suitable to be included in the development process (e.g., see Goodman, 2004; Kan, 2003). Therefore, taking into account the volume of literature that exists about software metrics, it is no more a question of finding metrics for an e-government or e-commerce project, rather than selecting the appropriate ones and extensively training engineering teams to utilize them (Hirsh, 2005). Given the large number of metrics (measuring almost everything), any attempt to select a metric without basing the selection on a detailed breakdown of the development needs and an extensive investigation of the proposed metric's applicability would result in minor benefits from its use or no benefits at all. To benefit from the use of metrics, apart from fully understanding the various existing metrics, one should also define well *why* he wants to measure, *what* to measure and *when* is the right time to measure it.

So the first question is: *Why use metrics?* The answer to this question is that metrics are needed to provide understanding of different elements of e-government and e-commerce software projects. Because it is not always clear what causes a project to fail, it is essential to measure and record characteristics of good projects as well as bad ones. Metrics provide indicators for the developed software. As Ragland (1995) stated, indicators are metrics or combinations of metrics that provide insights of the software development process, the software project, or the product itself. Measurements aim at the assessment of the status of the development process and the developed product. Therefore, metrics can be used for performance evaluation, cost estimation as Stamelos and Angelis (2001) have proposed, effort estimation, improving productivity, selecting best practices and—in general—for improving the quality of e-government and e-commerce systems.

This discussion leads to the next question: *What to measure?* As previously mentioned, process and product are what we need to measure. One may argue that, since the result of e-government and e-commerce projects is software, what we need to measure is only software. This is not true. According to Deming (1986), if the product you have developed is erroneous, do not just fix the errors, but also fix the process that allowed the errors into the product. This way you will not have to keep fixing the error in subsequent productions. Therefore, both process and product metrics and measurements are important in e-government and e-commerce software development.

It must be noted that, before selecting the appropriate metrics, it is very important to define the desired product quality characteristics. The selection of quality characteristics aids in defining what needs to be measured and what needs not, depending on the particular needs of the e-government and e-commerce application. In the early 1970s, McCall, Richards, and Walters (1977) defined a framework for measuring such characteristics and proposed the Factors Criteria Metrics model—also known as FCM model—defining what is software quality in terms of subcharacteristics. Incorporating FCM and experience from similar proposals, years later, the ISO standard ISO/IEC 9126 (2001) standardized what product quality is in terms of subcharacteristics. Therefore the definition of product quality is important, as product metrics are used in the software development procedure to measure those product characteristics that are related to product quality.

Having defined the goals and reasons for measuring, the next question is: *When to measure?* Although measurements should be conducted throughout the entire e-government and e-commerce software development life cycle, their scope varies depending on the development phase. Different measurement goals are defined at different development phases, thus resulting into different kinds of metrics. In the early phases of e-government and e-commerce software development, metrics are used mainly for estimation purposes. It is useful to collect metrics relating to different projects as these can serve as historical data for future projects, aiding in better results.

In the intermediate phases of the e-government and e-commerce development process, metrics are used for project monitoring purposes and, in the meantime, code metrics are used to prevent errors. Furthermore, defect reports during testing are used for evaluating product quality and calibrating the measurement methods of the early phases. This purpose is also served by collecting external measurement data following project delivery, namely during the beta testing or maintenance phases of an e-government or e-commerce project. So the time to measure is determined by the requirements and the aims of the measurement program and can vary from a project to another.

Summarizing, using an oversimplifying statement, it could be said that metrics are an important instrument for the development of software to be integrated into e-government and e-commerce systems; metrics aid in making estimations in the early phases of a project, preventing problems in intermediate phases and evaluating quality in the late project phases.

USING METRICS IN SOFTWARE DEVELOPMENT FOR E-GOVERNMENT AND E-COMMERCE SYSTEMS

This section classifies product metrics in two categories—internal and external—provides a short definition and examples of each category, and discusses their advantages and disadvantages. The section concludes by presenting how these metrics can be combined and used in software development for e-government and e-commerce systems.

Product metrics can be categorized (Fenton & Pfleeger, 2004) as internal product metrics and external product metrics. *Internal product metrics* are those used to measure attributes of the product that can be measured directly by examining the product on its own irrespectively of its behavior. *External product metrics* are those used to measure attributes of the product that can be measured only with respect to how the product relates to its environment.

Internal Metrics

Internal metrics can be classified in three categories based on the product attributes they measure. These categories are size, complexity, and data metrics. As far as internal product metrics in general are concerned, it is important to mention that one of their major *advantages* is that they are easy to automate and therefore data collection can be made in an easy, automated, and cost-effective way. Furthermore, the measurement results can also be analyzed in an automated way using statistical techniques and thus conclusions can be drawn rapidly. Tools such as QSUP (Xenos, Thanos, & Christodoulakis, 1996), Emerald (Hudepohl et al., 1996), GQM automation (Lavazza, 2000), and so forth have rendered internal measurements very easy to conduct. The screenshot from the metrics results

Figure 1. The results presentation window from QSUP Internal metrics

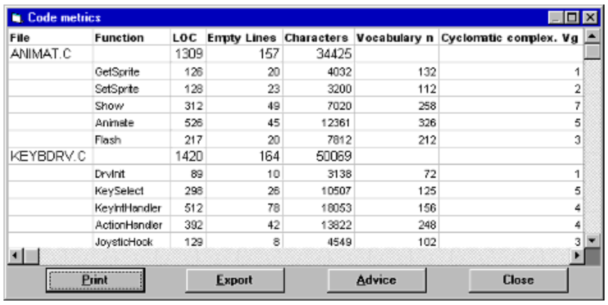


Table 1. High-level characteristics of e-commerce systems

Characteristics of e-commerce systems	Related quality factors
Easy access to the Web pages of the e-commerce system	Functionality, Usability, Efficiency
Easy navigation	Functionality, Usability
Adaptation to user profile	Functionality, Usability, Efficiency
Search engine service	Functionality, Usability, Reliability
Easy exit—undo functions	Functionality
Useful help service	Functionality, Usability, Efficiency
Electronic shopping cart	Functionality, Usability
Electronic shopping list	Functionality, Usability
Secure and reliable transactions	Functionality, Reliability
Security protocols SET, SSL	Reliability
Correct and accurate information about the products	Reliability
Direct delivery of the products	Usability, Efficiency
Indisputable financial transactions	Reliability
Recoverability of products and services	Usability, Functionality
Legitimate Web site	Reliability

of QSUP shown in Figure 1 is an example of the simple and automated way in which such measurements can be conducted. For further examples regarding metrics application, see Xenos (2003).

On the other hand, it should be mentioned that a major among the *disadvantages* of internal product measurements is the fact that they are often difficult to interpret. In other cases, the internal quantities measured are not clearly related to the external quality characteristics that one wants to assess. Such problems can only be solved in the framework of a well-defined measurement method that combines internal and external metrics, as will be discussed next.

External Metrics

Based on the ISO/IEC 9126 (2001) standard and on similar works such as Jung and Kim (2004), the *external factors* affecting software quality are Functionality, Usability, Efficiency and Reliability. For their definitions see "Key Terms," as defined by Kitchenham and Pfleeger (1996). External metrics are used to measure directly these four factors or the characteristics of which these factors are composed. For example, a set of high-level quality characteristics of e-commerce systems is presented in Table 1 (Stefani & Xenos 2001). This is important for the distinction between generic metrics and metrics defined especially for e-commerce systems.

Unlike internal metrics (measuring software internal characteristics and aiming at relating measurements of such characteristics to these factors), external metrics measure directly these factors or their characteristics. Such metrics can be based on subjective estimates. Among the means employed by external metrics are surveys on user opinion providing valuable measurements for software functionality or usability. Measures like defect reports or mean time between failures are used to determine product reliability, whereas measures like memory usage are used to determine efficiency.

As already mentioned, the application of external metrics implies that a certain extent of subjectivity is involved; even metrics that appear to be objective are often characterized by some degree of subjectivity. For example, defect reports seem to be a solid metric that can be used to objectively measure reliability. But the number of defect reports submitted by a user is influenced by issues such as the time and the extent of product usage, the user experience and even the user's motivation to edit and submit a defect report. Therefore, such metrics must be analyzed very carefully and under a framework that will take under consideration such issues.

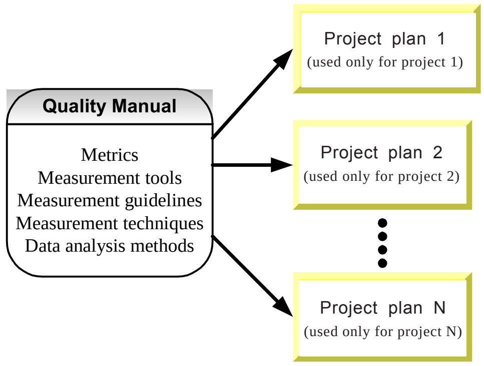
One of the major *advantages* of external metrics is that they measure directly the desired external product quality characteristics, thus no further analysis or interpretation is needed. Additionally, external metrics contribute to a great extent to what is considered to be one of the main goals of e-government and e-commerce quality: user satisfaction. On the other hand, *disadvantages* and problems should be seriously taken under consideration when deciding to use external metrics, the most important of which being that such metrics are not objective and as a result additional effort is required to ensure their objectivity. Furthermore, they are not as cost effective as internal measurements and in many cases it is difficult to conduct measurements due to high error rates especially in cases that error detection techniques have not been used during measurements.

Combining Internal and External Metrics into a Measurement Method

As already mentioned, internal and external measurements must be conducted under a well-defined framework with precise goals. Before selecting the appropriate metrics for any project, a *quality manual* should be established collecting and documenting all metrics available for use in the software developing entity. This manual is a basic component of the metrics application process and includes the metrics, the measurement techniques as well as the guidelines for the application of metrics, the data analysis and the corrective actions required for improving the developing process of e-government and e-commerce systems. It should also be mentioned that the quality manual includes all metrics that are available regardless of how many times they have been used, or the availability of measurements data from past software development projects.

Then, for each e-government or e-commerce project, a set of metrics appropriate for this particular project is selected from the quality manual. The criteria on which the selection of metrics is based are the particular quality factors that the project places emphasis on. This set of metrics is documented—using the guidelines available in the quality manual—and consists the *quality plan* of the particular project. Thus, an e-government or e-commerce project quality plan should include all the metrics, measurement guidelines and goals applicable for the project. It is self-evident that the project plan of a specific project may be entirely different from another project's plan and may use a completely different set of metrics. Figure 2 presents an illustration of the above procedure.

Figure 2. Selection of metrics for each project



The quality plan of each e-government or e-commerce project should include internal metrics so as to provide an easy and inexpensive way to detect possible causes for low product quality, as this might be perceived by the end-users, and take early corrective action. It should also include external metrics—applied during alpha or beta testing and post shipment—so as to measure external quality factors, as well as the soundness of the internal metrics and measurements results or even calibrate internal metrics.

It should be noted that the successful selection of metrics and measurement techniques to be included in an entity's quality manual is heavily dependent on the entity's maturity. The adoption of sophisticated techniques and complex metrics by a company may prove to be ineffective, if it is not supported by years of experience with metrics and measurements and large volumes of data from past project measurements. Software developing companies should always keep this fact in mind and set feasible measurement goals not aiming too high at the early stages of metrics application.

FUTURE TRENDS

For about 3 decades now, metrics have been used for the estimation of product related issues (such as product size, required effort, time required for testing, etc.) for early detection and prevention of problems during development and for product assessment after product release. Although in both cases metrics have proved to be successful in practice and have aided significantly towards developing higher quality e-government and e-commerce applications, the benefits from the use of metrics are not commonly recognized. This is partly due to the lack of awareness of metrics in small- and medium-size software developing companies. Although metrics are extensively used in large companies, in many cases, small- and medium-size enterprises are not even aware of the prospect and benefits of using metrics. However, this is constantly changing. More and more small- and medium-size e-government and e-commerce software-developing companies become aware of product metrics and measurements. Besides, the adoption of standards such as the ISO, or assessment in CMM higher levels, has contributed to this change since both standards are encouraging the use of metrics.

Another issue that is expected to change in the near future is the availability of more sophisticated tools. Although many measurement tools are available, using a number of metrics, there are not many tools available yet combining past projects' measurement data with current project data in order to aid in decision making. Combining metrics with decision support techniques, or methods for resolving uncertainty will lead to the development of valuable tools, which can aid towards higher quality software for e-government and e-commerce systems. A recent approach towards this direction (Fenton, Krause, & Neil, 2002) is using metrics and Bayesian networks for controlling software development, by automatically predicting defects in the released product.

CONCLUSION

This article introduced the reader to software metrics that are used to provide insight about different elements of e-government or e-commerce systems software. It presented internal metrics that can be applied prior to the release of the product to provide indications relating to quality characteristics, and external metrics applied after product delivery to give information about user perception of product quality.

Software metrics can be used to measure various factors related to software product development. These factors include estimation, early detection and prevention of problems, product assessment, etc. Their utilization within a measurements framework in combination to the use of automated tools can aid towards development process control and higher quality software for e-government and e-commerce systems.

Our focus was placed on the particular factors affecting the quality of e-government or e-commerce software. Such software can be measured effectively using a combination of generic internal software metrics and external metrics. The former are appropriate for most types of software, whereas the latter are designed especially for e-government or e-commerce systems.

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KEY TERMS

External Metric: A metric used to measure attributes of the product that can be measured only with respect to how the product relates to its environment.

Functionality: The external quality factor that refers to a set of functions and specified properties that satisfy stated or implied needs.

Internal Metric: A metric used to measure attributes of the product that can be measured directly by examining the product on its own, irrespective of its behavior.

Measurement: A process by which numbers or symbols are assigned to attributes of entities in the real world in such a way as to describe them according to clearly defined rules.

Metric: An empirical assignment of a value in an entity aiming to describe a specific characteristic of this entity.

Quality Manual: A manual used by the software developing company that includes the metrics, the measurement techniques, the guidelines for the application of metrics data analysis, and the corrective actions required for improving the software developing process.

Quality Plan: A plan developed particularly for each software project that includes all the metrics, measurement guidelines and goals applicable for this project only.

Usability: The external quality factor that is defined as a set of attributes that bear on the effort needed for the use and on the individual assessment of such use by a stated or implied set of users.

Special Features of Mobile Advertising and Their Utilization

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INTRODUCTION

Mobile advertising, or m-advertising, refers to ads sent to and presented on mobile devices such as cellular phones, PDAs (personal digital assistants), and other handheld devices.[1] M-advertising can be seen as a part of m-commerce (e.g., Mennecke & Strader, 2003), which is seen as radically different from traditional commerce (e.g., Choi, Stahl, & Whinston, 1997). Thus, it can be argued that m-advertising is also different. M-advertising enables the advertiser not only to send unique, personalized, and customized ads (Turban, King, Lee, Warkentin, & Chung, 2002), but also to engage consumers in discussions and transactions with the advertiser.

Any retailer can make use of m-advertising. Thus this study focuses on the brick-and-mortar retailers' use of m-advertising in Finland. In Finland, mobile phone subscriptions reached 84% of the population at the end of the year 2002 (Ministry of Transport and Communications Finland, 2003), and more than 30% of the users under 35 years and over 20% of all users have received m-advertising in the form of SMS (www.opas.net/suora/mob%20markk%20nous.htm). However, there are no commercial solutions available for the MMS type of m-advertising. Therefore, the empirical setting of this study is a service system SmartRotuaari, which is a part of a research project (see Ojala et al., 2003; www.rotuaari.net) offering the retailers an infrastructure and a service system for context-dependent m-advertising in the city of Oulu in Northern Finland.

This study focuses on permission-based m-advertising. In Finland, that is the only form of m-advertising that is legal. Firstly, we will discuss the features of m-advertising that make it unique. Secondly, we will present some empirical results from the SmartRotuaari case. Based on the recognized features, we study which of them retailers utilized in their m-ads, as well as those remaining unused. The aim is to find out how well the uniqueness of m-advertising was portrayed in the m-ads. The study concludes by suggesting how retailers could improve the use of m-advertising in order to fully harness its power.

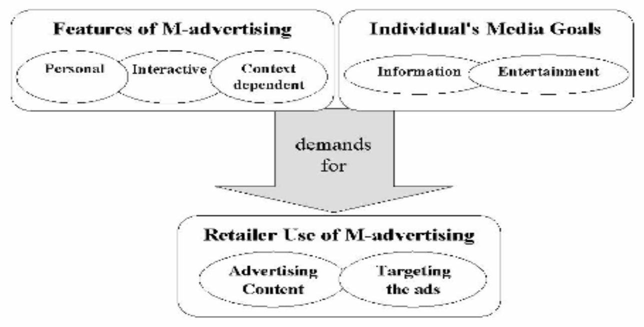
DESCRIPTION OF MOBILE COMMERCE

Based on existing research and the empirical data gathered for this study, we suggest a framework that describes the factors that influence the success of retailers' use of m-advertising. The factors are related to the media or advertising channel itself and its special features, and to the receiver of the messages—that is, the individual customer and her/his goal in using the mobile device.

Factors Influencing the Success of Permission-Based M-Advertising

Because of the special features, m-advertising can and should be used to deliver ads which are different from the traditional ones. The special features include: the personal nature of the device, the interactivity that the device enables, and the context dependency that the infrastructure enables. The features influence the type of content that permission-based m-advertising should offer to the consumer in order to be perceived as valuable and/or entertaining. The value of the content is also related to the individual's needs and reasons for using the media, such as media goals (Juntunen, 2001). A person may use a mobile device to receive information, but also for the purpose of personal entertainment. Both these goals influence the expectations she/he has for the mobile ads. Unless the consumer perceives permission-based m-advertising positively, she/he can deny the company or any company the permission to send ads to her/him. Thus it is vital for a m-advertiser to be aware of the special features and the requirements that the features set for the content of the ads, as well as for the segmentation or almost individual targeting of the ad. In the sections below we will take a closer look at each of the features depicted in Figure 1.

Figure 1. Possible features influencing the success of permission-based m-advertising



Personal Nature of M-Advertising

M-advertising is as personal as personal selling. Mobile devices, especially mobile phones, are highly personal devices, with personally selected or even self-composed ringing tones, individually tailored covers or general appearance, and additional decorations, not to mention the 'content' of the phone, including information on personal friends as well as a personal calendar. Moreover, the users wear their device almost everywhere and at all times. Thus the personal nature of the device is transferred to the information that is sent and received through the device (see also Barwise & Strong, 2002). Therefore, m-advertising is not for the masses, but for individuals.

Interactive Nature of M-Advertising

The mobile device allows m-advertising to be highly interactive—that is, the parties can act on each other, on the communication medium, and on the messages (Liu & Shrum, 2002). A customer may reply to an ad by phoning; sending an SMS, MMS, or an e-mail; or logging into the advertiser's Web page by using the mobile device. In addition, a customer may distribute the ad to her/his friends. Such viral marketing is very beneficial for the advertiser, as the customer forwarding the ad her/himself becomes the sender of the message and therefore the message gains in credibility.

Context Awareness of M-Advertising

The first context to be taken into account is the device to which the advertisement is distributed. Unless the message is tailored to the terminal, the receiver will face problems in receiving and understanding the message. Even if such problems are avoided, the devices have a relatively small screen size, limited screen colors, and limited battery time. However, the technology used in building m-advertising systems enables context awareness. The context may be location, time, and/or weather. For example, the m-advertising service is able to locate the user's mobile device and send an ad only when the customer walks by the retailer's shop.

An Individual's Media Goals

An individual's goals are often referred to as a person's cognition of what s/he is pursuing in a particular situation and to an associated inner state of arousal (e.g., Eysenck, 1982; Pervin, 1989). Thus an individual's media goal is her/his cognition of the processing goal s/he is pursuing when attending to her/his mobile device (see Juntunen, 2001), which in this case is the medium for m-ads. Depending on what type of goal the receiver is trying to achieve by using a mobile device also affects her/his processing of the ads. If the user's media goal is information, the customer will be more interested in ads that provide her/him relevant information on products/services or companies.

On the other hand, if the customer's goals are more towards entertainment, s/he will enjoy ads that are entertaining and provide experiential satisfaction through aesthetic pleasure, emotional stimulation, or social experience (see also Barwise & Strong, 2002). A consumer may wish to achieve both kinds of goals at the same time, and the relative importance of the types may change according to the situation that s/he is in.

In the above, we have discussed the features that make m-advertising a unique form of advertising, as well as the ways users are using their mobile devices. Together they place m-advertising closer to personal selling than traditional advertising—having the same message sent to many receivers with limited control over the context. Since m-advertising is so personal, it sets new kinds of demands for the advertising planning. We will now move into considering how to plan m-advertising—that is, targeting and planning the content of the ad.

Targeting the Ads

It is possible to target m-advertising if the retailer can make use of the user-specific information that is added to the m-advertising service system. This can be done through two different, but complementary ways. Firstly, each user, when granting the permission to send ads, also fills in a user profile that can include demographic details, user's current mood (e.g., is s/he hungry, looking for fun, shopping), and areas of personal interest (e.g., fashion, food, hunting). All this can be done directly form the user's mobile device. Secondly, the retailer may use existing data from the company's customer relationship management (CRM) database, which can be connected to the mobile user's personal customer number.

Moreover, the system may obtain up-to-date weather information from a local weather station via Internet. It is thus possible to send ads of sunglasses only when the sun is actually shining. In addition, time can be used in targeting. In the morning restaurants can send special breakfast offers or in the evening they can send discount coupons for a dinner if there are seats available.

A well-planned execution of m-advertising can be more effective than, for example, direct mail (which is often left unopened) or television advertising, although the number of receivers that see the ad is considerably smaller. Based on the targeting options, the retailer can send ads that match with the mobile user's personal interests and current needs, making sure that the customer will only receive ads that s/he is willing to. This is extremely important in permission-based m-advertising, since spam messages annoy the receiver (see also Barwise & Strong, 2002; Edwards, Li, & Lee, 2002). Therefore, the advertiser can reach high view-through rates by targeting the ad successfully. In SMS m-advertising, 81% of all trialists viewed all messages before deleting them and 77% did that as soon as they received the ad (Barwise & Strong, 2002). At the same time, this means that the same ad should only be sent to each customer once during a campaign. If the campaign contains repetition, the m-ads have to be different each time they are being sent to the same consumers, otherwise they can annoy the consumer.

Advertising Content

As for the content of ads, the advertiser in any type of advertising has to decide what is being said and how to say it. Both these decisions affect the success of m-advertising as well. Kalakota and Robinson (2002) suggest that m-ads work best if customers receive concrete benefits from it, such as retail alerts, coupons, special offers, and m-tickets. However, Barwise, and Strong (2002) found six types of ads used in SMS permission-based m-advertising, ranging from messages directed to long-term effects (like brand building) to messages attempting to engage the receiver in immediate interaction with the advertiser (competitions, votes). By applying the information given by the consumer and/or information retrieved from the CRM databases, the advertiser can also provide quick and timely information (i.e., news that interests the receiver). The existing research being scarce, we do not know which type of ads are the most effective ones.

The style of the ad is also an important issue to be considered. Duchnicky and Kolers (1983) suggest that reading from mobile devices may take more time and effort than reading from a desktop computer. Because of that, and also due to the space limitations, the copy should be kept short and the use of graphics or photos is encouraged (see Edens & Cormick, 2000). Humor and surprises in the design of the ad create positive feelings toward the advertisement and may lead to viral marketing, especially among the younger receivers (Barwise & Strong, 2002). Furthermore, we assume that the personal nature of the mobile devices as well as the context specificity and novelty of m-advertising will lead consumers towards high involvement. In such situations the contrast effect appears to stimulate consumers to process the advertising even more (De Pelsmacker, Geuens, & Anckaert, 2002).

IMPACT OF MOBILE COMMERCE ON THE ORGANIZATION

The empirical part of the study is derived from the SmartRotuaari service system. The system provides a functional framework for large-scale field trials for the purpose of empirical evaluation of technology, new mobile services, customer behavior, and retailers' use of the services (for more details see Ojala et al., 2003; www.rotuaari.net). The retailers use a Web portal to send ads, which are then delivered through a WLAN network to consumers' mobile devices, in this trial the PDAs.

Retailers' Use of Permission-Based M-Advertising

The data consists of 42 m-ads that were sent to trial users (186 persons) by 12 retailers (shops, bars, restaurants, cafes) during the first field trial of the SmartRotuaari.[2] Thus, the retailers had their first experiences of m-advertising during this trial, and they had not received any special training to guide their m-ad design decisions.

Thus, this data provides a great opportunity to study how retailers that are not advertising professionals apply the uniqueness of mobile channel.

The ads were analyzed using content analysis, as it is the standard analytical tool for advertising studies (e.g., Kassarjian, 1977; Kolbe & Burnett, 1991). As suggested by Kassarjian (1977), four coders (A, B, C, and D) analyzed the commercials. However, due to confidentiality of the data, the authors served as coders as well. The authors provided the coders A and C with instructions and a brief training before they commenced the task. Since the number of ads was relatively small, all disagreements between the two pairs of coders were solved through discussion (see Kassarjian, 1977). Since the coders were able to agree on all the decisions, no measure of interjudge reliability was calculated (see Perreault & Leigh, 1989)

All m-ads used the company location as the focal point from which the distance that triggered the sending of an ad was measured. However, there were huge differences in the way the retailers used the location awareness. The distance used varied from 75 meters to 3,000 meters. The diameter of the town centre in Oulu is below the 3 kilometres, so the use of the highest distance in the location awareness does not aid the targeting of the ads. The time awareness according to certain hours of the day (e.g., opening hours, lunch hours) was used in only 18 ads, although it could have been used in every ad, so that customers would receive ads only during the opening hours.

The most-used feature of the consumer that the retailers used in targeting was age. Only some clothing shops and a few restaurants did not use it. The bars and pubs especially targeted the ads towards either the younger or the more mature customers. The mood information was used in 65% of all the ads. Especially the clothing shops and cafeterias selected customers in shopping mood, and bars and restaurants people who were hungry, thirsty, seeking company, or in a mood to party. As for the consumers' interest areas, only 14 ads included certain interest areas as criteria for targeting. None of the 42 ads used the local weather as a criterion for sending the ad.

We also analysed the content of the ads. Fifty-five percent of the ads contained either photos (people, product, or the interior of a restaurant) or graphics. The copy length ranged from 0 to 31 words. As the ads were received on PDAs, even the longest copy was readable, but it did not provide an aesthetic pleasure. From the ads, there was only one that was classified as brand building, but this is easily explained by the fact that all the advertisers were retailers, and thus most of the ads concentrated on describing the shop or the restaurant (e.g., what type of food was served). Many ads (40%) included their contact address (only three with phone number), although it was possible for the consumer to use a mobile map to locate the company. Moreover, 45% of the ads contained information on opening hours, which explains the fact that many advertisers did not use the option of sending the ad during the opening hours only. One-third of the ads included price information or special offers, thus responding to the consumer's relevant information needs. Moreover, only three ads addressed the receiver in the copy by asking them a question ("Are you hungry?") or by welcoming them to the cafe.

The retailers used very traditional profiling criteria such as the age of the customer. We can also argue that although mood or interest areas are not really a criterion that can explicitly be used in, for example, magazine or newspaper advertising, it is used implicitly when choosing the magazine (e.g., interior magazines) or placing the ad under the 'entertainment' section. Also in the content of the ad, traditional newspaper advertising was clearly the point of reference when retailers designed the m-ads. How to fit the message and the format into the context of m-advertising is a question also to be solved by advertising agencies (e.g., Kiani, 1998; Kunoe, 1998).

CONCLUSION

This study on retailers' usage of permission-based mobile advertising underlines the notion that mobile advertising is different from any other form of advertising. In addition, the retailers, using m-advertising for the first time, are not able to apply the unique features of m-advertising. Thus, both the receivers and the senders of mobile advertising messages have to learn how to use this new channel and how to fully make use of the opportunities it offers for speedy, personal, and interactive advertising communication with the consumer (see also Pura, 2002). The features of m-advertising (personal, interactive, context dependent) and individual media goals (information and/or entertainment) should be the basis to start m-advertising activities and campaigns. Therefore, the m-advertising should be personal, thus requiring a certain amount of knowledge about the receivers of the m-ads. The message of the advertisement, as well as the way it is expressed, should be carefully designed to match the needs of the target person. Moreover, m-advertising should fit into the marketing communication mix, enabling interactivity. In time, we are sure that m-advertising will move more and more towards m-crm and constant interaction between buyer and seller.

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KEY TERMS

Mobile Advertisement: All advertisements sent to mobile and wireless devices.

Mobile Advertising: All advertising activities conducted via mobile and wireless devices.

Mobile Commerce: All commerce conducted via mobile and wireless devices.

Mobile Marketing: All marketing activities conducted via mobile and wireless devices.

Permission-Based Mobile Marketing and Advertising: All marketing activities conducted with permission of the consumer via mobile and wireless devices.

ENDNOTES

1 Mobile advertising can be used to refer to advertisements that move from place to place, (i.e., in busses, trucks, trains, etc.) (e.g., Hume, 1988; Goldsborough, 1995).

2 The SmartRotuaari service system consists of several mobile services, which are tested and studied in field trials. So far, m-advertising service is one possessing the most commercial potential.

Spreading Use of Digital Cash

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INTRODUCTION

Approximately 10 years have passed since the words such as *digital cash, digital money, electronic money*, and *e-cash* have been introduced. Progress has increased rapidly in the fields of communication and information technology (IT) and in the field of digital cash; its use and transaction volume have been increasing. However, little analysis has been done about this phenomenon especially from the academic field. The continued increase in its use is inevitable, and it is important to investigate its influence and problems from both practical and theoretical perspectives. The spread of the use of digital cash impacts economic activity and social structure. This article considers both the merits and the problems of digital cash in the modern economy.

This article analyzes characteristics of relationships between digital money, financial institutions, and financial authorities; considers the relation between digital cash and financial institutions; and analyzes the relation between digital cash and monetary policy authorities.

BACKGROUND

Digital cash may be classified into electronic wallet and online types (Kurihara, 2000). IC-card type digital cash has value in itself; the network type is maintained on the personal computer or the host computer. Both types of digital cash have appeared recently. The distinction between the two types has begun to disappear; Internet cash is one example.

This classification permits an examination of cost reduction and price cutting from the demand factor of the former for the reason of the cause to which digital cash spread, a technology of IC card reformation and price cutting from the supply side (U.S. Department of Commerce, 1998). The availability of the personal computer and the Internet have also prevailed, as well as Internet commercial dealings from the demand factor as an online-type personal development factor. The ongoing reduction of equipment costs (typically in computers) has helped to promote online transactions from the supply side. Electronic commerce all over the world has increased greatly. Moreover, it seems that the spread of mobile telecommunications (e.g., cellular phones) has contributed to the development of digital cash. In the near future, television or mobile phones will be used to complete financial transactions (Hammersley, 2004).

The difference between closed-loop and open-loop transactions is important. In closed-loop transactions, the transfer of the value is the same as with digital cash. For instance, when the user who receives the issue from the issue subject (typically a bank) and digital cash is allotted to pay for the commodity or service, the seller (typically, a retailer or service provider) completes the transaction for the transfer of value. Value cannot be moved among users in the closed loop, which is used in both IC-card and network digital cash transactions.

On the other hand, digital cash issued once can be used for other transactions, even if the value does not return to the issuer in the open loop. Rolling liquidity exists there. The IC-card type of the closed loop is most common in the early 21st century.

Although credit cards, checks, and debit cards have become remarkably widespread for making small payments electronically, the difference between them and digital cash is important. These transaction types should not be classified as digital cash. Considering monetary policy, the distinction from digital cash is very important.

Digital cash builds information on “near cash or itself” into the card, the network, and transactions. To qualify as digital cash, five characteristics must be present: a settlement, generality (use for any purpose), the transfer of funds, circulation (i.e., free availability), and anonymity. More concretely, digital cash is a legal currency and is legal as deposit currency. Time deposits, certificates of deposit (CD), trust money, and so on must not be included as digital cash. Debit, prepaid, and credit cards and checks do not comply with to the forgoing definition and are different from digital cash in spite of being traded in electronic form.

Although the generality of digital cash is much greater than that of prepaid cards (e.g., phone cards), it is inferior to usual money, and the transfer does not exist in the closed loop compared with current cash, either. Circulation is also low, and it is doubtful whether anonymity exists with deposit currency. Moreover, digital cash does not have the same legal status as cash. However, the examples of our statement comply with the above definition and should be classified as digital cash.

THE ADVANTAGES AND PROBLEMS OF DIGITAL CASH

Advantages

Both types of digital cash reduce cost, time, and human error. These advantages accrue both to the user and the donor of the digital cash (Davis, 2002).

With IC transactions, people do not have to carry about small change and have the advantage of high privacy buying. In network-type transactions, the buyer does not have to be present at the seller's establishment to conduct business. Furthermore, security against theft or loss is high. Even small retailers or sellers can reduce handling costs and increase business opportunities. International transactions benefit in particular (Davis, 2003).

Problems

On the other hand, there are some problems in spite of having a lot of merit, with the digital cash.

Who Pays the Cost of Digital Cash?

The cost of creating digital cash is high. The technology to manufacture cards and provide infrastructure against commitment is expensive.

How are Users Protected?

This is a legal problem as well as an economic and technological problem. For instance, it is common all over the world to construe that illegal use is the user's own responsibility in the case of online transactions. In the United States, there is a rule by which the liability is limited to $50 after the consumer's loss is borne.

Problems of the Issuing Body

Emergencies on the part of the issuing body are cause for concern. For instance, the European Central Bank (ECB) assumes that the issue of digital cash is the same as the acceptance of deposits for those who issue it. The issuing body must (a) defend the settlement system, (b) protect the consumer, (c) support the execution of monetary policy, and (d) promote competition. Only financial institutions should be able to issue digital cash.

- **User Equity:** People who do not or cannot use equipment such as personal computers, for instance, are at a disadvantage relative to other consumers.
- **Questions and Standards of Taxation:** There is a possibility of avoiding taxes incurred by digital cash. The World Trade Organization (WTO) and the United States are not inclined to tax network trading. However, the stance varies worldwide.
- **Counterfeiting:** Dealing with the problem of counterfeiting with digital cash is not as easy as with the present currency. The IC type of digital money has high privacy, but it also has the disadvantage of being easy to lose and easy to steal. In addition, money laundering has been an issue. However, digital cash transactions are not large, especially for IC type (Berger, Hancock, & Marquardt, 1996). This problem may apply more to the network type with its larger average transactions.
- **Privacy:** It is difficult to solve the problem of privacy because of the consequences of interfering with the security of network-type transactions.

DIGITAL CASH AND FINANCIAL INSTITUTION MANAGEMENT

Many banks in developed countries have adopted several kinds of Internet banking services. The possibility of cost reduction of customer services, severe competition, and increases in the number of Internet users have contributed to the prevalence of Internet banking.

The spread of digital cash has upgraded consumer access to and satisfaction with transactions. First of all, consumers need not even go to a retail establishment or ATM. With digital cash, former restrictions such as the geographical location of a shop and business hours no longer hamper consumers' ability to obtain desired goods and services. Economies of scale benefit both sellers and buyers. Even if it costs more to introduce the system for financial institutions, the customer channel can be secured widely (Davidson, 1997). SET is one example.

Some big companies are announcing an interface standard to be used for bank services. The construction cost of the system is expected to decrease further as a result. Certainly, at least handling costs of money will decrease. Movement toward the standard is becoming active in the United States. There also is some possibility that some types of settlements, particularly those beyond the type generally handled by banks, will grow with the spread of digital cash. Another possibility is a decrease in the number of branches and bank clerks required by banking institutions. Cline (1998) noted that advantages accrue to banks with fewer branches (mega commercial banks and some trust banks). The spread of digital cash may further influence financial institution management by permitting decreases in commission fees if the net settlement or the settlement at the same time is arranged. For the individual, it will be possible of losing by using the HD of a computer.

Additional management considerations are (1) banks' acquisition of business information concerning commercial distribution of creating monopoly, (2) possibility of tie-ups of institutions such as credit card companies with a set infrastructure, (3) participation by institutions other than banks may cause systemic risk. Changes in this kind of risk have been widely forecast. Operations risks may outweigh those imposed by traditional interest rates, liquidity, and market risks (Basle Commitment, 1998). Reducing the cost of acquiring information and the trend toward globalization makes it difficult for banks to monopolize technology and risk management operations (Salomon, 1996).

However, it does not seem that such a movement accelerates unilaterally. There is a view that the move to help banks obtain their vested right to profit from certain types of transactions disturbs the development of electronically managed settlement. Humphrey and Pulley (1998), BIS (2000), and Weiner (2000) stated that paper-based transactions are still mainstreams.

DIGITAL CASH AND POLICY AUTHORITIES

Digital cash influences the policy authorities. However, it is thought that digital cash is debt issued (i.e., deposited) by banks. It circulates under the assumption, guarantee, or trust that 100% of it can be changed into cash (in the form of a central bank note). Digital cash itself does not have the finality of the settlement. Policy authorities will not be greatly influenced by it in the near future. Areas of influence include the following.

Management of the Money Supply

Management of the money supply becomes difficult if settlements using deposit currency decrease as settlements with digital cash increase. Some fear the effects of the decrease of the function of deposit creation. However, there is no change in the money supply if the issued digital cash is immediately converted to currency. The problem might be the amount of money involved and the length of the time that it remains in the digital state. For instance, there is no change in the multiplier of money if the digital money is issued against a bank deposit, but the multiplier increases if digital money is issued against a national bond, for example. Moreover, there is some possibility that the multiplier becomes unstable at the diffusion period of digital cash. However, in the case of increasing the substitution of digital money for paper money, authorities can manage high-powered money and even the national debt.

It is important to consider payment preparation for the deposit. The effect of the multiplier exists as long as demand for the cash (issued by the central bank) or the preparation deposit is not extinguished. However, as digital cash prevails, the ratio of the payment preparations for the deposit becomes small. Though the spread of digital cash certainly decreases a necessary payment preparation, the multiplier rises and at the same time the effect of the monetary policy may also increase.

There is some possibility, however, that the side effect of the rise of the inter-bank market interest rates may result from a lack of preparation deposit. Moreover, the confidence multiplier expands to infinity because a legal preparation does not exist now. However, the issuing body has the payment preparation, part of it is converted into cash and a deposit, and lending demand is limited. So the one-sided acceleration of such a movement may not happen.

When the digital cash of the home country is converted into the digital cash issued in the foreign country, the management of the money supply becomes difficult.

Money Demand

The function of money is as value standard, payment instrument, and stored value. Digital cash chiefly accomplishes the function of payment instrument. Tobin's stock theory is useful when considering this aspect of digital transactions. The cost of going to a bank, changing a deposit into money, and cash demand are positively correlated. Using this theory, digital cash decreases the money demand. However, use of digital cash increases liquidity, so digital money may render money demand unstable.

It is difficult to forecast accurately the shift of the multiplier and the money demand. Policy authorities must consider these factors. In a standard theory of economics, if the shock of the economic fluctuation is real, stabilizing the amount of the money supply rather than the interest rate reduces the change of real gross domestic product (GDP; Poole, 1970). Therefore, when such shocks are not anticipated in the money market, in the appearance of digital cash, comes, it becomes important for policy authorities to stabilize the interest rate.

There has been much discussion whether or not monetary authorities should set money supply (or exchange rate) as an intermediate goal in the attainment of price stability or economic growth. The typical case in which money supply has been taken as intermediate goal is Germany (Gerlach, 1999). However, if authorities took such an instrument, they could control money supply with confidence. There should be a stable relationship between money supply and inflation. So it should be better for monetary authorities to control interest rates instead of money supply when the used of digital cash is dominant. Woodford (2000) stated that macroeconomic stabilization depends only upon the ability of central banks to control the short-term nominal interest rate.

Increased Use of Foreign Currency

If a part of domestic economic activity is accomplished using foreign currency, it may decrease the "real economy," provided by the domestic currency short-term interest rate. The influence of monetary policy then decreases because it can only influence bank lending by the domestic currency. Moreover, changes in the prices of goods and services in the foreign country may also influence the domestic economy.

Taxation Issues

Reductions in taxation may decrease revenue.

Restriction and Supervisor's Problems

Use of the Internet accommodates deposits to financial institutions in foreign countries, especially those with limited restrictions and supervisions. Monetary policy must consider the possibility of the spread of corruption from the foreign country. Moreover, there is a problem of the scope of the financial institution. Financial systems are different in each country. In addition, there is a problem of the scope of deposit insurance (See, FDIC's homepage, http://www.fdic.gov/).

Money Laundering

Government intervention regarding code keys and other transactions may arise. It is natural for authorities to want to take to such measures; however, a conflict with the individual's privacy surfaces (Mester, 2000).

Finally, the authorities lose profit, because money is a debt with no interest and the authorities get interest from asset. Yet, this is not their pursuit of profit for them.

FUTURE TRENDS

The many advantages of promoting digital cash are seductive. Accessibility provided to the elderly and the handicapped by such systems are among real benefits that should be explored. IT, and in this case, the use of digital cash, may make our world a more convenient and efficient place to live. However, there are some obstacles to overcome. Fraud is the most important matter to consider (Schwartz, 2001). Systemic risk may be much larger in the future than current predictions have indicated and should be investigated carefully.

CONCLUSION

As the use of digital cash spreads, economic activity and social structure will change. The merits of digital cash balance against the potential and realized problems. Both types of digital cash have the advantage of reducing of dealing cost, time, and human error. Defense against the high potential for fraud will call upon much needed self-responsibility on the part of the user and the supplier of the digital cash.

Financial institutions should consider the trend toward greater use of digital cash as a business opportunity. Those who lag behind in this area may disappear from the market. Authorities should examine this trend carefully. They should look to mature the "sound" market and not to confuse it with too much intervention. Their primary goal must be to develop and preserve sound financial systems.

Digital cash is here to stay. This phenomenon should be analyzed not just from a practical view but also from a theoretical view.

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KEY TERMS

Closed Loop: Transfer of value happens as with digital cash. For instance, when the user receives the issue from the issue subject, and the digital money is allotted to the money payment of the commodity or service, the seller will shut the settlement to the issue subject for the transfer of value.

Digital Cash: Classified into electronic wallet (IC card) or online type (network). Note that both types of digital cash have appeared recently. The distinction between the two types has been disappearing.

IC-Card Type Digital Cash: Has the value in itself. Money is stored in it.

Internet Cash: Users are digitally signed but are not stored in the database. It is a kind of debit card.

Network-Type Digital Cash: Maintained on the personal computer or the host computer.

Open Loop: Digital cash issued once can be used for the additional transactions, even if the value does not return to the issuer. The open loop provides rolling liquidity.

SET: Secure electronic transaction (SET) is a system for ensuring the security of financial transactions. Secure socket layer (SSL) is used more than SET. It is a simpler standard than SET.

Category: Concepts, Trends, and Challenges

Straight-Through Processing Adoption

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INTRODUCTION

Free trading has been instrumental in the enormous growth of the number and volume of cross-border trading transactions across all industries. In 2000, volume at the National Securities Clearing Corporation (NSCC) reached 18.1 million securities transactions, with actual daily share volumes regularly exceeding 5 billion shares in major financial markets (Depository Trust and Clearing Corporation [DTCC], 2000).

Securities trading starts with either an individual or a business institution expressing desire to purchase securities. While the process is deceptively simple, approximately $1.8 trillion of securities trades remain unsettled and outstanding every business day (David & Kumar, 2000), which poses significant risks to all participants and players in the securities trading cycle. A shorter settlement cycle is seen as an approach to reduce both nonpayment and nondelivery risks to all stakeholders in the trading cycle (Toppen, Smits, & Ribbers, 1998). Compressing settlement cycles needs the redesign and management of securities business processes with significant IT support and involvement. Recent advances in information technology provide ample opportunities for various stakeholders to communicate seamlessly through electronic communication networks (ECNs), enabling both speedier and richer information exchange (Dale, 1996; Venkataraman & Zaheer, 1990).

Currently, settlement times largely vary between 2 and 5 days. Constant push from governmental regulatory bodies is expected to reduce this to 1 or less than 1 day, popularly known as T+1/T+0 settlement times (Freund, 1991; Group of Thirty, 1993). While it is possible to achieve straight-through processing (STP) without targeting for T+1/T+0, it is almost impossible to attain T+1/T+0 without STP (Leman, 2003). There is a dearth of empirical research with emphasis on financial securities operations. This article attempts to address an existing void in this area.

The first part of this article examines current securities trading operations and STP, and discusses the business drivers of STP. The second part of the article elaborates the factors influencing the adoption of STP by various participants. Finally, the article discusses areas that are amenable to future exploration and empirical research with the aim of ultimately increasing the adoption of STP globally.

BACKGROUND

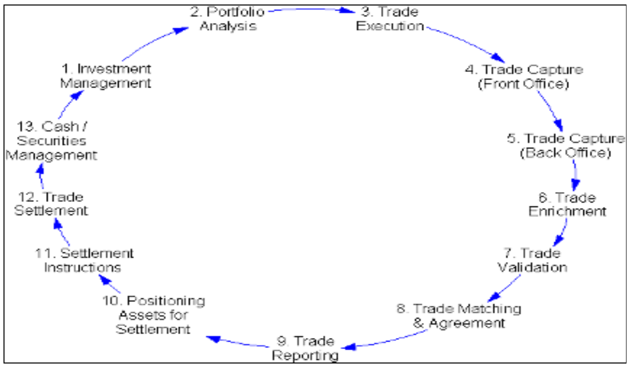
Securities Trading Process (Trading Cycle)

The steps involved in a trade, from the point of order receipt and trade execution through trade settlement, are commonly referred to as the securities trading life cycle (STLC). Basically, the STLC is a combination of the investment and portfolio analysis process, the trading process, and the settlement process comprising major phases like execution, confirmation, settling, and clearance (Toppen et al., 1998). Figure 1 depicts the STLC.

The STLC is usually initiated by an investor or an investment management organization deciding to either buy or sell securities. The preferred approach is the delivery-vs.-payment (DVP) approach in which the transfer of securities and payment takes place simultaneously to reduce nonpayment and nondelivery risks. Following the trade settlement, the investment manager ensures that cash and/or securities positions are updated to reflect the actual situation. The stakeholders involved in the STLC include the following:

- **Investor:** An entity (an individual or a business organization) initiating the STLC by buying and/or selling securities.
- **Investment Manager/Advisor:** A professional providing support to the investor in the decision to invest capital with the ultimate objective of maximiz-

Figure 1. Steps in securities trading life cycle



ing returns for the investor. Usually, investment managers also liaise with securities trading organizations and brokers as needed.

- **Securities Trading Organization (STO):** An organization involved in the buying, selling, and holding of securities for its own purpose
- **Broker/Dealer:** A broker or dealer places orders on behalf of the investor or STO for execution at the appropriate venue, like a stock exchange, which is based on the type of securities to be executed. A broker's primary objective is to match sellers and buyers.
- **Regulatory Authority:** Usually a government entity that sets rules for the functioning of the securities marketplace, and subsequently monitors and controls the activities of the marketplace to ensure compliance to rules and regulations.
- **Stock Exchange:** A government-recognized entity where securities can initially be issued and subsequently be bought and sold by investors
- **Custodian:** An organization that provides services to its clients including the holding of securities, holding of cash, settlement of trades, and collection of corporate actions.
- **Registrar:** An organization appointed by the issuer of a registered security to maintain a register of holders of that security. It is also known as a transfer agent.
- **Clearing Firm:** Central receiving and distribution centers that provide clearing facilities to entities involved in the trade.
- **Depository and Settlement Facility:** A central entity that holds all securities and usually facilitates the clearing, comparing, and settlement of trades.

Table 1 summarizes the primary involvement of various stakeholders along the STLC phases. With such a complex set of processes distributed across multiple participants, the smooth execution and practice of the STLC presents numerous challenges, including the following:

- Transmission of information among various stakeholders
- Multiple points of data entry
- Multiple interaction points between trading partners
- Definitive shift to cross-border trading practice with divergent rules and regulations
- Increased trading volumes
- Potentially long trade-execution time with high failure rates and increasing costs
- Nonstandard trading business processes among stakeholders
- High exposure to different operations and credit-risk profiles

What is Straight-Through Processing?

With the intention of addressing the challenges identified earlier, the Securities Industry Association (SIA) and the DTCC recommended a complete transformation of securities operations. This industry-wide initiative, called straight-through processing, encompasses all stakeholders participating in the STLC. STP increasingly is coming to represent a continually evolving set of aspirations rather than an existing reality (Douthitt, 2000; McIntyre, 2004). In its current (and still evolving) form, STP means the complete transformation and management of all aspects of investment operations (Douthitt, 2000). Straight-through processing is the capability of financial services companies to process cross-border trade execution, clearance, payments, settlement, custody, reporting, and accounting with minimal human intervention (David & Kumar, 2000). STP applies to all major trading areas including foreign exchanges, equities (including corporate actions), bonds, treasuries, money markets, commodities and futures, mutual funds, unit trusts, derivatives, and futures and options.

Table 1. Stakeholders in the STLC (Adapted from Toppen et al., 1998)

Stakeholders	Securities Trading Life-Cycle Processes												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Investor	X	X						X					X
Investment Manager/Advisor	X	X						X					X
Securities Trading Organization			X	X	X	X	X	X	X	X	X	X	X
Broker/Dealer/Agent			X	X	X	X	X	X	X	X	X	X	
Custodian										X	X	X	X
Clearing Firm			X								X	X	X
Securities Depository			X							X	X	X	X
Regulatory Authority			X								X	X	
Stock Exchange			X								X	X	
Registrar			X	X	X				X				X

According to Tower Group (1999), "STP is much easier to conceptualize than to accomplish." STP implementations are complex because of vastly different requirements of different stakeholders (Douthitt, 2000). The processes and activities within STP differ vastly with participants in the STLC depending on their respective roles. Furthermore, increasing the complexities is a continually evolving set of financial products that STP is expected to support. Against this backdrop, the critical areas that STP focuses on are (a) the capabilities required by buy-side financial institutions to accomplish STP, (b) the elements in the flow within the STLC, and (c) the value various entities add to the execution of the STLC.

Business Drivers of STP

Analysis of the challenges inherent in the STLC and the STP vision leads us to factors that drive the accomplishment of STP among STLC participants, which are the following:

- **Potential to Reduce the Cost of Trade Execution and Operational Inefficiencies:** In a completely automated STP environment, the cost of settling a trade is $10 (Society for Worldwide Interbank Financial Telecommunications [SWIFT], 2001). A manual or semiautomatic STLC is wrought with do-undo-redo cycles due to various reasons. It usually costs about $6 to correct a trade during the trade instruction step, but this increases to $16 if the mistake is identified during trade matching. Subsequently, according to SWIFT, this shoots up to $50 per trade if the mistake is identified and corrected during trade settlement. Currently, approximately 60% of all trades need correction during the instruction phase, about 10% need correction during trade matching, and about 15% of all trades fail to settle on time (SWIFT).
- **Increasing Risk Potential of Trading Operations:** The STLC presents several risk factors (McIntyre, 2004; Toppen et al., 1998). An analysis of financial disasters that have occurred in the recent past reveals the need for efficient processes, tighter process integration across trading partners, and lower throughput time to address risks like systemic risks, settlement risks, liquidity risks, custody risks, and legal risks.
- **High Error Rates and Complexities Leading to Delays in Trade Settlement:** The involvement of multiple participants, use of nonstandard procedures, and multiple points of data entry lead to nearly 20% of all trades needing manual intervention or exception processing (SWIFT, 2001).
- **Recognition of the Desire to Move to Real-Time Settlement (T+1/T+0):** Business needs and regulatory requirements are forcing STLC stakeholders to move to real-time (T+0) or near-real-time settlement (T+1). Achieving this is possible only if the complete STLC is subjected to business-process reengineering and transformation. Major benefits of shorter settlement cycles include the following (Frimmel, 2000).
  - Risk-exposure reduction by 67% of $750 billion by 2004
  - Possible reduction in the size of current clearing funds by one third
  - Approximated annual savings of $2.7 billion
  - Faster payments and better asset allocation and utilization due to synchronized trading cycles
- **Growth in Cross-Border Trading System:** The increasing globalization of businesses and financial markets is pushing up cross-border trading volumes 44.2% annually, increasing cross-border trades from 36 million in 1999 to 108 million globally in 2002 (Tower Group, 1999).
- **Technological Advancements Striving for Disintermediation:** One of the critical benefits of information technology is the ability to reduce and eliminate intermediaries from a process (Davenport, 1992). Advances in information and communication technologies are facilitating the integration of business processes between trading partners. Protocols like the Financial Information Exchange (FIX) and the Society for Worldwide Interbank Financial Telecommunications facilitate information exchange, which is a critical requirement to accomplish STP.
- **Mergers and Acquisitions:** Mergers and acquisitions (M&As) are an important business characteristic in large economies. The reasons for M&As are primarily linked to consolidation, economies of scale, market expansion, market share, and talent retention and acquisition. Financial organizations that are unable or unwilling to commit investment into the infrastructure to support STP are considering mergers or acquisitions.
- **Trading Operations Extending to 24/7:** With cross-border trading and globalization, securities trading needs to operate without breaks, stops, or disruptions. STOs, brokers, dealers, and agents who deal with multiple markets have to operate 24 hours (David & Kumar, 2000). Supporting this calls for a high degree of liquidity in the system so that, for instance, a trader can settle out of a trade in Tokyo and successfully trade in London without interruptions.

- **Global Aspiration to Move to Electronic Certificates from Physical Certificates:** Most securities presently exist in standard certified form. Trading involves the transfer of the ownership of securities, leading to the physical movement of certificates, which introduces risks of theft or loss (McIntyre, 2004; Simmons, 2002). There is a global shift toward electronic certificates in dematerialized form (demat form) for which securities holdings are represented by electronic records. The increased use of the demat form is heralding the move to STP.

FACTORS INFLUENCING STP ADOPTION

An analysis of the business drivers of STP reveals the compelling benefits of embracing STP for all stakeholders. The decision to embrace STP presents specific characteristics unique to the securities industry and stakeholders in the STLC. It is critical for stakeholders to understand these specific factors that influence the adoption of STP. Adding to the complexity are the business implications of STP that vary depending on stakeholders and the roles they play in the STLC. Current STP adoption rates range between 60 and 80% in developed economies (*Straight Through Processing Magazine*, 2000), and lower in other countries (David & Kumar, 2000). There are many factors that influence its adoption. Factors that positively influence and facilitate STP adoption (facilitators) and factors that negatively influence and obstruct STP adoption (obstructers) are identified and used to develop hypotheses to understand their significance in STP adoption.

Trading costs are cited in the literature as a major factor positively influencing STP adoption (David & Kumar, 2000; Frimmel, 2000). With the increasing complexities of the trading process and the involvement of multiple trading partners who have different expectations and success criteria, the cost of securities trading is not low and increases at a steady rate along the STLC (Frimmel). Stakeholders view trading-cost control and its minimization as a direct benefit of adopting STP. Therefore the following hypothesis:

- **H1: The securities trading cost positively influences the adoption of STP.** Trading error rates and complexities pose significant challenges as the steps of STP are distributed across various participants. The successful execution of the STLC necessitates a high degree of coordination and rich communication among partners. Inherently, this provides numerous opportunities to introduce errors during the trading cycle (David & Kumar, 2000; McIntyre, 2004). Reducing errors and simplifying the STLC is a major goal of STP. Therefore, the related hypothesis is as follows:
- **H2: The level of error rates in the STLC execution positively influences the adoption of STP.** Credit and operational risks are a big issue in the securities industry. Perhaps the most widely covered was the Barings Futures Singapore case in February 1995 with an estimated loss of $1.5 billion (Toppen et al., 1998). Longer settlement cycles introduce nondelivery and nonpayment risks, and absorb liquidity from the system. Therefore, the following hypothesis applies:
- **H3: The level of credit and operational risk positively influences the adoption of STP.** Trading volumes in the past few years have ballooned as businesses are going global. Also, many public-sector organizations in emerging economies like India and China are facing reduced government holdings as a result of market deregulation. This is inducing such companies to go public and offer its government-held shares to individuals and institutional investors, including foreign institutional investors. The increase in trading volumes is also being fueled by sharp increases in cross-border trading. According to Global Straight-Through Process Association (GSTPA) in 1999, cross-border trading is currently clocking an average annual growth rate of 44.2%. Therefore, the related hypotheses are the following:
- **H4: Trading volumes positively influence the adoption of STP.**
- **H5: The level of cross-border trading positively influences the adoption of STP.** The STLC is a complex business process governed by several business rules and regulatory requirements. The STLC presents several sources that introduce errors in the process, ranging from trade capture to trade enrichment, static data, trade validation, settlement instructions, and trade matching, among others. According to SWIFT (2001), currently, about 20% of cross-border trades fail to settle on time. Lowering settlements times to T+1/T+0 is the primary catalyst for adopting STP (Frimmel, 2000). According to SIA, the guiding principles for the T+1 vision are (a) seamless communication among parties, (b) concurrent exchange of information, (c) significant real-time processing, and (d) virtual, not physical, processing. Therefore the following hypothesis exists:
- **H6: Reduction in settlement times will positively influence adoption of STP.** Information and communication technologies are natural enablers in securities operations. On one hand, participants are

taking advantage of information technologies to realize securities business processes, and on the other hand, advances in communication technologies are paving the way for tighter integration and richer collaboration between trading partners. Therefore, the related hypothesis follows:

- **H7: The extent of advancements in information and communication technologies positively influences the degree of STP adoption.** The STLC is a classic end-to-end business process with sufficient ingredients to implement all aspects of business-process management (BPM; Smith & Fingar, 2003). Major guiding principles for business process management (BPM) within the STLC are (a) real-time automated business processes with no manual handoffs, (b) performance management and benchmarking, (c) automated exception handling, (d) business-driven process reengineering, (e) process integration across trading partners, (f) facilitating the deployment of standards like the financial products markup language (FpML), FIX, SWIFT, and ISO 15002 XML (extensible markup language), (g) Web-service enabling (Samtani & Sadhwani, 2002), (h) business-rules-driven approach, and (i) support for dynamic process topologies. Therefore, the BPM hypothesis is as follows:
- **H8: Business-process management will positively influence STP adoption.** Regulations, practices, and legal issues (http://www.stpinfo.com/supplements) play a very critical role in the adoption of STP. As more and more trades are characterized by their cross-border nature, issues pertaining to the conflict of laws, enforceability of rights, business practices, compliance requirements, and nonstandard operational procedures come into play. Many laws and regulations adopted by countries may serve national interests, but they create barriers to cross-border trading. These have the potential to create hindrances in seamless global securities operations. Therefore, the hypotheses follow:
- **H9: The governance of the STLC through national laws and regulations negatively influences the adoption of STP.**
- **H10: National interests negatively influence STP adoption.** Standards and protocols in communication technologies enabling STP adoption (Douthitt, 2000) include (a) FpML, which aims to standardize e-commerce activities for derivatives, swaps, and structured products, (b) FIX, which is a standard for sending and receiving messages on expressions of interests, orders, order acknowledgments, fills, and account allocations between financial institutions, brokers and dealers, and stock exchanges via ECNs, (c) SWIFT, which is a bank-owned consortium to create and transmit settlement messages and other aspects of trading, and (d) ISO 15002 XML, which is a convergence of FIX, FpML, and SWIFT. These standards and protocols work together with Web services. Therefore, standards and protocols lead to the following hypothesis:
- **H11: Standards and protocols positively influence the adoption of STP.** The STLC is characterized by the back-office nature of many of its steps, making them prime candidates for business-process outsourcing. With the rise in trading volumes and stagnant margins, many organizations in the securities industry are beginning to take advantage of labor arbitrage and lower costs by outsourcing part of or the entire back-office operations to countries such as India, the Philippines, and Malaysia (David & Kumar, 2000). Therefore the following hypothesis exists:
- **H12: Business-process outsourcing negatively influences STP adoption.** Fundamental changes in the securities marketplace are ushering in a slew of regulations and requirements. In the United States, the Securities and Exchange Commission (SEC) has identified three critical issues, namely, (a) price transparency, (b) intermarket linkages to displayed prices, and (c) the duty of best execution owed by brokers to customers (SEC, 2000). These moves by regulatory bodies like SEC are fueling the shift to STP. Therefore, the related hypothesis is as follows.
- **H13: Market changes positively influence adoption of STP.**

FUTURE TRENDS

STP is emerging as a mainstream e-commerce initiative in the securities industry. However, in order for STP to be adopted, certain issues need to be addressed. First, while the goals of STP are clear, these need to be extended, and specific measures and targets need to be developed. Communicating performance against measures and targets provides direction and motivation to STLC participants. Second, the business implications of adopting STP and targeting T+1/T+0 should be made explicit to all participants up front before any STP initiatives are started. This is critical as increased STP adoption potentially might lead to the disappearance (or reduced involvement) of certain participants from the STLC. STP adoption can be staggered with internal STP happening prior to external STP. Finally, prioritized services in the STLC that could be automated ahead of others need to be clearly identified and unambiguously justified in terms of overall business impact.

CONCLUSION

The phenomenal growth of automated trading and settlement, and advancements in information and telecommunication technologies provide STOs with ample scope to embrace STP. STOs can benefit significantly by reducing trading and settlement times, increasing liquidity in the trading system, and increasing operational efficiencies. Secondary data used to develop conjectures in this article, proposed in the form of hypotheses, provide a foundation for rigorous empirical research to (a) understand the importance of each facilitator and obstructer to STP adoption, (b) analyze interrelationships between influencing factors, leading to deeper understanding of the underlying systemic complexity, (c) uncover the strengths of these influences, and (d) develop an STP adoption road map that enhances the probability of accomplishing STP goals and objectives. The results can provide significant inputs to develop an implementation framework that addresses issues concerning the adoption of STP.

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KEY TERMS

Delivery-vs.-Payment (DVP): A securities-industry procedure in which the buyer's payment for securities is due at the time of delivery; that is, security delivery and payment are simultaneous.

Demat Form: The move from physical certificates to electronic bookkeeping. Actual stock certificates are slowly being removed and retired from circulation in exchange for electronic recording.

Electronic Communication Network (ECN): An electronic system that brings buyers and sellers together for the electronic execution of trades. ECNs represent orders in NASDAQ stocks; they internally match buy and sell orders, or represent the highest bid prices and lowest ask prices on the open market.

Financial Information Exchange (FIX): A vendor-neutral standard-message-format protocol for describing real-time security transactions. FIX is a public-domain specification owned and maintained by FIX Protocol, Ltd. The protocol supports all electronic conversations between brokers and other financial institutions.

Securities and Exchange Commission (SEC): The primary federal regulatory agency for the securities industry, whose responsibility is to promote full disclosure and to protect investors against fraudulent and manipulative practices in the securities markets.

Security: An investment instrument, other than an insurance policy or fixed annuity, issued by an enterprise, government, or other organization that offers evidence of debt or equity.

Settlement: The finalizing of the sale of securities as the title is transferred from the seller to the buyer (also called closing). A settlement marks the completion of all aspects of the trading instance. The average price at which a contract trades, calculated at both the open and close of each trading day, is called the settlement price.

Society for Worldwide Interbank Financial Telecommunications (SWIFT): An international body that sets protocols and standards for international payment systems, such as electronic money transfers.

Strategic Planning for Distance Training

Todd Brace
Provident Bank, USA

Zane Berge
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INTRODUCTION

As pressure increases for training to justify itself as an activity with a return on investment (ROI), it needs to align its activities with the strategic objectives of the organization. More importantly, it must position itself in the minds of the organization's decision makers as a necessary component in the strategic-planning process.

In most instances, training is seen as an on-call resource, basically given marching orders after the strategic direction is set. It might occupy a similar position in the process as the purchasing department—that is to say, none. After the strategic plan is set, orders for training are placed with the training function to be filled and delivered as ordered.

This article looks at the issue of training, specifically distance training and education (DT&E), as a factor in the business unit's strategic-planning process. The training function's historical place in the typical organization will be reviewed briefly, as well as a few of the unique dynamics introduced by the emergence of DT&E. To provide adequate background, a discussion of the strategic-planning process will be presented. Included will be a review of factors contributing to effective strategic planning that moves an organization forward. Additionally, common pitfalls of strategic planning will be discussed. The discussion will then move to training's role in strategic planning or, too often, the lack of training's role. The article concludes with a specific look at how distance training and learning is being addressed in the strategic-planning process.

BACKGROUND

In the past, governments ignored DT&E, and higher education only begrudgingly came kicking and sneering to e-learning. Training is undergoing increased scrutiny for its relevance in terms of the value it represents within the organization. Pepitone (1995) cited four key factors driving the evaluation of training. First, how does training assist the organization in responding to increasing competitive pressures? Second, how does it contribute to meeting the challenge of remaining profitable and developing a strategic competitive advantage? Third, to what extent is the aforementioned negative image of training accurate, particularly as a dark hole into which resources pour? Fourth, management often has a concern that the practitioners in training lack business acumen and may even hold disrespect for management. Training's value is made even more complex when one looks at distance training and education. DT&E has caused the training function to rethink everything from the fundamentals of instructional design to computing ROI.

The bottom line regarding training is changing completely, and that change is being driven by the growth of DT&E initiatives. The very competencies required of trainers have changed (Berge, de Verneil, Berge, Davis, & Smith, 2002). The up-front costs of DT&E are largely seen to be higher than traditional classroom training, with capital investments higher, and more common, complex, and extensive partnering with vendors and others (Kruse, 2000). This has been a catalyst for many changes, one of which is that training must explain and justify itself in terms of ROI. It is this focus on ROI that will help ease the training function's access to the strategic-planning table. Complicating this partnership, however, is the role strategic planning often plays in an organization. In truth, few organizations do it well.

WHAT IS STRATEGIC PLANNING AND WHY DO IT?

The strategic-planning process generally results in a visionary statement. Unfortunately, the vision is often unclear and fails to communicate the big picture that drives an organization's direction. Typically the process involves the preparation of a massive document, itself often a roll-up of disjointed data supplied by various parts of the organization. Discussions of the industry, competition, market share, cost cutting, and obligatory goals and objectives are the core of the document. Almost without exception, budgets, spreadsheets, and graphs are added to support the narrative (Kim & Mauborgne, 2002).

How Training Fits in the Planning Process

Where does training fit into the strategic-planning process? Does it fit in at all? Specifically, where does the application of DT&E fit in? In the model above, the role of training would be articulated in the environment-assessment stage. Training resources should be seen as those that need to be deployed to accomplish the strategic objectives. The usual approach, however, is for the various areas of an organization to approach the training function after the goals, objectives, and plans are in place. Essentially, departments place their orders for training. This approach often leaves the training function caught short—scrambling for time and resources. This situation almost always results in a function that cannot possibly provide all the services asked of it. Moreover, training must provide its support with the constraints of a budget that has little relationship to need.

Training is Out of the Information Loop

Many organizations persist in treating employees more as an expense requiring control than an asset to be both used and protected (Landes, 2000). It follows that within those organizations, support systems, such as training, are seen as an expense to be controlled.

Although that way of thinking is still common, or even predominant, in the workplace more companies are realizing that shortchanging employee development has a direct impact on the bottom line (Simpson, 2001). Strategic planning's increasing importance is largely a function of a business climate where rapid change is the norm. The changes that companies face are driven by technology, competition, societal trends, and people (Zuber, 1999).

LEARNING ORGANIZATIONS

A sign that training, or more precisely, staff development, is being seen as a strategic process is the emergence of the concept of learning organizations. A learning organization is one in which learning processes are developed and fully aligned with an organization's improvement and strategic goals. Learning organizations are those that recognize that learning is not confined to the training function, but that there are multiple channels for ongoing learning for the employees. In this case, training becomes one of several learning modes in the company (Gephart, & Marsick, 1996).

Training's role in an organization has been concretely defined over the years. Historically, training is the logical place where trainers should be expected to be working (Main, 2000). Companies that succeed in breaking out of the mold are taking a first step in becoming learning organizations. Because of the rapidly changing dynamics in the business world, survival for organizations requires that there be a change from a training to a performance focus in terms of staff development. Main suggested that this change in focus can take a committed organization 2 to 5 years.

This change in focus supports two critical signs that the learning-organization and human-performance models are moving closer to the strategic-planning process. It must be planned for over a multiyear period. Traditional training models rarely look beyond the current annual budget, let alone map out a long-range strategy that makes sense to the organization. Additionally, the second sign is that the change requires a champion to drive the change. That champion invariably must be someone placed high within the organization. That person, in championing the change in focus of employee learning, must also do so within the context of the organization's wider vision, known as its strategic plan.

The emergence of learning organizations has given a name to that champion: the chief learning officer (CLO). The CLO's primary responsibility is to foster a culture in which a significant emphasis is placed on learning. At first blush, this may sound a great deal like the role of the traditional training manager. However, in learning organizations, the CLO is often either the organization's CEO, or someone who has the full support of the CEO in developing a learning environment. In turn, the learning environment fully supports the strategic objectives of the organization (Simpson, 2001).

DISTANCE TRAINING AND EDUCATION

Distance training is perhaps the hottest topic in the training realm today. Distance training is actually nothing new. Step-by-step procedure manuals and correspondence education, around for decades, were the early forms of distance training. As personal computers became common workplace tools, training content was delivered digitally (Alessi & Trollip, 2001). Today, DT&E can take a lot of forms, from asynchronous self-based training tutorials to instructor-led synchronous and asynchronous learning activities. Organizations have an interest in DT&E for its apparent strategic advantages. These include the potential for lower overall cost, reduced learning times, increased retention through learner-directed review, consistent delivery of content, the ability to track participation and outcomes more efficiently, and anytime, anyplace availability (Kruse, 2000).

DISTANCE TRAINING AS A STRATEGIC PARTNER

As a subset of the training function, DT&E's contribution in the strategic-planning process is closely aligned with training's contribution in general. However, there are some things that indicate that the unique aspects of DT&E make it more of a player in strategic planning.

First, the up-front costs of implementing DT&E initiatives can be staggering (Segers, 2002). The hardware, software, licensing, consulting fees, development costs, maintenance costs, outsourcing, and unique training-staff competencies needed for varying levels of distance training can add up to a significant amount—so much so as to be on the radar screen of the executives who keep an eye on the bottom line.

The end result is that initial forays into distance learning do not just require the sign-off of upper level management. Required is the intense attention of upper level management. This is not like traditional training burying Proxima projectors, overhead projectors, poster printers, or other training materials in an otherwise lightly scrutinized budget roll-up. The investment in distance training requires sign-off at the very highest level of the process. This means that it must make sense from a strategic perspective. ROI, always the elephant in the china shop from training's perspective, is not simply a goal to work toward, but must be fully articulated at the outset. Some organizations factoring distance training into their strategic plans are using a 1- to 3-year payback period, in terms of cost reductions or productivity improvements, as a yardstick with which to approve distance training's use or to measure its impact (Martin, 2001).

ROI measurements as a part of distance training means that a training manager implementing such a strategy must align with the strategic-planning process if the initiative is to be approved and sustained (Berge & Kearsley, 2003). DT&E's up-front costs, accounting, and cultural impact is such that they require attention and sign-off at the very highest level of the business unit. At that level, decisions are made on expenditures according to their relative merit for accomplishing the organization's business objectives. This indeed is a function of strategic planning.

REALITY, DISTANCE TRAINING, AND STRATEGIC PLANNING

In August 1997, Boeing Co. merged with two of its biggest competitors, and in so doing, doubled its workforce from 110,000 to 248,000 (Benini, 1999). Boeing knew, before it moved on the merger, that it could not follow traditional classroom-based instruction models to merge the learning dynamics of the new organization. Indeed, it calculated that it would take years before all staffers were adequately trained. Distance training was a part of the strategic plan for this merger from the very beginning. It might not be an exaggeration to say that without distance training, and its careful consideration in the early stages of the planning process, this strategic direction might not have even been a possibility.

In September of 2000, CTC Communications Group announced that it had just implemented an online, Web-based distance learning program for its sales and service personnel. Designed to replicate the instructor-led classroom environment as much as possible, its intent was to maintain the skill sets of its widely dispersed 450-person sales and service team ("CTC Communication," 2000).

If the deployment was simply to make training more accessible, then it may have been considered a success the moment the system was turned on. It became a strategic initiative, however, when specific business-related goals and objectives were tied to its deployment. CTC had a growth plan that included doubling its business market and doing so within an environment of cost containment ("CTC Communication," 2000).

The skill development of the workforce, done economically, efficiently, and effectively, was considered to be a critical component of accomplishing the business objective. The company realized $200,000 in savings based on training-related travel and other expenses. It was training's clearly defined role in the strategic objectives, and the plan for measuring the attainment of those objectives, that put distance training in the mix of strategic planning as opposed to traditional training models.

DT&E is seen as a cornerstone of strategic business strategies for many retail banks. Retail banks have grown in the last 10 years largely through acquisitions. Very few are opening many new branches. From a straight balance-sheet perspective, this is an easy way to acquire deposit bases, loans, mortgages, physical locations, and even market share. Most importantly, it provides market penetration as a bank moves into an area in which it previously had little or no presence.

What is difficult about this process is that each acquisition also requires the assimilation of workforces, cultures, policies, procedures, systems, products, services, and knowledge inventories. The problem is not unlike Boeing's in those respects. Where it does differ, however, is that when a bank acquires another bank, it is acquiring retail outlets with perhaps dozens of locations spread out over thousands of square miles.

Following the instructor-led model makes this process extremely difficult and expensive. Training centers must either be set up in the remote locations, or the individuals must travel to existing training locations. Either way, the costs and logistics can be considerable.

Factor in that the workers are retail workers, and leaving retail establishments to attend training creates severe coverage and customer-service challenges. It is no wonder that financial-services industries are among those who are in a position to best exploit the strategic advantages of distance learning (Martin, 2001).

FUTURE TRENDS

As globalized business moves from e-commerce to m-commerce (mobile commerce), the demand and needs for learning and performance improvement will continue to expand rapidly. Innovation by an enterprise cannot happen unless something new is learned first (O'Driscoll & Briki, 2004). The companies and industries that are truly exploiting distance training for its potential strategic payback are looking at it from the top down, not the bottom up. Bottom-up distance training is driven by the training department, and while DT&E initiatives may impress executive management, the decision makers may or may not actually see the business potential beyond some obvious efficiencies gained.

In the examples shared here, representative of countless others, we see businesses and industries that view DT&E as actually being a component that truly expands the enterprise's capacity and therefore its growth potential. If strategic planning is the tangible mapping of an organization's growth, in the previous examples DT&E has truly integrated itself in strategic planning.

Perhaps an announcement in 2000 by eYak, a provider of carrier-class voice and data application servers, is an early sign of things to come. The announcement was that eYak was adding two recognized distance learning experts to its Strategic Advisory Board. Indeed, in this example, DT&E is literally at the strategic-planning table ("Dr. John Flores," 2000).

CONCLUSION

Effective strategic planning is becoming more of an imperative for competitive organizations today. Organizations that do a good job with the process realize that factoring in the human-performance variable is more critical than ever. The workforce is required to better acquire and apply knowledge, and the organization must find ways to exploit that knowledge more effectively.

DT&E contributes greatly to an organization's ability to maintain a current knowledge base within the workforce. However, deploying DT&E requires cultural change, different types of capital investments, and different ways of measuring the performance and efficacy of training programs. It is not something that can be entered into lightly or without serious analysis on the part of upper management. It can dramatically stretch the capacity of an organization. Conversely, it can be an expensive party favor if not carefully incorporated into the company's strategic direction.

Because the use of DT&E requires that it is tied to the strategic plans for a company, one might conclude that DT&E has served as a catalyst that brought the training function closer to the strategic-planning table. Without the advantages and related considerations that accompany DT&E, the traditional training function might still be languishing far from the strategic-planning process, continuing to dutifully fill orders for training, and being seen as the first expense cut when an organization fails to accomplish its objectives.

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KEY TERMS

Assessment: Used here as the process of gathering, describing, or quantifying information about performance.

Distance Training and Education (DT&E): The process of delivering instructional resources for the purposes of training and education to a location (or to locations) away from a classroom, building, or site to another classroom, building, or site by using video, audio, computer, multimedia communications, or some combination of these with other traditional delivery methods.

Learning Organization: An enterprise that facilitates the learning of all its members and continuously transforms itself.

M-Commerce (Mobile Commerce): Using wireless technology such as telephony and computing for commerce.

ROI (Return on Investment): Traditionally defined as the increase in financial value provided by a new investment. However, this definition does not work well for intangibles, such as e-learning and the effective management of human capital.

Strategic Planning: Defined as the process of developing and maintaining a strategic fit between the organization's goals and capabilities, and its changing marketing opportunities.

Synchronous and Asynchronous Learning Activities: Events, either in real time or delayed time, in which a learner increases his or her skills and knowledge.

Category: Concepts, Trends, and Challenges

Structure and Components of E-Commerce Business Model

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INTRODUCTION

A successful e-commerce venture requires a viable business model and a long-term sustainable strategy. When planning and implementing e-commerce ventures, business executives must address several strategic questions, such as: What are the functions and components of a viable business model? How does one capture and capitalize on the unique features of the Internet and e-commerce to achieve sustainable competitive advantage and profits? How are values being created in the Digital Economy? How can network effects and scope economies change a company's competitive position in e-commerce? How can cost, revenue, and growth models in e-commerce differ from the traditional businesses? This article extends Lee (2001) and Lee and Vonortas' (2004) works on business model and strategy to discuss the structure, components, and key issues of a viable e-commerce business model.

BACKGROUND

A business model describes the basic framework of a business. It is the method of doing business by which a company can generate revenue to sustain itself (Rappa, 2003; Turban, King, Lee, & Viehland, 2004). It also tells what market segment is being served (who), the service that is being provided (what), and the means by which the service is produced (how) (Chaudhury & Kuilboer, 2002), and how it plans to make money long term using the Internet (Afuah & Tucci, 2003, p. 51). A firm's business model should also describe how the organization is positioned in the industry value chain. Timmers (1998) defines business model as an architecture for the product, service, and information flows, including a description of the various business actors and their roles; a description of the potential benefits for the various business actors; and a description of the sources of revenues. Weill and Vitale (2001) define an e-business model as a description of the roles and relationships among a firm's consumers, customers, allies, and suppliers that identifies the major flows of product, information, and money, and the major benefits to participants.

In terms of business areas, Rappa (2003) identifies nine basic Internet business models. They are: brokerage, advertising, infomediary (e.g., recommender system, registration model), merchant, manufacturer (direct marketing), affiliate (provide commission for online referrals), community (voluntary contributor model or knowledge networks), subscription, and utility (e.g., pay by the byte). In addition, Turban et al. (2004) also identify several types of Internet business models including: name your price, find the best price, dynamic brokering, affiliate marketing, group purchasing, electronic tendering systems, online auctions, customization and personalization, electronic marketplaces and exchanges, supply chain improvers, and collaborative commerce.

As for the specific components, an e-commerce business model should consist of multiple components and perform different functions. Rayport and Jaworski (2001) argue that a "new economy" business model requires four choices on the part of senior management. They include the specification of a value proposition or a value cluster for targeted customers; a scope of marketspace offering, which could be a product, service, information, or all three; a unique, defendable resource system—that is, the associated resource system to deliver the benefits; and a financial model, which includes a firm's revenue models, shareholder value models, and future growth models. To study the role of the business model in capturing value from innovation, Chesbrough and Rosenbloom (2002) identify the functions of a business model, which include: (1) to articulate the value proposition; (2) to identify a market segment; (3) to define the structure of the firm's value chain; (4) to specify the revenue generation mechanism(s) for the firm; (5) to describe the position of the firm within the value network; and (6) to formulate the competitive strategy to gain advantage over rivals. Other scholars, such as Dubosson-Torbay, Osterwalder, and Pigneur (2002) and Alt and Zimmermann (2001), also made significant contributions to the theoretical discussions and business practices of e-commerce business models.

MAJOR COMPONENTS AND KEY ISSUES OF AN E-COMMERCE BUSINESS MODEL

In order to sustain a successful business venture, a viable business model should address a number of issues and the dynamics of the respective elements which include: what value to offer customers (strategic goals and value proposition), which customers to provide the value to (scope of offerings), what capabilities are needed to build a successful and unique resource system, how to price the products or services and generate streams of revenues, how to increase the scale and the scope of the venture, and what strategies and processes are needed to build and sustain a successful e-commerce business model.

Structure and Components of a Viable E-Commerce Business Model

Table 1 lists and discusses major components and several key issues of a viable e-commerce business model. It can be used to assist business executives and entrepreneurs in planning and implementing e-commerce business ventures. It also serves as a basic framework for further study of the e-commerce business model and strategy.

Table 1. Components and key issues of the e-commerce business model

Component	Element	Key Issue
Value propositions	**Choice of focal customer benefits**	**Core products/services:** • What kinds of value or benefit do we provide for our customers? • How uniqueness is the value or benefit? • Do those values satisfy customer's demand? • Does the products or services have strong network effects? • Are there substitutes for our products or services? **Supplement products/services:** • How important are the supplement products or services? • How to increase customer value by improving or redesigning business processes? • How important do we need to provide product instructions, user training, and customer services?
	Target segment	**Market attractiveness** • How substantial is the market segment? • Whether the market is underserved or over-served? • What is the growth rate of the market segment? • Which stage is the product in the product lifecycle? **Intensity of market competition** • What is the market or industry structure? • How intensity is the competition? • How large is the entry and exit barriers?
Scope of offerings	**Customer decision process**	**Pre-purchase** • How to make easy for customers to obtain and compare product- or service-related information? • How importance is the advertising to inform or persuade customers to make the purchase? • Do we need to obtain a 3rd-party certificate or verification (e.g., VeriSign) in order to build a trust relationship with our customers? **Purchase** • When, where, and how do customers make the purchase? • What kinds of service are required to assist customer in purchasing the product or service? • Whether the delivery of products or services is efficient? **Post purchase** • Do we understand customer's evaluation and satisfaction of the products or service? • Do the majority of the customer make repeat purchase? **Purchasing process** • How important is to offer customer assistance in the whole process of purchasing a product? • Can we identify customer decision process and be able to provide effective assistance? • Do we have an effective e-commerce site that is user friendly? • How to lower the "transaction costs" to make easy for customer to do business with you?

Table 1. Components and key issues of the e-commerce business model (cont.)

	Product or service contents	**Core product or service** • Do we understand which business we are in? • Do our products or services solve the customer's problems? **Supplementary product or service** • Do we build and maintain a set of "digital assets" in order to know our customers better? • How to leverage on a single set of digital assets to provide value across many different and disparate markets? • How to increase customer's "switching costs" of using your company's products or services? **Core delivery process** • Do we understand and take advantage of the economies of scope in production and distribution of the product or service? • What kinds of channel (digital and/or physical) do we need to deliver our products or services? • How efficient and effective the products or services being delivered?
Unique resource system	**Resources and capabilities**	**Specifying a resource system** • Do we identify the resources (e.g., labor, capital, assets) needed to build our core competencies or capabilities? • Do we have all the necessary core capabilities to support our scope of product or service offerings? • Do we need to outsource and/or partner with others to gain missing capabilities? • Can we identify key players who can fill out the missing capabilities? • How important is the role of intellectual property rights (e.g., patents and trademarks) in building capabilities? **Assessing the quality of the resource system** • How uniqueness of our resource system? • How difficult is for competitors to imitate our system? • Do each of the capabilities support the delivery of a customer benefit? • How well do the capabilities complement and support each other? • Are the specific resources mutually reinforcing? Are they complementary? • Does the online resource system support the offline system?
	Logistics and delivery systems	**Integration** • Can we deliver a unique customer experience through e-commerce? • Are we able to achieve supply chain integration and synchronization (e.g., applying Internet-based collaborative planning, forecasting, and replenishment)? • Are we able to collaborate with business partners across a common technical platform using common e-business applications? **Fulfillment** • Can we match the performance of the physical activities to the virtual world? • Can we develop a flexible and reliable channel to reach the end customers? • Can we radically reduce the order-to-delivery time to customers?
Revenue and growth models	**Revenue models**	**Product/service sales** • Are our revenues primarily deriving from product sales or from complementary products or services? • Can we generate revenues from utilizing intellectual properties? **E-Commerce related revenues** • How to identify new sources of revenues from e-commerce (e.g., advertising, referrals, subscription, membership, commissions, transactions, etc.)? • How to use information to create value in both online and offline (e.g., FedEx's packaging tracking system)? • How to develop cross-selling opportunities to achieve synergy? • Do our customers value the benefit of one-stop shopping? **Pricing** • How to test prices, segment customers, and adjust to changes in supply and demand in real time? • How to analyze digital assets and experiment new way of pricing? • Are we able to implement innovative e-commerce pricing methods (e.g., reverse auction, one-to-one bargaining)? • How to build online brand equity to enhance loyalty and to reduce price sensitivity?

Table 1. Components and key issues of the e-commerce business model (cont.)

	Financial growth models	**Growth strategy** • How should we develop new revenue growth? (e.g., deeper penetration into the current market, new product development, new market development, and/or completely new products and markets) **Growth model** • Do we need to spin off online division to establish a new company? • Do we need to establish strategic alliances or merge with other online/offline companies?
Competitive strategy	**Value chain positioning**	**Value system or network** • Where do we position our products or services in an industry value chain? Can we integrate or move upstream or downstream to increase added values? • How do we create value? Do we create customer value as a partner in a supply chain (e.g., manufacturer or retailer), as a value shop (e.g., professional service), or as a central player of a network (e.g., intermediary service)? • Can we join a "business ecosystem" (Gossain and Kandiah, 1998) (e.g., online mega sites such as Amazon.com) as a member to provide products or services to the final customers?
	Generic Strategy	**Competitive advantage** • Do we have advantages over our competitors, in terms of marketing, cost structure, and product or service differentiation? • Do e-commerce and the Internet redefine the competitive advantage in the market or industry we are in? **Generic strategy** • Which strategy should we pursue in order to sustain our competitive advantages? (e.g., increase entry barrier or block strategy, innovation or run strategy, and/or alliance or team-up strategy)

Value Creation in E-Commerce

In the physical or traditional industrial economy, inputs to a value creation process are raw materials or all of the necessary physical inputs that are required to produce the finished products or services. Outputs are finished goods or intermediate goods used as inputs to the subsequent downstream value creation processes. In the value creation process, information serves as a supporting element. Information, such as design and engineering know-how as well as production methods and procedures, is applied to facilitate the "physical" transformation process which involves one or more of the four value-adding activities describe in Meredith and Schaffer (1999): inspect, alter, transport, and store. Under this paradigm, general management's main focus is to make the transformation process more efficient.

In contrast, input to the value creation process in the digital economy (Tapscott, 1996) is information (e.g., customer information or digital assets, and the status of production and distribution process) that firms gather, organize, select, synthesize, and distribute (Rayport & Sviokla, 1995) in the transformation process to provide individual customers a customized solution. In the digital economy, information is a source of value, and every business is an information business (Earl, 1999). Organizations in the Digital Economy should understand and be able to apply the concept and practice of virtual value chain (Rayport & Sviokla, 1995) to create value and to generate new business opportunities. Since physical and digital economies coexist within a firm and across industry supply chain, business executives must go beyond focusing on improving the transformation process itself to concentrate on leveraging information assets and capitalizing on the unique features of e-commerce and the Internet to create more value for the customers.

Five Steps toward E-Commerce Success

Lee (2001) proposes that there are five essential steps toward e-commerce success. First, companies must redefine their competitive advantage in the Digital Economy because e-commerce is changing the basis of competition. Business executives must redefine their competitive advantages in terms of cost, differentiation, marketing, and distribution. For example, Compaq built the best retail-distribution network in the computer industry in the 1990s, but cannot compete with Dell's "fast and light" direct-sales approach enabled by the Internet technology (Browning & Reiss, 1999). Second, companies must rethink the traditional ways of formulating business strategy. Executives must generalize thinking beyond building must re-engineer the organization structures and processes to capitalize on the benefits of e-commerce. For example, to implement a customer-centered e-commerce model, a company needs to integrate its suppliers, back-office functions, and front-office functions in order to achieve the organizational flexibility necessary to move at Internet speed and to satisfy customer demand. Finally, companies must be able to reinvent customer services by building cost-effective total experience and loyalty-enhancing relationships with the most profitable customers. Companies can involve customers in the product development process through initiating technology-facilitated dialogue. In addition, companies can gather knowledge about its customers by building and controlling a comprehensive customer database (i.e., digital assets). For example, mega retailing sites such as Amazon, Yahoo!, and eBay are able to redefine economies of scope by drawing on a single set of digital assets to provide value across many different and disparate markets to maximize customer value.

FUTURE TRENDS

Business models are largely believed to determine the success of an e-commerce venture. Alt and Zimmermann (2001) argue that business models are perhaps the most discussed and least understood terms in the areas of e-business. Business scholars have been conducting research in the e-commerce business model for more than a decade to assist business executives and entrepreneurs in formulating and implementing innovative business models. We now have a much better understanding of the taxonomy, components, and architecture of business models. Future research on the analysis, design, development, implementation, and controlling of the e-commerce business model include, but are not limited to the following areas:

- Innovation in the e-commerce business model and the continuing business model innovation process to achieve competitive advantage
- Convergence of strategy and business model
- Models and modeling techniques of e-commerce business models
- Trust building in the e-commerce business model
- Sustainable business models for services, digital contents, mobile commerce, collaborative commerce, and peer-to-peer architecture
- Other specific industry perspectives on implementing e-business models

CONCLUSION

The article discusses major components and addresses several key issues of designing and implementing e-commerce business models. A viable business model in the digital economy must transform value propositions and organizational structures and systems to enhance value creation. It must be able to take advantage of the Internet network effects and other unique attributes to achieve and sustain a critical mass of installed base of customer. Companies must also build and maintain a large set of digital assets and leverage them to provide a scope of offerings or value across many different and disparate markets to satisfy customers' demands. That is, companies must identify customers' latent needs and transform their business models from a product- or component-based model to a knowledge- or solution-based model. To achieve those goals, companies must be able to build a unique resource system that supports their value propositions and product or service offerings. Companies should also be able to use the Internet to make pricing more precise, to be more adaptable in responding to fluctuations in supply and demand, and to segment customers more effectively (Baker, Marn, & Zawada, 2001). In addition, companies need to understand the impact of e-commerce that has redefined a company or industry's competitive advantages, and be able to formulate and implement competitive strategies to gain and sustain new competitive advantages in the digital economy. Finally, this article discusses the five essential steps for companies building a successful e-commerce model in order to transform their business practices in the digital economy.

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KEY TERMS

Business Ecosystem: A system in which companies work cooperatively and competitively to support new products, satisfy customers, and create the next round of innovation in key market segments.

Business Model: The method of doing business by which a company can generate revenue to sustain itself.

Digital Assets: The information (in digital form) a company collected about its customers. Companies that create value with digital assets may be able to reharvest them through a potentially infinite number of transactions.

Digital Economy: The economy for the age of networked intelligence. The digital economy is also a knowledge economy. Information, in all forms digital, is the input of an organizational transformation or value creation process.

Economies of Scope: *Supply-Side Economies of Scope*—Cost of the joint production of two or more products can be less than the cost of producing them separately. *Demand-Side Economies of Scope*—A single set of digital assets can provide value for customers across many different and disparate markets.

Network Effects: Products or services whose value to an individual buyer increases when many other people also consume the same products or services.

Switching Costs: Refers to costs incurred by buyers when they switch to a different supplier.

Transaction Costs: Costs associated with contractual relationships in a market economy—that is, costs that the consumer or the producer pays to make the market transaction happen.

Tailorable E-Government Information Systems

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INTRODUCTION

Real-world information, knowledge, and procedures after which information systems are modeled are generally of dynamic nature and subject to changes, due to the emergence of new requirements or revisions to initial specifications. E-government information systems (eGIS) present a higher degree of volatility in their environment, since requirement changes may stem from multiple sources, including legislation changes, organizational reforms, end-user needs, interoperability, and distribution concerns, etc. (Jansen, 2004; Prisma Project, 2002; Scholl, Klischewski, & Moon, 2005. To this end, the design and implementation of eGIS must adhere to paradigms and practices that facilitate the accommodation of changes to the eGIS as they occur in the real world. Object-oriented technologies have been extensively used to encapsulate reusable, tailorable software architectures as a collection of collaborating, extensible object classes; however the inherent conflict between software reuse and tailorability has inhibited the development of frameworks and models that would effectively support all requirements exposed by eGIS (Demeyer, Meijler, Nierstrasz, & Steyaert, 1997). The lack of such frameworks has lead to eGIS that cannot easily be adapted to the new requirements, mainly because only the predetermined specifications are taken into account and design decisions are fixed during the implementation phase (Stamoulis, Theotokis, Martakos, & Gyftodimos, 2003).

A key issue to a viable solution eGIS modeling is the provision of the ability to multiple public authorities (PAs) to represent different aspects of the same real-world entity, while maintaining at the same time information consistency. Aspect representation is not only limited to data elements that describe the particular entity, but may extend to behavior alterations, when the entity is examined in different contexts. For example, an entity representing the citizen is expected to assume the behavior of *beneficiary*, when used in the context of the Ministry of Social Security, and the behavior of *taxpayer*, when accessed from the Ministry of Finance's eGIS. Distinct behaviors may rely on different data representations and/or respond differently in requests. In this work we present a role-based modeling and implementation framework, which can be used for building eGIS and we argue that this model promotes the tailorability and maintainability of eGIS.

BACKGROUND

Currently, the representation of different real-world entity aspects is mainly achieved through the use of multiple, totally independent representations of the real-world entities, one per PA eGIS. Each representation encompasses the data elements, and models the behavior pertinent to the specific organization. Note that these data and behavior may include portions administratively regulated by other PAs, (e.g., the Ministry of Transport is administratively responsible for defining vehicle ownership-related data), however the Ministry of Finance eGIS should include such data, for taxation purposes.

At the other extreme of each eGIS having its own real-world entity representations, a single, centralized repository can be employed. According to this approach, some PA develops and maintains an eGIS, which is the authoritative source for both defining the schema and storing all data values for real-world entities. The schema must consolidate all data-related requirements of all PAs, while security rules can limit the access of any PA to the schema elements pertinent to its task(s).

Between the fully replicated and the fully centralized approach, a federated database approach (Chorafas & Steinmann, 1993) could be adopted, according to which each PA eGIS defines a schema portion, which is *exported*. PA eGISs may also *import* schema portions that have been exported by other "federation members", with each import augmenting the locally defined schema. The federated approach decentralizes schema maintenance tasks, with each PA updating the global schema portion for which it is responsible.

A methodology towards meeting both the requirements of multi-aspect modeling and context-specific behavior, while enhancing the overall system maintainability is the adoption of *two base constructs* for entity modeling: the first construct models fundamental behavioral system blocks, providing only the essential behavioral elements of the most abstract version of the modeled entity; this construct is termed *ATOMA* (Theotokis, 1997) and realizes the most basic collaboration and reuse contracts (Codenie, De Hondt, Steyaert, & Vercammen, 1997). Enhanced and context-specific behaviors are modeled using a second construct, namely *roles*, which are attached to atoma for modeling functional behavior related to a basic entity. Role attachment and removal can be performed dynamically, and multiple roles can be attached to a single entity, effectively modeling *facets* of this entity. Roles also implement their own collaboration and reuse contracts, through which operations are requested in the context of eGIS.

The Atoma framework is based on the concept of *separation of concerns* (Theotokis, 2003), which is a key concept in realizing deferred design decisions as it facilitates the notion of "injectable" behavioral adjustments in existing operational eGIS. The ATOMA model allows object-oriented design and code to be decomposed into units, describing basic behavior, as this is captured during the initial design phase from the contractual requirements, and units that specify either variations or changes to these requirements, or new requirements, as these emerge in time. Both at design and implementation level, the former are represented as standard object-oriented classes, while the later are roles that, when composed with classes, realize the ever-emerging requirements. Each role can therefore be refined separately to a code artifact, and the details of the code composition can be derived from those of the design composition.

THE ROLE-BASED MODEL FOR TAILORABLE E-GOVERNMENT SYSTEMS

eGIS Modeling Using the Atoma Framework

According to the atoma framework, for each real-world entity, a single atoma construct is defined, which encapsulates the fundamental data and functionality needed for managing this entity. The PA eGIS within which the construct is defined may be chosen on the basis of various criteria, such as administrative responsibility, technical know-how, expected access patterns and so forth. Once the construct for modeling a real-world entity has been defined, it may be *exported* for use by other eGIS, which will *import* this construct. Each eGIS also provides implementations for the roles that will be assigned to the atoma to be used within its context, either locally defined or imported. For example, the Ministry of Transport may define the roles *taxi* and *bus* that will be assigned to atoma of type *vehicle* (locally defined), while the Ministry of Finance may define the role *taxpayer,* which will be assigned to atoma of type *person*, a type imported from the Ministry of Social Security. Correspondence between roles and atoma types is not necessarily one-to-one: the Ministry of Finance may define the *taxable good* role, which can be assigned to atoma of types *building*, *car*, *value-added service* and so on. The communication between a role and the atoma construct to which it has been assigned is based on the collaboration and reuse contracts provided by the atoma construct; thus, the *taxable good* role can be assigned to any atoma construct that implements the collaboration contract *price*, which will be invoked to obtain the net price (before taxation) of the relevant real-world entity. During the period that an entity is assigned the *taxable good* role, its behavior is enhanced with the operations defined in the role (e.g., *tax amount*), while some of its operations may be overridden by respective ones implemented by the role (e.g., the *price* behavior will be redefined to return the net price plus the tax due). Note that both the role and the underlying entity may independently evolve without any disruption in their communication, as long as the collaboration contracts are respected. Moreover, the interaction between a role and the eGIS it is used within will function properly, as long as the existing elements of the collaboration contract implemented by the role are not altered (new elements may be added with no side-effects).

Similarly to atoma constructs, roles can also be *exported* by the PA eGIS that has defined them and imported by other PA eGIS for use, if the functionality they provide is useful in the context of the importing eGIS. For instance, the *taxable good* role, defined by the Ministry of Finance, may be imported by the Ministry of Commerce and assigned to atoma constructs, either locally defined (e.g., *value-added service*) or imported (e.g., *car*).

Maintaining Role-Based eGIS

When a new requirement is added or an existing one is changed, a new design aspect (a role) is created to address it. The new design aspect can then be composed with the existing design. Afterwards, the design aspect can be refined to a code aspect (role implementation), which is similarly composed with the existing code. The changes are localized without risking the rest of the system's stability, so there is no tangling, and both traceability and monitoring are preserved. In addition to this, dealing with the alignment problem, the decomposition into roles alleviates the monolithic nature of the design, and allows for concurrent development, while the composition underlying the ATOMA model provides a powerful mechanism for integration, evolution, customization, adaptation, tailorability and improved reuse.

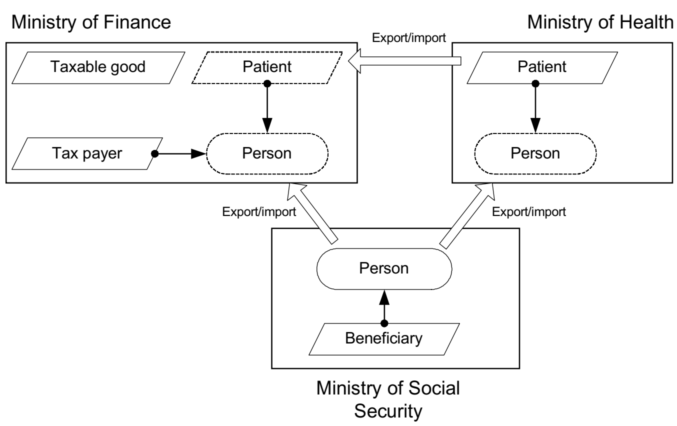
It is in fact this composition mechanism that provides a remedy to the problem of constructing rigid systems. The necessary inflexible mapping of requirements to design units is no longer required, and design decisions, which fix requirements into design, and subsequently code, are no longer necessary. By separating the various cross-cutting aspects of a system, modeling them independently and composing them back to deliver the required function of the eGIS, we advocate that deferred design decisions can be realized, and thus enable the construction of truly tailorable eGIS.

Using Atoma and Roles: A Case Study

Figure 1 presents an example of an eGIS with three constituent PA eGIS. The case study has been drawn from the Greek public administration, by studying the related legislation and practices. Atoma are represented as rounded rectangles, whereas parallelograms are used for roles. Solid lines indicate that the construct has been defined within the eGIS it is depicted in, while dashed lines indicate imported constructs. Role assignment to atoma is shown through arrows. Only one atoma construct is defined in this example, namely Person. This construct is defined within the Ministry of Social Security, which additionally defines the *beneficiary* role that it assigns to the person construct. In this manner, a *Person* exhibits the behavior of *beneficiary* only when it is treated within the context of the Ministry of Social Security, whereas outside the scope of this eGIS only the basic *Person* behavior is available. The two other ministries (Health and Finance) import the Person construct and assign to it locally defined roles (Patient and Taxpayer, respectively). The Ministry of Finance additionally imports the Patient role from the Ministry of health, and assigns it to the Person construct, since the hospitalization expenses (included in the Patient role's contract) are needed within the context of the Ministry of Finance's eGIS, to enable their deduction from the person's taxable income.

Since roles are independent of one another, it is possible that two or more roles implement different behaviors under the same collaboration contract. For instance in Figure 1, it is possible that both roles, *Patient* and *TaxPayer,* include a *Checkup* contract with different semantics (triggering clinical tests and initiates a detailed audit of tax records, respectively). Since within the Ministry of Finance's eGIS both roles have been assigned to the Person construct, an ambiguity issue is raised regarding which behavior should be selected. This ambiguity is resolved by defining priorities for role assignments, effectively dictating the order in which role contracts will be scanned for elements matching any individual contract use. It is generally expected that locally defined roles should be assigned higher priorities than imported roles, however no such restriction is imposed by the model. The atoma framework encompasses even more powerful methods for atoma and role combinations, such as molecules, which can be used in more complex cases (Theotokis, 2001).

Figure 1. Definitions, exports, and imports of atoma and roles



Comparing the Atoma Framework and Other Approaches

As noted in the background section, the dominant approaches for modeling multiple aspects of real-world entities within eGIS belonging to different PAs are; (a) the use of totally independent systems, (b) the introduction of a centralized repository where all schemata are consolidated, and (c) the use of a federated schema approach. These practices, however, have a number of disadvantages seriously impeding the design process, modeling of context-specific behavior, tailorability and maintainability.

The practice of using independent systems introduces multiple autonomous representations, which are a potential source of inconsistencies, both at the level of schema representation and at the level of stored data values (Lenz, 1996; Wiesman, et al., 2000). Indeed, if a change affecting the schema of the data used for a specific purpose is decided by the administratively responsible PA, this change should be communicated to all other PAs that handle such data, and their eGIS should be accordingly modified; the distributed nature and the scale of these maintenance activities increases the associated costs and the probability of errors. At data instance level, changes to data values stored in one eGIS do not affect the corresponding values in other eGIS, leading to discrepancies in the representation of the same real-world entity. Finally, multiple copies of the same information are maintained, increasing the overall storage requirements.

The centralized repository approach eliminates inconsistency problems (only one schema is defined and a single copy of each datum is stored), it hinders however the modeling of context-specific behavior for the entities. If entity behavior was modeled within the global repository, a single behavior would be provided for all eGIS using the entity, regardless of the context. If entity behaviors were provided separately by each PA eGIS, changes to the "global schema" would necessitate maintenance activities for all affected PA eGIS. Note also that global schema amendments and the PA eGIS maintenance should be performed "almost synchronously", since the PA eGIS data model should exactly match the repository data model upon any access.

Finally, the federated database approach cannot address the issue of context-specific behavior: if each PA eGIS fully models the behavior entities should have in its context, changes in some schema portion would again call for maintenance activities to all PA eGIS importing the modified schema; if the behavior were provided by schema publishers, context-specificity would be hindered and an additional concern would be raised, regarding where to code behavior that uses multiple schema portions, exported by different PA eGIS.

The role-based model presented above successfully tackles all these issues, by allowing organizations to model both the data items and the behavior pertinent to the entity within the role concept, which is attached to the basic atoma construct corresponding to the real-world entity. Roles can be shared between eGIS, at both schema and instance-data level, removing thus any inconsistencies due to multiple copies. Context-specific behavior is directly modeled through new context-specific roles and/or by fine-tuning the assignment of roles to atoma. Finally, maintenance is facilitated, since changes in existing requirements or emergence of new ones can be addressed through the modeling of new roles. Note that the creation and assignment of new roles (as well as the de-assignment of existing ones) can be performed at any instant, removing the need for fixing design decisions at early stages, and increasing the overall system flexibility.

FUTURE TRENDS

eGIS have emerged in the past few years, aiming to exploit information and communication technologies for providing public services with improved quality and reduced costs (Forman, 2002). Insofar, most of the work has been devoted to developing isolated informational and transactional services, but service interoperation and integration, which provides added value for service consumers [e.g., for handling *life-events* (Wimmer & Tambouris, 2002)], has not received comparable attention. It is expected that the research and implementation agenda for eGIS will include these aspects, for which the work presented herein provides the necessary technical infrastructure. Of equal importance is the provision of a methodological framework that would support the phases of eGIS requirements analysis and design, enabling involved stakeholders to unambiguously distinguish between basic and context-specific functionalities of real-world entities, providing appropriate input to the implementation phase. Methodologies extending beyond traditional service-provision systems, to include the dimensions of managerial effectiveness improvement and democracy promotion (Gil-Garcia, 2004; Cohen, 2002), providing a holistic framework for e-government will also be of essence.

CONCLUSION

In this article we have presented a framework for constructing tailorable eGIS. The proposed framework employs two basic constructs for modeling real-world entities, namely *atoma* for encapsulating basic representational needs and fundamental functionality, and *roles* for representing context-specific behavior that is attached to atoma on demand, according to the needs of the eGIS within which the entity is examined. By employing this design and implementation frameworks organizations enhance the overall system maintainability, since atoma and roles may evolve independently, provided that the reuse and collaboration contracts are respected along the evolution. New behaviors, necessitated by changes of existing requirements or emergence of new ones can also be seamlessly integrated into the system, by modeling new roles and attaching them to the pertinent atoma. Future work will address the formulation of a methodology for eGIS design according to the atoma framework, as well as issues related to migration and mobility of atoms and roles, as well as versioning and persistency.

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KEY TERMS

Atoma: The most abstract level of representation of a real-world entity, encompassing only the most basic data and functionality for representing and manipulating the entity.

Centralized Representation Repository: A single database in which all real-world entity representation models are stored, and any information system willing to access a model retrieves if from there. This approach keeps the models consistent but shifts the maintenance issues to the client information systems.

Export/Import: Information systems may define atoma and roles and then *export* them to be used by other information systems. An information system may *import* any of the exported atoma and roles and use it in its own context.

Federated Representational Model: An approach for building representational models according to which each information system defines some aspects of an entity model, contributing thus to a "global" entity model.

Representational Diversity: the practice according to which real-world entities are represented through totally independent and unsynchronised models in different information systems, leading to inconsistencies and maintenance problems.

Role: A situation- or context-specific aspect of a real-world entity. A role may be dynamically associated and removed from an atoma construct when either the real-world entity evolves accordingly (e.g., a *person* becomes an employee or looses this property) or when the behavior modeled by the role becomes/ceases to be pertinent to the current context.

Tailorability: The dynamic accommodation of context-dependent behavioral variations in an existing software system.

Category: Concepts, Trends, and Challenges

Topology for Intelligent Mobile Computing

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INTRODUCTION

We discuss an *interconnectivity framework* for data and content delivery to *mobile devices* that allows data of higher priority to reach the mobile unit in the *shortest time* possible. Two possible scenarios are presented; one that connects the servers in an *N-cube* configuration network, and another that shows the same N servers connected in a grid type network. The goal is to minimize the rate of *data jumps* from server to server until it reaches the mobile device. As the mobile user travels, the mobile device registers itself with the next server and the session is migrated from the old server to the new one without interruptions, in an analogous way, cell phones move from one cell to another. Starting with the idea that all data is not equal (in importance/priority), this article suggest a framework topology for intelligent mobile computing that guarantees data will reach the mobile device in a minimum amount of time, assuring at the same time the privacy of transmission. The integration of this type of technology into the 3rd Generation (3G), and 4th Generation (4G) *mobile computing* is also discussed.

Pervasive computing is rapidly emerging as the next generation of computing with the underlying premise of simplicity (of use), minimal technical expertise, reliability, and intuitive interactions. As technology continues to advance and mobile devices become more and more omnipresent, the aim towards achieving easier computing, more availability and prevalence is becoming a given. Through the clever use of advanced technologies, the new generation of intelligent mobile computing has the opportunity to serve user needs via prevalent computing devices that are ever more transportable and connected to an increasingly ubiquitous network structure. *Mobile communication* is changing as the trends of media convergence including the Internet and its related electronic communication technologies and *satellite communications* collide into one.

A change is being ushered by the 3G (3rd Generation) mobile technology with the usability and usefulness of information delivered to mobile devices taking on added features. For example, *multimedia messaging*, as opposed to *voice transmissions*, being delivered to cell phones has rendered such mobile devices an integral part of people's lives and a core part of how they conduct their daily business rather than an add on tool (Buckingham, 2001).

The *3G mobile phone* system aims at unifying the disparate standards of current second generation *wireless systems*. The idea is to eliminate the different types of *global networks* being adopted with a single standard network. This will allow for the delivery of multimedia content and propagation through the network without the need for conversion from one standard to another. 3G systems need smaller cells thus the need for more base stations (mostly due to their operating frequency, power requirements, and modulation) and in many cases will not be feasible to install them in areas where population is not so dense (i.e., rural areas) (Garber, 2002). Because of these requirements and conditions, a better way to deliver the communication must be established. However, global access to such mobile devices will create *data delivery* challenges and servers can become clogged with unwanted communication, like that of wired Internet access. The need for moving relevant data to mobile devices in the shortest time possible becomes of utmost importance.

BACKGROUND

As the evolving functionalities of mobile computing take on primary roles at both the individual and the organizational levels, researchers and developers move to further enhance the technology. Bettstetter, Resta and Santi (2003) offer a random waypoint model for wireless ad hoc networks suggesting that the spatial distribution of network nodes movement, according to this model, is in general nonuniform and impairs the accuracy of the current simulation methodology of ad hoc networks. They present an algorithm that looks at the generalization of the model where the pause time of the mobile modes is chosen arbitrarily in each waypoint and a fraction of nodes remain static for the entire simulation time. They further show that the structure of the resulting distribution is the weighted sum of 3 independent components: the static, pause, and mobility (Bettstetter et al., 2003)

Xie and Akyildiz (2002) address the problem of excessive signaling traffic and long signaling delays in mobile IP. They argue that it is possible to have a distributed and dynamic regional location management scheme for Mobile IP where the "signaling burden is evenly distributed and the regional network boundary is dynamically adjusted according to the up-to-date mobility and traffic load for each terminal". This is suggested for minimizing the cost of content delivery over mobile IP networks (Xie & Akyildiz, 2002).

La Porta (2002) describes mobile computing as "a confluence of communication technologies (particularly the Internet), computing devices and their components, and access technologies such as wireless." He argues that a mobile computing environment will include not only real-time mobility of devices, but also mobility of people across devices, stressing the fact that the environment must include a wide range of devices, applications and networks (La Porta, 2002).

Zimmerman (1999) states that "The proliferation of mobile computing devices including laptops, personal digital assistants (PDAs), and wearable computers has created a demand for wireless personal area networks (PANs)" showing at the same time the fact that the mobility of such devices places considerable requirements on PANs not only for connectivity, cross-platform and networks but also for content delivery in minimum time (Zimmerman, 1999). This article further addresses the subject of data and content delivery to mobile devices with a keen interest in time and cost issues.

MOBILE COMMUNICATION SYSTEMS

There are four major categories in which data can be classified. These are real-time data, daily data, occasional data, and junk data:

1. **Real-Time Data (RTD):** Both hard and soft real-time is data that needs to be sent/received as soon as possible regardless of cost.
2. **Daily Data (DD):** Data that is sent only once or twice a day at a predetermined time (status reports, weather forecasts, etc.).
3. **Occasional Data (OC):** Data that is sent from time to time (software updates, customer service reports, etc.).
4. **Junk Data (JD):** Data that is considered useless (spam).

One way to speed up the data delivery is called data shorthand, where properly configured computers can send chunks of data based on data changes so only the changed data is sent to the mobile device (Ungs, 2002). But this type of data exchange requires mobile devices to store each of the exchange. Caching transmissions can be used successfully for non real-time data communication (like browsing the Internet, checking e-mail, etc.). For real-time message exchanges, caching cannot be used and other methods of speeding up delivery become necessary.

Convergence between broadband wireless mobile devices and access is currently a significant issue in wireless communications. With the recent technological advances in digital signal processing, software-definable radio, intelligent antennas, and others, the next generation of mobile wireless systems is expected to be more compact, with limited hardware and will feature flexible and intelligent software elements (Rao, Bojkovic, Milovanovic, 2002). Wireless mobile Internet (WMI) is a key application of the converged broadband wireless system where the actual device will be compatible with mobile and global access services, including wireless multicasting and wireless trunking. Some of the characteristics of these mobile devices will be: at least 90% of the transmission traffic will be data, voice recognition functions will be operational for every command, the mobile device will support multiple users and various service options, the mobile device will be adaptive and upgradeable, and the entire transmission will be encrypted for ensuring privacy of communication (encryption will be done in hardware for faster processing).

Mobile wireless communication implies support for user's mobility and the overall communication infrastructure needed to handle movements within the home network cell/servers map but also outside the home network in situations where communication is provided by other providers (Agrawal & Zeng, 2003; Rao et al., 2002). A mobile station (MS) should be able to communicate without session interruptions as it travels anywhere using local wireless infrastructure facilities. Because of this, session handoff between cells and mobile switching centers (MFCs) of various wireless service providers should be supported. As a MS travels from a location to another, it has to register itself with the next cell/server that serves that particular area. Each of the servers maintains a visitor location register (VLR) that is an index of the MS IDs that are in its active area. As the MS leaves a cell/server, an entry is made in the home location register (HLR) of the home network so the current location is known at all times. Based on these registers, data can be sent over the network to reach the mobile device. Our work is concerned less with the way the handoff of the communication session takes place, but more with how many times the data has to jump before it reaches the mobile device as is described below.

NETWORK INTERCONNECTION FRAMEWORK

First, we look at a possible N-cube configuration for mobile switching centers/servers. Each imaginary cube will have eight servers (one server in each corner of the cube). The worst-case scenario will be a maximum of three jumps inside a cube. Any server can be reached from any other one with 1, 2, or 3 jumps. The 2nd cube will also have eight servers and so on all the way to N cubes. The total number of servers will be N [cubes] $\times$ 8 [servers/cube]. Each of the MSCs will only have knowledge of their neighbors MSCs as well as the corresponding MSCs in the adjacent cubes. If we consider that for the real-time data (RTD) a maximum of 0.001 s propagation time between two MSCs inside the same virtual cube, and considering the propagation speed of the signal to be at $2/3 \times C$ (where C is the speed of light in vacuum=300,000 [Km/s]) then the maximum distance between two adjacent MSCs should not exceed: D = (2/3 $\times$C) x 100 ms = (2/3$\times$3$\times$10^8 m/s)$\times$0.001 s = 200 [Km]. This will make the worst-case scenario to be three jumps inside any given virtual cube that means a 3×0.001 [s] delay = 0.003 [s].

If the mobile station (MS) is not in the area covered by a cube, then a jump is needed from a cube to the next cube. If the MS is not registered with a cube, all eight servers/switching stations know that from the VRL list, so it will send the transmission to the next adjacent cube (1 jump only). If we consider the adjacent virtual cubes to be with in 200 [km] of each other, then the jump will not take longer than 1 micro second (0.001 s). In the case of N cubes, we have a maximum of Ln (8N) / Ln (2) jumps to reach the MSC that has the MS registered. In that case considering that every jump introduces a 0.001 [s] delay, in the worst-case scenario we will have 0.001 [s] $\times$ Ln (8N) / Ln (2). So if, for example, an MS travels, say, 5000 [km], that means that the area can be covered with the maximum 5000 [km] / 200 [km] = 25 virtual cubes.

If data needs to propagate from the HS (home station) to the position where the MS station is (5000 Km away), then the total number of jumps (in the worst-case) will be given by: Ln (8×25)/Ln (2) = 7.65 $\rightarrow$ 8 jumps. At 0.001 (s) delay for each jump, then the MS will be reached in minimum 8×0.001 s = 0.008 (s). Of course this would represent the best-case scenario ignoring the overhead and delays introduced by the switching equipment itself. If we use a safety factor of 2 (to cover the overhead delays) then in the worst-case scenario the MS at 5000 km away will receive the data 0.016 (s) after it was sent. This would apply to real-time data (RTD) that cannot be cached and needs to reach the MS the fastest way possible. For the data that is not real time and/or has smaller priorities, if channels in MSCs are available, it can be sent the same way as real-time data. But if the MSCs are busy routing real time transmissions, the lower priority data will be cached and put in a FIFO queue for later delivery.

Another possible interconnection of MSCs would be having the servers in a grid type network. Keeping the same constraints like for the virtual N-cube configuration, then the distance between each of the servers would be 200 [km]. Considering that each of the MSCs/servers can only communicate with a maximum of two other MSCs (no diagonal communication), and the grid has a square profile $(m \times m)$ with n number of MSCs, then the total number of jumps inside the grid would be 2(m-1). Considering the same example as above, with the MS traveling at 5000 [km] away. That distance can be covered by a 25×25 grid with each located at MSC at 200 [km] away from its neighbors. That would imply a number of jumps equal to 2(25-1) = 48. At 0.001 [s] delay per jump, the total delay in the case of a grid network would be 0.001 [s] $\times$ 48 jumps = 0.048 [s]. If we consider that the system has some residual delays, and if we use the same safety factor as in the N cube network, then we have a delay of 0.096 [s] which is six times worse than the virtual N cube configuration delay.

For the case when the MS travels outside an area covered by any of these two types of interconnections, a satellite service (MSAT-mobile satellite service) must be used to relay the data. MSAT are communication satellites in geostationary (Keplerian) orbits (35,786 km) and operate in the frequency range of 1626.5-1660.5 [MHz] for uplink and 1550-1559 [MHz] for downlink and currently serve only the US and Canada (Roddy, 2001). The periodicity of such satellite is 23 hr 56 min 4 sec which matches the Earth's periodicity. Some relevant points regarding this type of satellite: the satellite must move Eastward at the same rotational speed as the Earth, the orbit must be circular (and must maintain the same distance from the Earth), and the inclination of the orbit must be zero degrees (Roddy, 2001). Also, there is only one geosynchronous orbit thus communication via those satellites is still expensive for private use (for a two-way communication).

Satellite communication will introduce an additional delay due to the time it takes for the signal to reach the satellite and come back. At 35,768 [Km] away, a signal takes a time T= 35,768 [km]/300,000 [km/s] = 0.119 [sec] each way (Statica, 2002). So the round trip delay would be $2\times$ 0.119 [s] = 0.238 [s]. If we use the same safety factor of 2 (for delays due to sending acknowledgments, control signals, etc.), then the delay introduced by the satellite would be 0.238 [s] $\times$ 2 = 0.476 [s]. This time would be added to the time it takes to propagate through the terrestrial N cube or grid network when the signal arrives from the satellite.

Because the home location register (HLR) knows the exact location of the MS when is registered with any of the VLRs, when the value for a particular MS is not known by the HLR, two possibilities are considered: the MS is turned off (thus unable to communicate with any of the MSCs and register itself in a VLR) and the MS traveled outside an area covered by the terrestrial MSCs. At that point, if communication arrives at the HS for a MS that doesn't have the position known (registered) with any VLRs, then the HS must buffer the communication. When the MS comes on line and registers with a local MSC, even if that MSC is not directly connected to any N cube or grid network (for example is in another country where the HS is located), the MSC that has registered the MS will send a registration request via the satellite to the HS. At that time, the HS will know where to send the data for that MS and the transmission is relayed via the geosynchronous satellite. Of course satellite communication is not suitable for real-time data, due to the delays it introduces, but the MS can still get the data if needed (but not in real time).

FUTURE TRENDS

The push for advanced technology and the high demand for reliable, secure, low cost, high speed wireless connections as well as the high demand for access of data anywhere and anytime has revolutionized the wireless industry and moved the wireless systems from the secondary means of communications to a primary means crossing the line and merging at the same time the personal communication systems with business systems. Third generation (3G) wireless systems are in place, but there are already faster systems that will make the 3G network technically obsolete. Also, the fact that smaller cells are required for 3G systems would create a disadvantage when the technology is deployed over large and less populated rural areas. These systems considered to be the 4th generation (4G) aim at delivering high-definition video signals at rates 10 times faster than the 3G systems (and also cheaper). 4G systems will focus on integrating wireless networks and become the platform for mobile systems. Also, 4G systems will be IP-based multimedia services in a seamlessly integrated network that will allow users to us any system at anytime and anywhere.

The new generation of wireless communication will be multi-everything (multi-mode, multi-band, multi-functional) and is aiming to provide the best connection to users (Kim et al., 2003). 4G systems will also incorporate automatic switching functions for mobile networks, mobility control, fast hand-offs and rapid routing of packets. Because of these capabilities, it is estimated that the 4G systems will improve the coverage in highly populated areas and it will carry more traffic by utilizing various technologies and methodologies to deliver the best possible services in the most efficient way. Important advantages of 4G over 3G are higher transmission rate (almost double), higher capacity, higher frequency band (higher than 3GHz), single mobile device, increased area of coverage, and lower system cost.

As these new systems continue to be developed and improved, the need to be able to deliver data as fast as possible (with minimum delays) becomes a major factor that needs to be incorporated so the new systems live up to their promise of delivering real-time video and data to mobile units.

CONCLUSION

As the integration trend of voice and data transmissions and making them available on the same mobile device grows, it becomes important to route data from the home station (HS) to the mobile station (MS) in the shortest time possible. Moreover, real-time data (RTD) must have the highest priority, should not be queued, and ought to be delivered to the MS also in the shortest time possible. The framework discussed in this article presents a possible N cube configuration and a grid type interconnection of the Mobile Switching Centers (MSCs), which are actually data servers, so the data can jump a minimum amount of servers and reach the MS as quickly as possible. In the case when the HS does not have a direct connection with the network that the MS is registered with (while traveling), a possible satellite communication is suggested using a mobile satellite service (MSAT) network.

In an N cube configuration, it is shown that the worst-case delay would be given by the equation: $0.001\ [s] \times \mathrm{Ln}\ (8N) / \mathrm{Ln}\ (2)$, where N is the number of cubes the data has to jump. The number of cubes N is calculated based on the distance the MS is at, considering a distance of maximum 200 [km] between cubes (and between each of the MSCs inside a cube). In the square grid configuration it is shown that the worst-case delay is given by the equation: $0.001\ [s] \times 2(m-1)$, where m is the side of the square. Using the MSAT satellite will introduce a minimum of 0.476 [s] delay, only due to the propagation of the signal.

We found that having an N cube interconnection of MSCs will give the smallest time in data delivery to a MS. With relatively small number of cubes, we can cover a relatively large area of service. For example, for a 5000 [km] travel of MS we need around 25 cubes. The proposed topology fits well in the design of the 4G systems and will help in achieving the design parameters of the 4th generation wireless networks by allowing data to reach the end user the fastest (and cheapest) way possible.

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KEY TERMS

Antenna: The part of a transmitting or receiving device that radiates or receives electromagnetic radiation (electromagnetic waves).

Bandwidth: The difference in Hertz between the limiting (upper and lower) frequencies of a spectrum.

Broadband: Refers to systems that provide the user with data rates in excess of 2MBps and up to 100 Mbps.

Cellular Network: A wireless communication network in which fixed antennas are arranged in a special pattern (hexagonal pattern) and mobile stations communicate through nearby fixed antennas.

Channel Capacity: The maximum possible information rate through a channel subject to the constraints of that channel.

Downlink: The communication link from a satellite to an Earth station.

Frequency: Rate of signal oscillation in Hertz.

Geostationary: Refers to geosynchronous satellite angle with zero inclination. So the satellite appears to hover over one spot on the Earth's equator.

Packet: A group of bits that includes data (payload) plus source, destination address and other routing information (in the header).

Transmission Medium: The physical path between a transmitter and receiver (can be wired (guided medium) or wireless (un-guided medium).

Uplink: The communication link from an Earth station to a satellite.

Wireless: Refers to transmission through air, vacuum or water by the means on an antenna.

Traditional and Internet EDI Adoption Barriers

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INTRODUCTION

Electronic data interchange (EDI) is a conduit to innovative ways of conducting e-business processes, as well as facilitating e-business applications and services. EDI is the electronic exchange of business documents using standardized document formats (Blackstone & Cox, 2004). *Traditional EDI*, based on proprietary *value added networks (VANs)*, went through the early adoption stages in the 1990s (Clinkunbroomer, 1991; Premkumar, Ramamurthy, & Crum, 1997). Many factors caused the slow diffusion of the technology, including, but not limited to, high investment costs (Wilde, 1997), proprietary standards, poor integration capability with existing corporate systems, rigidity, poor scalability (Peters, 2000), poor performance in auditing trails, document certification needs, and the perceived need for hardcopies of the documents (Banerjee & Golhar, 1994). Despite these adoption obstacles, many large and small organizations have been leveraging the open architecture of the Internet to improve their agility and competitiveness. Unlike traditional EDI, *Internet EDI* adopts an open standard (extensive markup language or XML) and entails higher business agility by integrating the information systems of the business partners. Internet EDI is becoming an alternative to traditional EDI. Their natural differences pose an interesting, timely, relevant, and applicable research question: What would it take to accelerate the adoption of traditional and Internet EDI to support electronic business?

This article proposes a theoretical framework based on Rogers' (1983; 2004) *innovation diffusion model* and interorganizational theories. Major technological and managerial obstacles confronting widespread adoption of traditional EDI and Internet EDI are addressed. Future trends of these technologies are discussed as a conclusion.

BACKGROUND

Depending on the electronic means adopted, EDI can generally be classified as traditional EDI (connecting via proprietary VANs) and Internet EDI (connecting via the Internet using open XML standards). *Small- and medium-sized enterprises (SMEs)* have been reluctant to adopt traditional EDI due to a lack of financial (Ahlin, 1991) and technical support (Banerjee & Golhar, 1994), as well as the constraints EDI places on business practices. The Bank of America, NASA, and Avex Electronics Inc. allied with Premenos to initiate the first Internet EDI project in 1995. This pioneer project's success accelerated the popularity of Internet EDI. Internet EDI is an anticipated alternative for SMEs from the perspectives of economics, operation (e.g., faster establishment of customer-supplier relationships) (Lehmann, 2002), and scheduling. Internet EDI allows business partners to conduct business over the Internet and saves money in purchasing and learning expensive software. Traditional and Internet EDI have natural differences in closed versus open standards, high vs. low cost, and business rigidity vs. flexibility. Expectations are that Internet EDI will be superior to traditional EDI at some point in the future, although the transition is inhibited by (1) the reliability and security of the technology, (2) unrealized benefits of the existing investment in traditional EDI, and (3) immature legislative regulation (Threlkel & Kavan, 1999). It is vital to understand their differences in technological and managerial barriers of adoption.

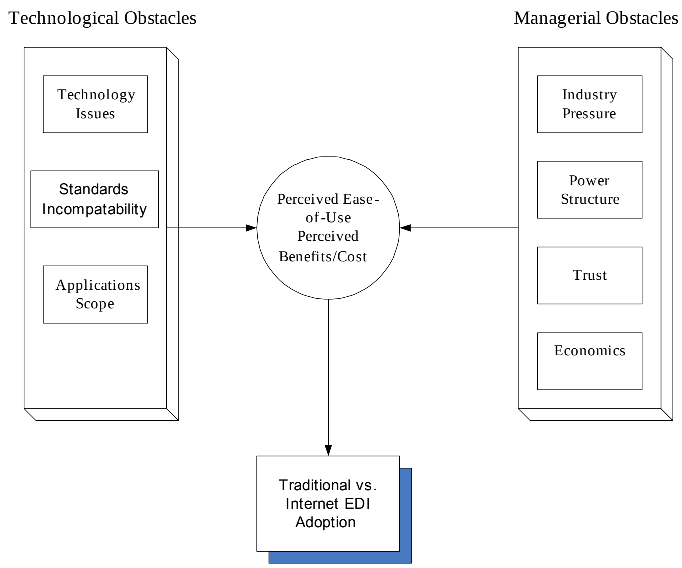
BARRIERS TO TRADITIONAL AND INTERNET EDI ADOPTION

Two major groups of obstacles present barriers for EDI reaching critical mass in its adoption curve: technological and managerial (Figure 1). Technological and managerial obstacles contribute to companies' perceived ease of use and perceived benefits/costs (Iacovou, Benbasat, & Dexter, 1995). These, in turn, impact traditional vs. Internet EDI adoption.

Technological Obstacles

Technological obstacles include technology issues, standards incompatibility, and application scope. Each is discussed in the following paragraphs.

Figure 1. A model to study EDI adoption issues



Technology Issues

The success of traditional EDI relies on the technological capability of dedicated, private or third-party proprietary VANs to interconnect heterogeneous systems and data communication *protocols*. Each company usually has unique ways to operate its business. Significant coordination and configuration efforts are imperative to reconcile the difference between trading partners. The installation of traditional EDI may also require changes in the existing business processes across different functions (Burrows, 1990). As a result, EDI adoption is usually susceptible to a sustainable and long learning curve. Technological barriers to the deployment of traditional EDI are even higher when supplier and customers use different VANs that do not have same coverage area or use incompatible technology. A Commonwealth of Australia report surveyed 227 respondents and found that "lack of EDI-capable business partners" (59%) and "integration of EDI with internal applications" (44%) are two major technological barriers to traditional EDI adoption.

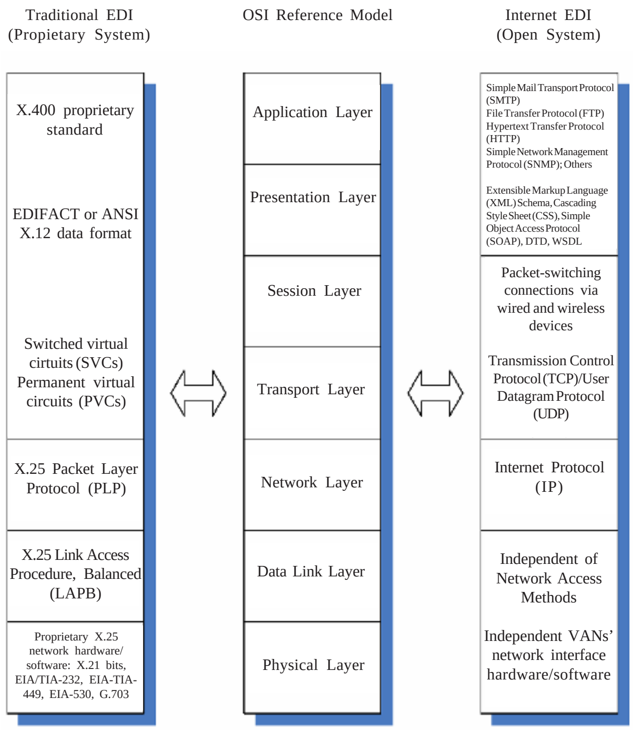
Internet EDI needs to overcome different technological obstacles. The "hub-spokes" model of traditional EDI based on the coverage area of a service provider (Angeles, 2000) is no longer a relevant issue. Instead, suppliers and customers need to decide which e-marketplace or trading community they want to be associated with. Once a decision on a particular community is made, the supplier or customer will be connected instantly to larger buyers' or suppliers' base. One major shortcoming with the Internet EDI is that data traffic on the Internet is less predictable. It is possible that Internet EDI slows or terminates during the transactional process due to the burst of data traffic. Therefore, Internet EDI is potentially weaker than traditional EDI in reliability and traceability. The mechanism for Internet Protocol security and networking management like Internet Engineering Task Force's AS2 (Applicability Statement 2) security protocol must be in place to monitor, detect, and correct network security and congestion problems.

Standards Incompatibility

How do we handle data that can vary in data format, document architecture, syntax, data type, and templates that are customized for the backend applications of suppliers and customers? How far along the value chain and supply chain can a company go with a proprietary traditional EDI? Will traditional EDI interfere with existing backend applications? How long will it take to coordinate and configure common global standards to reach a customer's suppliers? These are standards incompatibility issues. Figure 2 compares traditional and Internet EDI with respect to the Open Systems Interconnection (OSI) Reference Model.

Traditional EDI adopts the *EDIFACT* (Electronic Data Interchange For Administration, Commerce and Transport) or *ANSI X.12* (American National Standards Institute) protocols that map to the lowest three layers of the OSI reference model. These three layers are so strictly

Figure 2. Traditional vs. Internet EDI architecture



defined that business partners can only interconnect with each other via the proprietary standard. The upper service level covers four OSI layers. Traditional EDI needs to establish a virtual or dedicated circuit connection between business partners. VANs serve as a middleware or hubs to translate and integrate data generated by heterogeneous systems of trading partners.

In contrast, Internet EDI is refrained from the rigidity of EDIFACT or ANSI X.12 standards by modularizing tasks at four independent layers. Data move across networks in different data formats at different layers. Since each layer performs the same functions, data formats at the sender and the recipient sides are the same. This allows the interconnection and information exchange between customer and supplier without standardizing heterogeneous systems of trading partners. At the session layer, trading partners can adopt either public or private networks according to their business requirements for bandwidth. Wired and wireless devices adopting packet switching technology can converge with each other. Standardized port numbers and service protocols further increase the scope of applications.

Applications Scope

Top traditional EDI VANs were GE Information Services, IBM Global Services, Sterling Commerce, Harbinger, MCI, and AT&T. Major industries adopting traditional EDI were retail, transportation, manufacturing, health-care, high-tech and grocery. EDI can deliver: (1) operational benefits—cost reduction, automation of standardized procedures, improvement of information transparency, and enhancement of sensing and responding capabilities; and (2) strategic benefits—stronger customer-supplier relationships, increased barriers to entry, managing post-sales supply chain, and creation of new strategic possibilities.

The Internet's ubiquitous nature extends the use of EDI by SMEs. Internet EDI also improves the accessibility and cost-effectiveness of traditional EDI. For instance, the Global eXchange Services Trading Grid (http://www.gxs.com/) is a B2B e-marketplace where more than 100,000 business partners adopt Internet EDI to service more than 300,000 customers across industries worldwide. Such a large customer base is beyond the capability of traditional EDI. Organizations can electronically exchange volume-intensive data, such as product catalogue and product specification information which contains rich information such as images, audio- and video-on-demand without adding additional cost. However, to migrate from tradition EDI to Internet EDI, an organization needs to address many concerns: (1) standards and version control, (2) EDI tags modification for ease to read via a browser, (3) EDI files modification to be stored easily in relational databases (Hamdar, 2002), and (4) interorganizational and trading agreements between partners (Gottardi, Bolisani and Biagi, 2004).

Managerial Obstacles

Four key factors of an alliance—industry pressure, power structure, trust, and economics—can influence the decision of an organization to adopt EDI. These are discussed in the following paragraphs.

Industry Pressure

Industry pressure creates external pressure to influence the intention of suppliers and buyers to adopt EDI technology (Iacovou et al., 1995). Industry pressure includes strict standards, inter- and intra-industry competition, standards-regulatory, business partners, and government. The Internet Engineering Task Force drafted the AS2 specifications that detail how to securely transport an EDI file over the Internet. Industry EDI proponents often demand their buyers migrate from traditional to Internet EDI. RosettaNet (EDI for the computer industry), EDIFACT, and other XML-based EDI e-marketplace are products of the industry pressure. A company may have to comply with industry pressure to transact with business partners belonged to the industry association. When industry pressure creates the industry-level compliance, a firm can lower the degree of asset specificity and uncertainty (imperfect information), but increase the number of input resources (Williamson, 1971). Thus, it becomes easier for business partners to transact with each other using Internet EDI. From the comparative institutional perspective (Hennart, 1994), Internet EDI can potentially achieve three cooperative and exchange gains: (1) create awareness of gains through joint efforts, (2) discourage parties from bargaining their own gains, and (3) enforce agreed-upon agreements. Industry pressure creates pressure to adopt and increases perceived benefits of adopting Internet EDI.

Power Structure

Hart and Saunders (1997) asserted that a set of mechanisms should be deployed (ranging from convincing power to compulsory power) to influence an organization to adopt an *interorganizational system (IOS)*. EDI is an IOS to support business operations (Soliman & Janz, 2004). To realize the above mentioned benefits, power mechanisms are important considerations for EDI adoption. The convincing power mechanism focuses on reward and incentive approaches to encourage an organization to change; this is useful for maintaining a long-term alliance relationship. In contrast, the compulsory power mechanism, like punishment, is often used when an organization has many partners and needs to influence business partners with a relatively low bargaining power to implement EDI. When one party has a higher convincing power, it can influence the perceived benefit of implementing EDI for business partners. This pressure will help convince business partners to implement EDI. The convincing power of a business partner correlates with an organization's perceived benefits versus the actual cost of EDI implementation. An organization is more likely and willing to implement EDI when there are high benefits and low costs. (Premkumar & Ramamurthy, 1995).

Firms with dominating power over their business partners—such as the ability to penalize business partners by reducing or canceling orders—are more likely to force the use of interorganizational systems. Iacovou, Benbasat, and Dexter (1995) suggested a firm use compulsory power to pressure business partners to comply with its policy. The more bargaining power a firm has over its business partners, the higher the possibility that the organization can obtain resources from its business partners. This unbalanced relationship will force companies to maintain a relationship and make them more receptive to the adoption of Internet EDI.

Trust

Trust is another important factor that influences an IOS (Hart & Saunders, 1997; Smith, Carroll, & Ashford, 1995). Therefore, trust is also an important factor for the success of EDI. Trusting organizations are more willing to invest in EDI and share information with their business partners. Moreover, trust can stop opportunist behavior from appearing. When the opportunists' behavior declines, the opportunity to share information with business partners will improve. When business partners propose adopting EDI to facilitate their transactions, an organization trusting its partners is more likely to reach consensus in terms of the benefits they can realize with EDI. An organization may also think it is worthwhile to invest in EDI because of trusting its partners. An organization needs to face many security challenges of EDI to an interorganizational relationship. The first challenge is security in transmitting information between business partners. Internet EDI is potentially less secured than traditional EDI because transactional activities are highly distributed among users. It is easier to intercept confidential information when the information exchange process between the sender and recipient is widely distributed than one centrally managed. A supplier also needs to face the risk of leaking confidential information to its competitors by sharing confidential information with their same customers via

Internet EDI. This risk may potentially jeopardize customer-supplier relationships.

Economics

Mukhopadhyay's (1993) EDI framework is useful to assess the business values generated by traditional and Internet EDI. Internet EDI's network size is much larger than traditional EDI. Hence, its locus of impact on the operational and strategic benefits of adopters is higher. Because of sunken costs that have not been realized, traditional EDI adopters may not retire the technology immediately. The perceived significant cost savings in operational cost via Internet EDI have convinced traditional EDI adopters to seek middleware or upgrade their existing EDI software. The deployment of a traditional EDI is complex and needs continuous support to maintain the EDI system and train users. The deployment cost of traditional EDI includes purchasing EDI software, customizing EDI by developing conversion software, integrating EDI with the existing legacy information systems, and establishing the data communications and networking infrastructure with business partners. It is crucial to establish and maintain a reliable value-added network to support the successful deployment of traditional EDI. Many mega suppliers like Wal-Mart have perceived a significant savings of opportunity cost by replacing traditional EDI with Internet EDI. Manufacturers and retailers can save between $500,000 and $1 million for every $1 billion in revenue in the data synchronization effort alone according to the consulting firm A.T. Kearney (Bednarz, 2005). Another savings for Internet EDI is the operational cost measured by the cost per message. Traditional EDI message transmission costs are 13 times higher than Internet EDI for every 25,000 messages per month (Adhikari, 1996). The savings are being further increased with the decreased information communication and telecommunication cost. A typical SME can save approximately $2,000 a month by switching to Internet EDI from traditional EDI (Barlas, 2004).

FUTURE TRENDS

Most companies have been rationally weighing the benefits and cost of the EDI adoption in the traditional economic sense. Most companies seem to be reluctant to replace traditional EDI with Internet EDI immediately. Diffusion theory asserts that a newer innovation would replace the older technology when it becomes outdated and inefficient. Internet EDI has much higher relative advantages over its predecessor traditional EDI. To accelerate the adoption of Internet EDI, it is important to increase the urgency to replace traditional EDI with Internet EDI. This is not an easy task since many adopters of traditional EDI have not received enough returns from their investment. An organization needs to minimize the degree of resistance to the replacement decision. To accelerate the replacement process, an organization needs to create resistance to traditional EDI by promoting Internet EDI among innovators. It is also crucial to sidestep resistance by convincing early adopters that Internet EDI is much superior to traditional EDI in both technological and business arenas. Another emergent theme is the continuously increased industry pressure from large suppliers like Wal-Mart for a larger trading community via Internet EDI. Closer cooperation between standards regulatory institutions and suppliers is being forged to develop a more secured technology such as AS2 security protocol. Despite the mandatory use of Internet EDI by some larger suppliers, some trading partners are not convinced of the technology's reliability and security. Some firms are adopting phased development approaches to extend the applications of Internet EDI across functions and suppliers. Another trend is the increased demand for users to play the VAN role. For instance, salespeople who are using Internet EDI need to know how to generate expense reports, access customers' data, and get information about other parts of the company. Employees in the accounting department need to receive security awareness training to adequately verify the integrity of transactional data. A firm also needs to have a

Table 1. Assessing the business values of traditional and Internet EDI (Adapted from Mukhopadhyay, 1993)

Stages of Assessment	Traditional EDI	Internet EDI
Step 1. Examine the transaction sets and the application systems interfacing with EDI to determinate the locus of impact	Average of 2-10 transaction sets; Low impact	Average 10,000-200,000 transaction sets; High impact
Step 2. Find out the extent of the EDI network (e.g., number of trading partners) to assess the magnitude of the impact.	2-5 trading partners	1000-30,000 trading partners
Step 3. Study the production/operation process to identify control variables.	VANs	Membership
Step 4. Determine the exogenous industry or economy-wide trends that may mitigate the results	High entry barriers	Low entry barriers

help desk that is knowledgeable and responsible enough to respond to mission-critical problems. Training programs will become a necessity.

With the increased number and size of network communities, the awareness of relative advantages of Internet EDI over traditional EDI will be improved. Part of the delay of the innovation diffusion process for many innovations is the direct result of inadequate communication (Gatignon & Robertson, 1985). Internet EDI enables many-to-many relationships among business partners and increases the importance of their communications. In the future, the communication process will become more prevalent to narrow the gap of perceived benefits and costs between business partners.

CONCLUSION

Internet EDI innovation promises business benefits, including operational efficiency, operational innovation, and new business opportunities. Removing technological and managerial obstacles is the prerequisite to the realization of these benefits. This article proposes a theoretical framework to examine these obstacles based on innovation and interorganizational relationship theories. Technological obstacles include technical issues, standards incompatibility, and applications scope. Managerial obstacles include industry pressure, the power structure, trust among business partners, and economic issues. Future challenges are to remove the technological and managerial obstacles of Internet EDI adoption. Overcoming these challenges can effectively accelerate Internet EDI innovation diffusion, and retire traditional EDI applications.

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KEY TERMS

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ANSI X.12 (American National Standards Institute): The standard for the electronic exchange of business documents in North America.

EDIFACT (Electronic Data Interchange For Administration, Commerce, and Transport): An international standard for the electronic exchange of business documents widely used in Europe

Electronic Data Interchange (EDI): The electronic exchange of business documents using standardized document formats.

Internet EDI: The use of the Internet to exchange business documents using standardized document formats.

Interorganizational Systems (IOSs): Systems that provide information links between companies.

Protocols: Rules and conventions that define how data is transmitted over communications media.

VAN (Value-Added Network): Public data communication networks that provide basic transmission capabilities plus enhanced services (security, error detection, video conferencing, etc.).

Transformation of E-Fulfilment Industry Capabilities

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INTRODUCTION

Over the last decade, organisations have been forced to re-examine the role of ICT as a support tool and accept that it has become a major driver for business change (Ash & Burn, 2003, pp. 297-308.). Indeed, new business opportunities have arisen solely based on e-business: *e-fulfilment* is one such example (Alexander & Burn, 2004, p.1). These services were estimated to be worth US$1,006 Trillion in the United States alone, or 10.1% of their GDP in 2000 (Rogers, 2002). Furthermore, 21% of all logistics transactions are expected to be online by 2005, with the long-term possibility that traditional freight companies will ultimately cease to exist (Homs, Meringer, & Rehkopf, 2001). This article explores the concepts which are encompassed in the term e-fulfilment, and presents a model of e-fulfilment activities. This model is then validated through the analysis of *e-fulfilment capabilities* of 48 UK based e-fulfilment companies. The findings from this analysis lead to an extension of the model and suggest a long term transformation model for the industry as a whole.

BACKGROUND

A review of the literature on e-fulfilment and online retailing identifies the following issues, which need to be considered:

- **Location Design and Picking Systems**;
- **Packing:** Specific packaging for delivery of products, can include breaking original packages and repackaging, often must be customised for each order;
- **Customer Service:** Managing customer queries and complaints;
- **Financial Transactions:** calculating and including fulfilment costs, and electronically settling these with appropriate organisations;
- **Warehouse Costs:** associated with product storage;
- **Delivery:** Systems and delivery alliances;
- **Transport Mechanisms and Flows:** Using multiple delivery mechanisms to ensure deliveries arrive on time and undamaged;
- **Procurement Management:** Purchasing arrangements automatically (electronically) integrated with fulfilment suppliers, triggering delivery transactions;
- **Management Information Systems:** Concerned with integrating and managing all aspects of the process;
- **Front End (Ordering) Services:** Which electronically trigger the fulfilment process automatically from a Web-purchaser's mouse-click;
- **After-Sales Service:** To ensure fulfilment problems are resolved;
- **Returns:** Manage reverse logistics related to incorrect, damaged or fit-for-use product issues, this must not only ensure convenient and quick return of goods, but often must initiate re-delivery (of the correct goods);
- **Real-Time Tracking:** For management of all pools of product, and also commitment to promises made by front-end ordering systems.

These are recognised as integrated components which create virtual proximity between e-trader and customer and cover everything a company does to satisfy customer demand within an e-commerce framework, and a succession of activities which are necessary for the successful supply of customers and markets (Klaus, 1998).

Figure 1 collapses these concepts into a single diagram, and illustrates the scope of what can explicitly be termed *e-fulfilment.*

CAPABILITIES MODEL DEFINES E-FULFILMENT

The annual report produced in the UK by *E.logistics Magazine* and known as the E-fulfilment Index (Rowlands, 2003), provided the basis to examine 48 third-party e-fulfilment service providers based in the UK.

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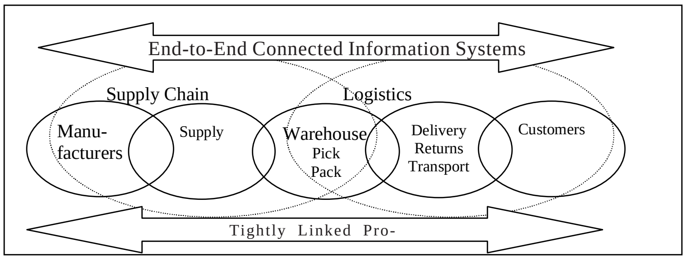
Figure 1. E-fulfilment scope



The range of capabilities offered by the e-fulfilment providers examined is shown in Figure 2. These 13 capabilities are in the following categories, which align with aspects of the model outlined in Figure 1:

a. Capabilities for carrying out physical parts of the fulfilment process.
b. Capabilities that link processes. These are enabled by using call centres, and online track/trace capabilities.
c. Capabilities that extend fulfilment into the suppliers' and related providers' value chains.

Figure 3 shows the frequency distribution of the number of separate capabilities offered by each of the sample. It is clear from this that there are a minority of *specialists*, a large group of providers offering a half or more of the possible capabilities, and 30% of the sample offering *all* capabilities analysed.

Further analysis of these 48 organisations examined "*last mile*" capabilities, warehousing space, size and stability, turnover and relationships to parent organisations. Last mile is an area of intense interest with e-fulfilment providers (Alexander & Barnett, 2004; Alexander & Burn, 2004; Punakivi, 2001, 2002; Schulz, 2003). The capabilities include open customer delivery windows and alternative goods reception strategies.

Slightly more than 50% of the sample have already adopted most of these capabilities, or are willing to. But tellingly, almost 50% (almost all the remainder) are considering or are willing to offer these capabilities. Clearly, as these organisations feel the economic and operating pressures of last mile delivery, their activities in setting up new last-mile-specific solutions is frenetic. The data strongly indicates that the future direction for these businesses will include the provision of last mile capabilities.

Though almost all e-fulfilment providers are derived from, or are in their own right, established logistics/warehouse/transport operators, 68% are able and willing to provide new services such as Web development and hosting facilities. For established logistics providers, this

Figure 2. Percentage of sample showing specific e-fulfilment capabilities

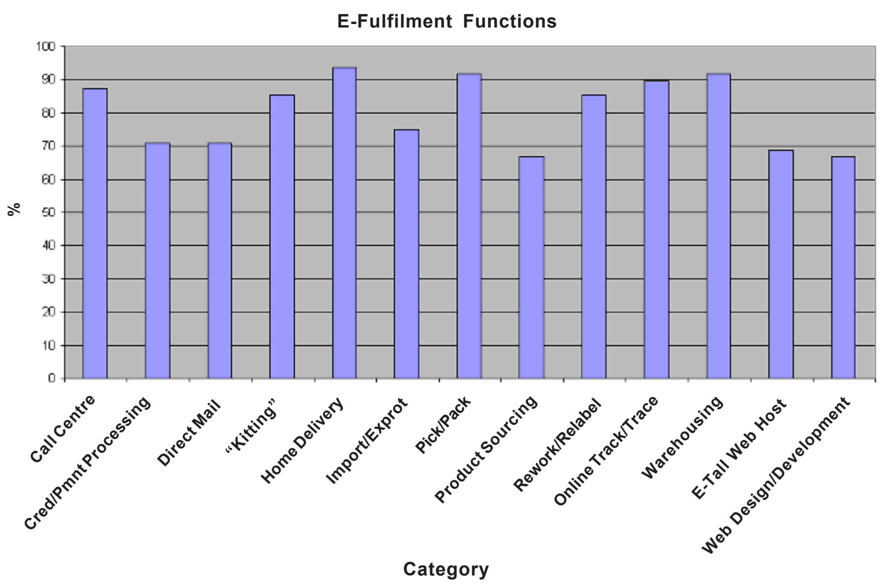
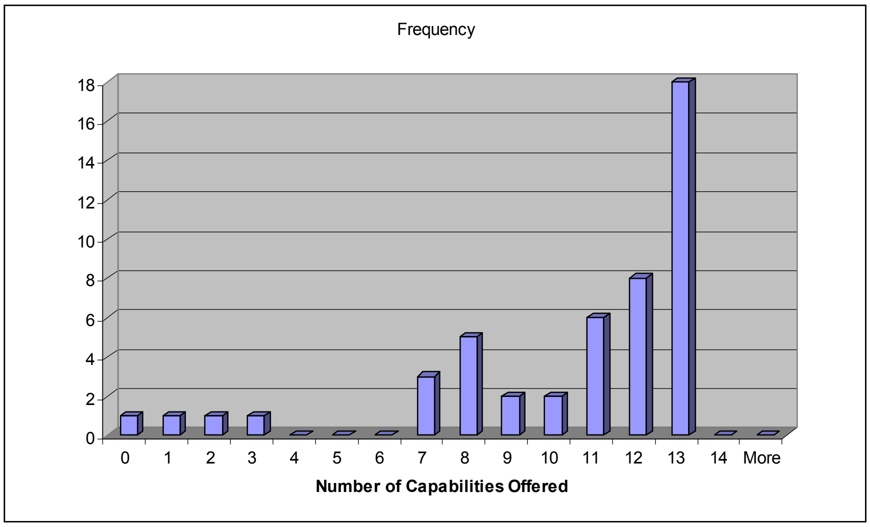


Figure 3. Specialists or generalists



is an interesting development. Not only have these companies implemented the online and Web-based changes required to be a credible e-fulfilment provider, but they appear to be keen to offer these services to customers. This data clearly indicates new business opportunities in the industry as a whole; an idea that will be developed in the next section.

A TRANSFORMATION MODEL

These organisations all targeted online retailers, either primarily, or as a recognised sector of their market. (Duffy & Dale, 2002) recognised 10 critical support processes required for success by such retailers, and e-commerce operators in general (see Table 1). Of these 10, eight align

Table 1. Critical e-commerce success and e-fulfilment capabilities

E-commerce critical success capability (Duffy & Dale, 2002, p.432)	*E-fulfilment operator capabilities in the sample*
Order fulfilment	Yes
Revenue generation	No
Revenue collection	Last Mile capability
Financial control	No
IT/Web changes	Yes
Business processes	Significant integration
e-integration	Yes
Order generation	Integrated
Call centre integration	Yes
24/7 operation	Enabler
Consumer behaviour	Influences customer experience

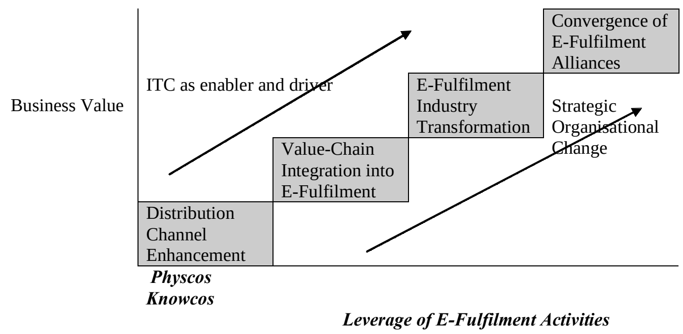
with capabilities exhibited in our sample (the remaining two cannot be evaluated at this stage). Evidently, they provide some or all of the range of services e-tailers consider essential, and therefore provide most or all of the services in the model we presented. They all have tight end-to-end electronic systems to control their processes, and provide facilities call centres, payment systems and online components to integrate their services with those of the online retailers.

In most cases, this integration appears to be to the point of providing a single outsourced solution for online retailers' e-fulfilment needs, which in turn appears to result in offerings of diverse sets of services, rather than specialists in particular services. However, there is significant evidence of the e-fulfilment organisations themselves outsourcing certain of their functions to specialists, particularly noticeable with Web site aspects of the businesses. When viewed as a whole, the online retailer, the e-fulfilment partner, and the specialist e-fulfilment service provider are all cooperating as a "virtual organisation." For instance, those with expertise and assets able to handle large-size products (e.g., furniture) are becoming aligned with online retailers with that product range.

A staged transformation can be seen taking place within the industry which can be related to a model of e-business change as identified by Deise, Nowikow, King, and Wright (2000). (See Figure 4.)

This begins with the use of ICT within the parent company (typically transportation or warehousing) to enhance distribution channels through some form of e-commerce. This is followed by the application of ICT

Figure 4. The e-fulfilment transformation model (Adapted from Deise et al., 2000)



within and across value chains, and extending into e-fulfilment. This inevitably leads to industry transformation as networks of organisations are formed through extended e-business operations; for example, the move we observed within e-fulfilment companies towards Web site design activities. And finally there will be a convergence where many e-fulfilment companies and their offshoots come together and work within the same e-space in virtual environments.

As e-fulfilment organisations move from left to right across the panorama painted by the *transformation model* (see Figure 4), they are likely to gain added value but also to encounter much greater risk. As they move through these stages, they will be looking to exploit means of revenue enhancement, cost reduction and relationship management. This transformation can be viewed as the transformation of a company reliant on physical assets to one which is solely dependent on knowledge assets.

As companies collaborate along their value chains the nature of the industry begins to change as organisations decide to outsource some of their traditional functions and focus only on their core competencies. The term "going to market" will no longer be defined as the way a company enters the marketplace but rather it will characterise the way an integrated group of companies creates a set of cascading values to transform the marketplace into a network of value providers.

At this stage companies will make a conscious effort to orient their strategies toward becoming knowledge-based "Knowco" or physical goods-based "Physco" companies (Deise et al., 2000). This is not normally a complete transformation but rather an orientation towards one or the other. Knowcos will focus on building brands, capturing ownership of the customer-end market relationship, and investing in knowledge-based core competencies such as e-marketing and Web services development. They may well expand into providing customer knowledge management services to other companies in their marketplace. Physcos will become hubs of processing expertise. Their success will be based on speed, quality and delivery.

FUTURE TRENDS

A survey with emphasis on companies' perceptions of near-future e-fulfilment challenges and opportunities, whether they were developing Physco or Knowco capabilities, and how they were preparing for these suggest two relatively discrete approaches to future environment, depending on whether the companies are "general outsourcers" (GOs) representing 30% of e-fulfillers, those providing a full range of capabilities, or "specialised outsourcers" (SOs) targeting a more niche-market strategy and with typically fewer capabilities. Whichever category they might fall in, they appear to be comfortable in that approach, with no intentions to alter their customer or geographic focus.

Strong pressures to move to non-traditional capabilities in the GOs, with some, but much less perceived imperative in the SOs, who are more focused on relationships with customers in their sector. This behaviour in turn appears to drive the nature of development of the capabilities. The GOs are developing new customer-facing capabilities while the SOs are more intent on improving internal processes and infrastructure of existing capabilities.

Regardless of their degree of specialisation, they are using and recognise the importance of Web facilities for their organisations, though it is the GOs who see online services as more significant. They are also more intent on increasing their expertise and developing these capabilities.

Though almost all e-fulfilment providers are derived from, or are in their own right, established logistics/

warehouse/transport operators, 68% are able and willing to provide new services such as Web development and hosting facilities. This data clearly indicates a strong desire to develop Knowco capabilities.

Interestingly, despite the importance of these services, most organisations are comfortable in outsourcing them. While this is understandable in SOs, who do not appear to regard them as so central, it is unexpected, given the GOs' intended direction. Nevertheless, it conforms to a pattern found within the general logistics market with outsourcing being heavily service driven (Wilding & Juriado, 2004).

In terms of future environments, e-fulfilment organisations are anticipating new opportunities generated by new software applications, and by delivery infrastructure enhancements, often relating to the postal service.

When it comes to threats, while all respondents are concerned with security (more particularly, online security issues), GOs are also concerned with substitutable products, which aligns with earlier noted intentions to enhance customer-facing capabilities.

CONCLUSION AND FUTURE RESEARCH

E-fulfilment businesses are both successful and stable in the UK, where they have in many cases evolved from traditional fulfilment-logistics-transport businesses into enhanced e-fulfilment businesses showing many of the features expected from the knowledge capabilities model outlined.

Many of these businesses have chosen to become *generalists*, offering the whole range of services classified under the heading of e-fulfilment. This is driven, at least for some businesses, by a perceived opportunity in outsourcing online retailers' fulfilment needs completely. Such a marketing strategy is logical when not only does the outsource provider have individual capabilities, but has developed systems and skills that link them closely together, enhancing efficiency and reducing problems (Hoek & Chong, 2001).

There is also a place for specialists, who although fully embracing online and general capabilities, are very focused on meeting their customers' needs with respect to efficiency and services offered.

E-fulfilment businesses are preparing for a market place they believe is incrementally expanding. They feel constrained by delivery infrastructure and threatened by a potential backlash from traditional retailers. But even though the market appears to be evolving steadily now, e-fulfilment organisations are transforming as a fast rate, acquiring knowledge-based capabilities that integrate them better with their customers. When those capabilities are integrated with online solutions such as customer Web-integration, we note that many companies have chosen to outsource these capabilities. This may well have been a suitable response to rapidly acquiring skills not part of the traditional e-fulfilment businesses from which many e-fulfillers are descended, but if this has suppressed development of core online skills then strategic decision-making in the area may be affected. Having such core skills may become a differentiator for gaining competitive advantage in the future.

Future research in this area is likely to focus on the evolution of e-fulfilment capabilities over time, with particular attention on the knowledge component of the capability. Representing this information as an "index" will also allow comparisons between businesses and over time, and relating such indices to competitiveness is a tantalising opportunity for which preliminary evidence already exists and if proven, can lead to practical and useful benchmarking measures for the e-fulfilment industry.

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KEY TERMS

Capability Transformation Model: Traditional logistics, transport and warehousing capabilities are based on the ability to provide physical resources to assist the customer. These appear to be transforming, with the inclusion of knowledge-based skills and service additions. For example, an e-fulfilment provider may extend traditional supplier-pickup services (which is a physical outcome) to an offer to manage a complete supplier relationship (which is based on knowledge of contracts and supplier environment). Note that the mere inclusion of an information system (for example, a track-and-trace system in a transport operation) does not imply a knowledge capability, but rather is a means to improve a physical capability. Such a model can be used to assess each of a provider's capabilities for the balance between physical and knowledge-based outcomes and arrive at an index representing the overall degree of knowledge-based outcomes offered by the company.

E-Fulfilment: The activities required to ensure a product ordered through an online retailer is delivered to a consumer, and may also include reverse logistics (return of goods) activities. E-fulfilment providers provide services derived from those offered by traditional logistics, delivery and warehousing providers, as well as an emerging range of new capabilities. Such services may be provided by in-house departments or increasingly by third party outsourcers who offer a wide range of supply chain services to online retailers.

E-Fulfilment Capabilities: E-fulfilment providers may be identified from a well defined set of capabilities they utilise in offering their services. These incorporate traditional logistical, delivery and warehousing services as well as picking and packing, kit delivery and payment-taking systems. Increasingly, capabilities are incorporating knowledge-based skills and resources and include such services as online retail Web site development or hosting, supplier management and customer relationship management. These capabilities are not uniformly adopted by provider organisations.

Generalist E-Fulfilment (GO) Providers: Third party e-fulfilment providers may choose to offer a large range of e-fulfilment capabilities. These may be either Physco or Knowco in nature, though a greater proportion of GO providers are tending to concentrate on Knowco capabilities. GOs appear likely to compete in more open markets using innovation and cost-competition. Though these providers may have large customers, they are more likely to have a large range of customers.

Knowcos: E-fulfilment organisations concentrating on knowledge-based capabilities such as Web development, business consulting, supplier management and customer management are termed *Knowcos.* They concentrate on offering innovative services to become competitive through effectiveness of such services and the ability to outsource supply chains and customer-facing tasks for online retailers. The degree of Knowco-ness, and the range of capabilities it applies to varies for different providers.

Last Mile Capabilities: A new category of e-fulfilment capabilities which involves all aspects of delivering to customers' workplaces or homes. Quality, cost-effectiveness and flexibility of such deliveries is critical to the success of online retailers but includes a host of problems that must be overcome. Issues such as payments, security, extended delivery times, returns, customer presence, and handling of different-temperature and perishable deliveries have catalysed the development of new capabilities such as locked-boxes, wireless payment devices and innovative courier networks.

Physcos: E-fulfilment organisations concentrating on physical capabilities such as transport, warehousing and pick-pack services are termed *Physcos.* They concentrate on improving such services to become competitive through efficiency and scope of such services. The degree of Physco-ness, and the range of capabilities it applies to varies for different providers.

Specialist E-Fulfilment (SO) Providers: Third-party e-fulfilment providers may choose to offer a subset of e-fulfilment capabilities. These may be either Physco or Knowco in nature, though a greater proportion of SO providers tend to concentrate on Physco capabilities. SOs appear to be driven by needs of dominant customers who dictate the services they need. Such providers are sensitive to such customers' needs, and will modify and add capabilities that address them.

Trust as an Enabler of E-Commerce

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INTRODUCTION

E-commerce is a viable mode of shopping. Forrester Research Inc. estimates that the U.S. online sales will reach $316 billion by 2010, which accounts for 12% of total U.S. retail sales. However, security, privacy, and delivery concerns remain issues of concern to both buyers and sellers. Since trust alleviates these concerns, while the lack of trust prevents buyers from buying online, managing buyer trust is crucial. This article discusses how institutional and interpersonal mechanisms can increase trust by reducing social uncertainty. An illustrative example based on eBay is included.

BACKGROUND

Trust is the willingness of a person or group to rely on another because of confidence in the trusted party (Mayer, Davis, & Schoorman, 1995; Zand, 1972). Trust is based on the expectation that the other party will not indulge in opportunistic behavior by taking advantage of the situation (Gefen, 2002). Generally, the need for trust arises because of social uncertainty (Deutsch, 1958; Johnson-George & Swap, 1982; Kee & Knox, 1970), which is the inability to predict human behavior with certainty because people do not always behave rationally (Lewis & Weigert, 1985). Since making calculated decisions requires reducing this social uncertainty, people tend to trust others and in doing so assume away the possibility of unacceptable social conduct (Gefen, 2000).

ROLE OF TRUST IN E-COMMERCE

Trust is essential in e-commerce because social uncertainty and risk are prevalent also in e-commerce, and more so than in other types of commerce because of the online nature of transactions (Lee, 1998). Online buyers and sellers may not have a prior acquaintance, may be separated in time and space, and may have no social cues which might enable a buyer to make judgments if to trust a seller (Gefen, 2000; Gefen, Karahanna, & Straub, 2003b; Gefen & Straub, 2004; Kim, Xu, & Koh, 2004; Reichheld & Schefter, 2000). Moreover, the Internet makes verification of real identity problematic (Ba & Pavlou, 2002; Gefen et al., 2003b). Trust reduces these perceptions of risk and makes e-commerce possible (Gefen, 2000; Gefen & Straub, 2004; Jarvenpaa, Tractinsky, & Vitale, 2000; McKnight, Choudhury, & Kacmar, 2002; Pavlou & Gefen, 2004).

DIMENSIONS OF TRUST

Mayer, Davis, and Schoorman (1995) conceptualized trust as being the product of three dimensions of trustworthiness beliefs: ability, integrity, and benevolence. Ability is the belief in the skills and competence of the trusted party. Integrity is the belief in the trusted party's adherence to the expected ethical or moral code. Benevolence is the belief that the trusted party cares about the buyer. This model of trust have been extensively verified (Gefen, 2002; McKnight et al., 2002; McKnight, Cummings, & Chervany, 1998). Integrity and ability are typically the most salient beliefs in initial contacts, with benevolence developing over time as the parties get to know each other (Mayer et al., 1995).

INITIAL AND ONGOING TRUST

Trust develops gradually over time (Blau, 1964; Lewis & Weigert, 1985; Zand, 1972). Typically, people enter new relationships with a degree of initial trust which develops into ongoing trust as the relationship develops over time. Initial trust and ongoing trust are different. Initial trust is not based on a detailed acquaintance with the trusted person or organization (Bigley & Pearce, 1998), but is a general credit extended to the other person based on unrelated considerations. After gaining experience in the relationship, people's initial trust evolves into ongoing trust. This ongoing trust is based primarily on prior experience with the trusted party (Gefen, Karahanna, & Straub, 2003a).

There are several modes of creating these types of trust, and these modes change in relative importance as the transition from initial trust to ongoing trust is made. Accordingly, initial trust may sometimes be greater than ongoing trust (McKnight et al., 1998). Both initial and ongoing trust are based on a person's disposition to trust (personality-based trust), on calculative-based trust, on institutional-based trust, and on transference-based (Stewart, 2003; Strub & Priest, 1976), but more so in initial trust (McKnight et al., 1998) because in ongoing trust familiarity with the trusted party takes the lead as the determinant of trust (Gefen, 2000).

Disposition to trust, also known as personality-based trust, is a general tendency to trust others based on a person's life experience and socialization (Gefen, 2002; McKnight et al., 1998; Rotter, 1980). As an example, a potential buyer at eBay, the leading online auction house, may refrain from taking part in any such activity because of fear of being cheated based on childhood experience of being taken advantage of by others whom he or she trusted.

Calculative-based trust is based on the assessments of whether it is worth the other party's while to cheat (Brewer & Silver, 1978; Lewis & Weigert, 1985; Meyerson, Weick, & Kramer, 1995). Calculative-based trust is a scrupulous estimate made by the trusting party about the probable behavior of the trusted party (Shapiro, Sheppard, & Cheraskin, 1992). It affects both initial trust (Doney & Cannon, 1997; Lewicki & Bunker, 1995; Shapiro, Sheppard, & Cheraskin, 1992) and ongoing trust (Gefen et al., 2003b). Calculative-based trust is formed based on a calculation that people will refrain from opportunistic behavior if it is not in their advantage to do so (Shapiro, Sheppard, & Cheraskin, 1992). To continue the eBay example, a shrewd buyer may decide to place a bid with one seller and not with another based on a calculated assessment of whether each seller could get away with cheating if it wished to, considering the type of product, seller location, and so on.

Transference-based trust is based on trusting an unknown person or organization because a person whom the trustor believes in trusts this person (Stewart, 2003; Strub & Priest, 1976). In our example of the eBay buyer, a person who has never bought from eBay before may decide to trust a seller because his or her friend recommends this seller. Trust transference happens from a trusted person (Uzzi, 1996), a trusted source (Henslin, 1968), a trusted institutions, or an industry association (Milliman & Fugate, 1988). Usually, transference creates trust when there is no prior interaction with the trusted party, but there is a high level of trust in the transference party (Ba, 2001; Lewicki & Bunker, 1995; Stewart, 2003; Uzzi, 1996). If a person trusts eBay, the transference party, he or she is more likely to trust an unknown seller in this online auction house (Pavlou & Gefen, 2004).

Institutional-based trust is based on the guarantee mechanisms provided by a trusted third party (Shapiro, 1987; Stewart, 2003; Zucker, 1986). These mechanisms may include situational safeguards and structural assurances that are built into environment (Ba & Pavlou, 2002; Gefen et al., 2003; McKnight et al., 2002; Pavlou & Gefen, 2004; Zucker, 1986), escrow services, credit card protection, and feedback mechanisms on a portal (Pavlou & Gefen, 2004). Institutional-based trust, when available, is a primary mode of trust creation (Gefen et al., 2003b; McKnight et al., 2002; Pavlou & Gefen, 2004). In the eBay example, institutional trust may convince a buyer to trust a seller based on the escrows, security, and privacy mechanisms eBay provides (Pavlou & Gefen, 2004).

Familiarity-based trust, in contrast to the above modes which are not based on a personal interaction between the parties (Kim & Prabhakar, 2004; McKnight et al., 2002), is based on prior experience with the seller. Generally, familiarity is the primary trust builder in ongoing trust, while institutional-based, when available, is the primary builder in initial trust. Knowing the trusted party based on previous interactions with it typically the primary creator of trust (Blau, 1964). These relationships are shown in Figure 1.

The modes of trust creation create a sense of trustworthiness and trust. This trust then results in behavioral intentions. In the eBay example, trust will be one of the contributors to the decision if he or she is going to place a bid with a specific seller. Also part of the model is the role of feedback. Positive and negative experiences (Holmes, 1991; Lewicki & Bunker, 1995) affect both trustworthiness beliefs and trust (Mayer et al., 1995), as well as the modes of trust creation (Marsh, 1994).

FUTURE TRENDS

Institutional-based trust (Gefen et al., 2003b; McKnight et al., 2002; Pavlou & Gefen, 2004; Zucker, 1986), disposition-based trust, calculative-based trust (McKnight et al., 2002; McKnight et al., 1998), and transference-based trust (Stewart, 2003) are salient modes in the formation of initial trust. In the lack of actual familiarity with the trusted party, these modes take precedence. These modes help to reduce buyers' perceptions of uncertainty in e-commerce transactions while providing a subjective measure of security and probability of success of e-commerce transactions. The importance of institutional-based trust as a major contributor to initial trust in online transactions is made possible by the availability of third party guarantees, accreditations, escrow, credit card guarantees and other security enhancing mechanisms (Pavlou & Gefen, 2004). After successive positive experiences, the salience of institutional-based trust decreases as familiarity takes

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Figure 1. Conceptual model of trust relationships

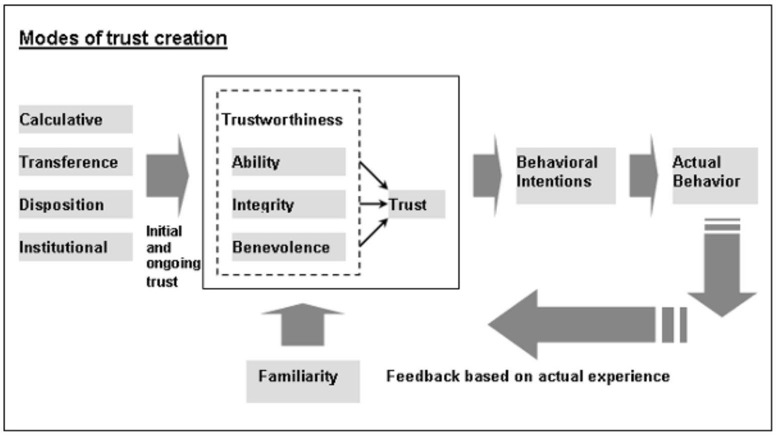
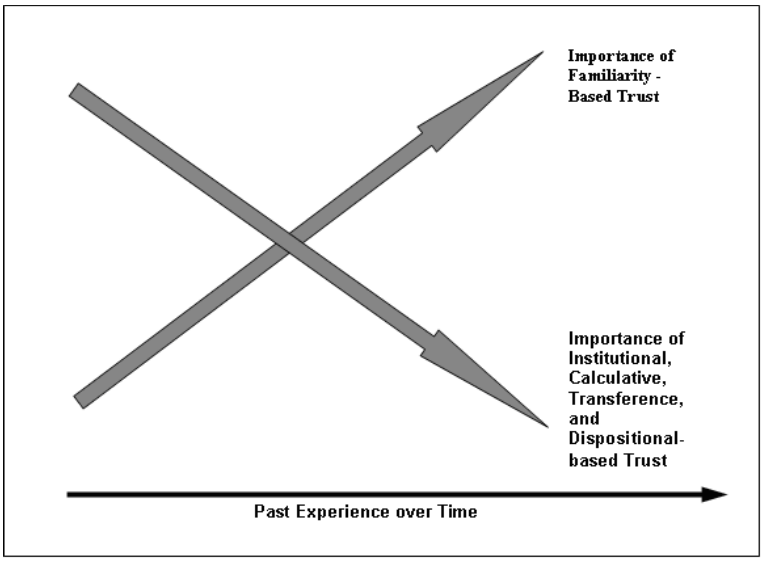


Figure 2. The relative change in trust modes with experience



precedence. In the eBay example, a buyer, after many successful transactions, will trust a seller, even without relying as much on the institutional guarantees provided by eBay. This change in the salience of the trust building modes is shown in Figure 2. Institutional guarantee mechanisms, as well as disposition, calculative, and transference, are important primarily during the initial stages of trust formation. In the absence of personal interaction on which familiarity can be built, these modes reduce social uncertainty and in doing so create trust. As familiarity increases, the necessity of other modes decreases (Blau, 1964; Lewis & Weigert, 1985; Zand, 1972). Still, it should be emphasized, all these modes continue to continue to trust even as familiarity increases.

CONCLUSION

The changing salience of trust creation modes in e-commerce over time has not been extensively empirically tested. A growing interest in this transition is expected as trust and its creation modes become established artifacts of e-commerce research. Increased interest in the creation and maintenance of institutional-based trust structures, which to date have proven rather successful, is also expected.

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KEY TERMS

Ability: The beliefs the trusted party is capable.

Benevolence: The belief the other party cares about the trustor.

Calculative-Based Trust: Trust based on the calculation that it is not in the best interest of the trusted party to cheat or take advantage of the situation, regardless of their trustworthiness.

Disposition-Based Trust: The socialized tendency to trust or not to trust others.

Familiarity-Based Trust: Knowing what to expect of the trusted party based on previous interactions with it.

Initial Trust: Trust in another person or organization before the trusting party gets to know them.

Institutional-Based Trust: Trust based on the guarantees of a third party.

Integrity: The belief the other party is honest and adheres to accepted modes of behavior.

Ongoing Trust: Trust after the trusting party knows the trusted party.

Transference-Based Trust: Trusting another person because someone else who is trusted somehow recommends them.

Trust: A willingness to depend on another person or organization based on confidence in the trusted party.

Trustworthiness: Beliefs based on which people are willing to trust. Typically, these are ability, integrity, and benevolence.

Trust in E-Government Services

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INTRODUCTION

Based on the results of the information and communications technologies (ICTs), a new "digital" economy and society are arising. This new computer- and communication-networked environment needs new set of services and technologies besides new rules and values, which determine the behavior of its actors.

In the starting phase of information society the Internet, later on the Internet-based technologies (e.g., the Web) have changed the way business was done the world over, and is now changing the way government interacts with citizens and business sector. With the dramatic increase of the Internet as a business tool and the incredible growth of e-technologies have changed not only the economy but the society as well.

According to researchers, early e-government was a form of e-commerce as both used Internet-based technology for the benefit of the information society. Today, e-government can be defined as online government services, that is, any interaction one might have with any government body or agency, using the Internet or World Wide Web. As the mobility is an important characteristic of the information society, new e-government solutions apply wireless/mobile networks as well.

The insufficient security of many Internet services is an important limitation of using the Internet. Lack of trustworthy security services is a major obstacle to the use of information systems in private, in business as well as in public services. Trust is intimately linked to citizens' rights, like security, identification, authentication, privacy, and confidentiality. Secure identification, authentication of the users and communication security are main problems in today's networked systems. These demands for trust and security are valid in an increased extent in case of digital government applications.

BACKGROUND

Definitions and Types of E-Government

It is not easy to define e-government because of its multidimensional aspects. Many international organizations attempted to define it and there were many different approaches. Part of them focused on the functions of e-government by underlying the governance aspects (functional definition), others referred e-government through its different processes (descriptive definition), a few propositions tried to capture its essence (conceptual definition), others presented e-government by reference to e-commerce (definition by reference) and still others combined all of those elements together (complex definition). The main concept behind those definitions, however, was that e-government was more about *government* than about *e*.

A complex definition is given by the World Bank as follows: "eGovernment refers to the use by government agencies of information technologies (such as Wide Area Networks, the Internet, and mobile computing) that have the ability to transform relationships with citizens, businesses and other arms of government. These technologies can serve a variety of different ends, better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information, or more efficient government management" (World Bank, 2005).

Implementing e-government can be risky, expensive and difficult, it is not sufficient simply to add "ICT" to "government" to have "e-government." Fundamental transformations and changes will affect all layers of e-government including, for example, the legal aspects that is a basic factor.

The basic types of connections in e-government are government-to-government (G2G), government-to-business (G2B), and government-to-citizens (G2C) solutions. There are different other classification of the connections among government and organizations or citizens, but this three category can be found in each approach.

The objectives of the three main e-government types are as follows:

- **G2G:** Government to government enable all levels of government to more easily work together to better serve the needs of citizens and businesses; federal government needs to streamline reporting requirements imposed on states and localities; changing the culture of the civil service from reactive to proactive; open and accountable government; cost-effective procurement.

- **G2B:** It is the concept that businesses and government agencies can use central Web sites to exchange information and do business with each other more efficiently than they usually can off the Web. For example, a Web site offering G2B services could provide businesses with a single place to locate applications and tax forms for one or more levels of governent. G2B may also include e-procurement services, can support the idea of a virtual workplace.
- **G2C:** Government to citizen provides non-stop, online access to information and services to individuals; citizens should be able to find what they need quickly and easily, and access information in minutes or seconds, instead of days or hours (24-hour/7-day/52-week access); receiving services that are citizen, not agency focused; disintermediation of civil service staff—delivering services directly to citizens; building and enhancing trust.

With the expansion of opportunity to perform transactions online, citizens are eager to take care of a variety of tasks on the Internet, including interactions with different levels of government. National, regional, and local governments are beginning to respond. Across the globe, governments are the latest participants in the promise of the Internet, and the way in which governments interact with businesses and citizens is in early stages of transformation. The different types of e-government can be realized on different levels as international (European Union, United States—federal), national (central), regional, and local.

The benefits of e-government applications are:

- improving efficiency of administrative processes,
- increaseing transparency,
- improving services,
- decreasing corruption,
- contributing to revenue growth, and/or cost reductions,
- helping achieve specific policy outcomes,
- contributing to economic policy objectives,
- major contributor to reforms, and
- helping trust building between governments and citizens.

Definitions and Forms of Trust

Trust can be defined as a psychological condition comprising the trustor's intention to accept vulnerability based upon positive expectations of the trustee's intentions or behavior (Rousseau , Sitkin, Burt, & Camerer, 1998). Those positive expectations are based upon the trustor's cognitive and affective evaluations of the trustee and the system/world as well as of the disposition of the trustor to trust. Trust is a psychological condition (interpreted in terms of expectation, attitude, willingness, perceived probability). Trust can cause or result from trusting behavior (e.g., cooperation, taking a risk) but is not behavior itself.

The structure of trust in digital communication according to Fukuyama claims: "Trust is the expectation that arises within a community of regular, honest, and cooperative behavior, based on commonly shared norms, on the part of the members of that community" (1995, p. 45). In shifting to electronic environments, Fogg and Tseng (1999) focus on trust among individuals mediated by technology, writing that trust indicates a positive belief about the perceived reliability of, dependability of, and confidence in a person, object (such as computers, networks, and software), or process (such as credit card transactions and airline e-ticket reservations). There are numerous additional definitions of trust; all fields where trust is important have developed its own definition. In spite of this diversity there are components that are included into most definitions of trust (Harrison, McKnight, & Chervany, 1996):

- willingness to be vulnerable / to rely,
- confident, positive expectation / positive attitude towards others, and
- risk and interdependence as necessary conditions.

Trust has various forms as well, according to different authors (e.g., Luhman, 1979) trust has forms such as

- **Intrapersonal Trust:** Trust in one's own abilities; self-confidence, basic trust (in others);
- **Interpersonal Trust:** Expectation based on cognitive and affective evaluation of the partners; in primary relationships (e.g., family) and nonprimary relationships (e.g., business partners);
- **System Trust:** Trust in depersonalised systems/world that function independently (e.g.,, economic system, regulations, legal system, technology); requires voluntary abandonment of control and knowledge; and
- **Object Trust:** Trust in nonsocial objects; trust in its correct functioning (e.g., in an electronic device).

Trust Building is More Than a Simple Approach

In building trust there are two approaches; information technology approach and human centered approach, based on culture and morality. Information technology approach means that security has to increase by different architectures, protocols, certifications, cryptography, authentication procedures and standards and this increased security generates the trust of users. This means access control (passwords, firewalls), protect integrity and privacy of messages and databases (cryptography), identification of users. Parallel stressing the effectiveness of these technologies for the humans (users) can cause that they will trust in the systems based on this convincing action. Based on the technological approach 100 % security never can be obtained (there will be always security holes somewhere in the systems), so full trust can not guaranteed based on these mechanisms.

The human side of trust is more complicated. There were different researches (e.g., Hoffmann, Novak, & Peralta, 1999) focusing on this side of trust. From this aspect user interface has the main role (i.e., the menu structure, the messages send for the user by the system). In case the user feels that is easy to use, it is transparent, he or she can control the system (even with low level computer knowledge); that is, the system is "user friendly," through this she or he can be convinced that she or he is using a trustworthy system.

It would be a mistake to think that applying only the human-centered approach would generate trust, the technological part has to be added as well (e.g., biometrical identification), so mainly the structured integration of the two approaches can result the expected level of trust.

ROLE OF TRUST IN E-GOVERNMENT

Communication Technologies for E-Government

The partners of the digital government are connected through different media according to the actual demands of the tasks. The conventional tools are the telephone, fax, writing letters. On the next level are the computer network-based solutions (e.g., e-mail, ftp, telnet). A higher quality of communication media is the Web-based communication solutions. Through Web pages a secure, easy, and fast communication can be realized. A new way of connection is the application of different wireless technologies for communication. Wireless technology means mobility, namely individuals is available independently from location and time. This mobility is an important attribute of today's organizations and people.

This mobility can be achieved by using different types of wireless networks as satellite communication, wireless wide area networks (WWAN—different types of mobile phone systems—GSM, GPRS, UMTS and iMode), wireless local area networks (WLAN, such as WiFi—also called mobile Internet (IEEE standard 802.11a/b/g) and Wireless Personal Area (or Pico) Network (e.g., Bluetooth). These networks can be connected, so the user can be reached really at any place through a type of wireless connection.

Mobile phones have Internet connections so they can handle e-mail and WEB pages. Multichannel access (e.g., Web site, mobile WAP; Call center; e-mail) to e-government services is an important factor of trust building especially when using the same interface structure (e.g., for Web and WAP).

Connection of Trust and E-Government

Transforming government functions through technology is harder than the infrastructures (conceptual, political and technical) created to support efforts into electronic government. Everything "e" this approach could not meet the expectations. The term digital government allowed for a more comprehensive view of governing through technology, but, if the act of governing were the central issue, then perhaps digital governance would focus the attention on the larger, more significant task. The ability to do the public's business and earn the public trust requires a new understanding of the interface between citizens and the act of governing.

The building and preservation of the public trust is the most critical issue facing the Internet technology today. With growing public awareness of online privacy and security issues, media attention to high-profile breaches of Internet security, and an increasing awareness of how citizen and customer data is being used by Internet and service providers, it is clear that government must address issues of public trust for e-government to be successful. Trust is the most critical factor facing the introduction of e-government, so governments must successfully handle the topic of public trust for e-government in order to have long-term success (NIC, 2000).

E-government services have a higher level of trust from the start than e-commerce sites because they are familiar for people and lack of competition. Although the starting level of trust is high, the confidence in government technology and safeguards is not. Most users expect good service and friendly handling from government agencies, so governments also have to earn user trust also by protecting their privacy and providing secure transactions.

This fact can be considered that e-government efforts might be more successful with high preexisting starting levels of trust, than developing more user-friendly Web sites, namely political efficiency can be important determinant of initial trust level for e-government (Parent, Vandebeek, & Gemino, 2004).

When citizens and business participants begin to interact with their governments in a great crowd directly, online and experience the increased benefits, trust in government may be raised to higher levels resulting more democratic processes, that also builds public trust (Holzer, Melitski, Rho, & Schwester, 2004). In this way developing public trust can become a self-inducing process.

The combination of experience-based trust with protection personal information will enhance adoption of e-government for citizens and businesses. Through protection of personal data, authentification, identity management, privacy and data protection, network and information security, the fight against cybercrime and general political efficiency could administration keep the needed level of public trust.

Technical Side of Trust Building: Application of Security Mechanisms

Approaching security from the side of trust, security is the set of different services, mechanism and software and hardware tools for generating trust with pure technology. More generally security is a condition that results from the establishment and maintenance of protective measures that ensure a state of inviolability from hostile acts or influences.

The building blocks, elements of security are the security services and the security mechanisms. The security services are, access control, authentication, confidentiality, integrity, and nonrepudiation. The means for achieving these properties depends on the collection of security mechanisms that supply security services, the correct implementation of these mechanisms, and how these mechanisms are used. Encryption, digital signatures and checksums/hash algorithms are the applicable security mechanisms.

The main factor of trust is confidentiality that can be achieved by technologies that convert/hide the data, text into a form that cannot be interpreted by unauthorized persons. The major technique to fulfil this goal is the encryption. Encryption is transforming the message to a ciphertext such that an enemy who monitors the ciphertext cannot determine the message sent (Schneier, 1996).

Human Side of Trust Building: Feeling of Trust

The feeling of security experienced by a user of an interactive system does not depend on technical security measures alone. Other (psychological) factors can play a determining role; the user's feeling of control can be one of these factors.

Trust is a dynamic process, and it alters, based on experience. Trusting process begins when an individual perceives indications that suggest a person/organization may be worthy of trust. These indications can include behaviors such as manners, professionalism and sensitivity and these forms are designed to represent trustworthiness. These formal claims to trustworthiness become strengthened over time and are eventually transformed into "character traits," such as dependability, reliability, and honesty.

It has to be analyzed why people feel safe and secure, what causes these feelings. The hypothesis of D'Hertefelt (2000) was that "the feeling of security experienced by a user of an interactive system is determined by the user's feeling of control of the interactive system." The more a user feels in control of an interactive program, the more the user will trust the site, the program, and the service represented by the site.

The process of building trust is slow; trust is formed gradually, it takes quite a lot of time and repeated positive experiences (Cheskin, 1999). Online trust can be described as a kind of human relationship. The initial stage is that of interest and distrust; there has to be a motivation, a need, to get interested in the service, or co-working. In subsequent phases the trust will evolve or in case of negative experiences the cooperation will terminate.

Trust is depending on the time span of cooperation and the type of connection as well. It can be stated that there are differences in trust building process in short-term and long-term relationships. In case of short-term relationships trust must be achieved quickly, and then maintain with no, or rare face-to-face interaction. In long-term relationships there are four factors that are influencing trust building (Rocco, Finholt, Hofer, & Herbsleb, 2001):

- greater investment in building trustworthy relationships,
- more time to establish trustworthiness through routines and culture,
- more communication channels,
- trust formation may assume a higher priority.

Tools for Trust Building

The tools for trust building can be hardware and software ones that protect user's privacy, provide secure transactions and generate the feeling of control. Interfaces, digital signature and encryption are the software parts for generating trust, while smart cards and personal trusted devices are hardware means that embody SW tools that can help in trust building.

Generating Trust By Human-Computer Interfaces

As a communication/information system term an interface is the point of communication between two or more processes, persons, or other physical entities. Interfaces are the key points for gaining the trust of the user/ customer. They are the first connection point between the user and the system, identification of the users take place at this point (e.g., password input, fingerprint reader, smart-card reader), the dialogues are realized by using the menu structure (feeling of control), so they have to be designed very carefully taking into consideration ergonomic and psychological aspects besides the technical ones.

Digital Signatures

A digital certificate is an electronic means of establishing the credentials of users when doing different transactions on the Web. It is issued by an independent certification authority. It contains the name, a serial number, expiration dates, a copy of the certificate holder's public key (used for encrypting and decrypting messages and digital signatures), and the digital signature of the certificate-issuing authority so, that a recipient can verify that the certificate is real.

Encryption

Encryption is the transformation of plaintext into an apparently less readable form (called *ciphertext*) through a mathematical process. The ciphertext may be read by anyone who has the key that decrypts (undoes the encryption of) the ciphertext.

Smart Cards

There is a strong need for a tool that can fulfil the functions connected to trustworthy services. Smart-card technology can offer a solution for current problems of secure communication by fulfilling simultaneously the main demands of identification, security and authenticity besides the functions of the actual application. Smart cards are bankcard size plastic plates that contain a chip. This chip can be programmed, can store different data and has all the basic functions of a computer. The major features mentioned for use of smart cards are that they

- contain identification information (e.g., biometric templates), application specific data (profile, rights, etc.), possibly updateable, public key certificates;
- support simple authentication of device and/or cardholder, electronic signature, exchange of encryption keys; and
- create valid electronic signatures, including cryptographic features.

Smart cards start their carrier now as they can be applied very well as (e.g., health care/ social security cards, electronic citizen and civil servant identification card with digital signature features).

Personal Trusted Device

As wireless devices (mobile phones, PDAs) are always with the users so they can become a personal trusted device (PTD) as well. Using PTD for trust building can make authentication and confidentiality easier, more reliable that support the services of e-government in a great extent.

FUTURE TRENDS

Citizens are choosing to meet their government online as the use of online government services in the United States stand at 43% at the end of 2002, with an increase of 9% in just the last 12 months. In selected program areas, up to 79% of users have chosen the Internet over all other channels in accessing government information and services. The advantages to the states are clear—the cost of providing a unit of service on the Internet is as much as 75% less than through conventional delivery channels. And these new channels are increasing government capacity by up to 93% (CDG, 2003).

Although the transition toward automated and electronic delivery of government services has begun, it will be a long and difficult process to achieve true e-government. Governments must invest significant financial and human resources into a technology infrastructure to support e-government transactions. These investments will be expected to yield both increased quality in government services and their delivery as well as create tax money savings. Citizens and politicians will have very high expectations for significant return on investment for e-government initiatives.

However, the challenges faced by e-government could be summed up as information infrastructure, efficiency, and quality of service, citizen participation, governance and public administration. Researches have to focus on these topics. In the citizen and business community participation the results of researches on trust building will define the rate of participation in e-government services in a great extend.

CONCLUSION

There is an international consensus that e-government has become an important challenge for the Information Society. According to numerous studies, surveys and researches, e-government offers potential solutions to leaders to better assume their responsibilities by providing efficiency, quality of services, citizen participation and enhanced public administration. E-government made it possible to establish a more open, inclusive, and productive public sector, in line with good governance. In the sense of e-government, good governance could be achieved by the proper combination of information and communication technologies, organizational innovation and improved skills.

In order to be able to realize all of these positive expectations the trust of the users of e-government services has to be gained as the first step. Without trust no one will use these brilliant systems, as it could be experienced at some spectacular, but "trust-free" e-business/e-commerce solutions.

Ultimately, e-government is about citizen's relationships with their civic institutions and the foundation of their next-generation communities. It is about extending the social contract to provide better services to all citizens and business participants.

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KEY TERMS

Biometry (Biometrics): Generally, biometrics refers to the study of measurable biological characteristics. In computer security, biometric technologies are defined as automated methods of identifying or authenticating the identity of a living person based on his or her physiological (e.g., fingerprint, hand, ear, face, eye—iris/retina) or behavioral (e.g., signature, voice, keystroke) characteristic. This method of identification is preferred over current methods involving passwords and pin numbers, as the person to be identified is required to be physically present at the point of identification, so the person or user is identified, not the device, as in case of PIN and password.

E-Government: E-government focuses on the use of new information and communication technologies (ICT) by government as applied to the full range of government functions. In particular the networking potential offered by the Internet and related technologies has the potential to transform the structures and operation of government" (OECD, 2005).

Personal Trusted Device: The Personal Trusted Device has to be personal, always carried by user, small, cheap, battery works, and common user interface, secure as a smart card. Mobile phones can fulfill the role of a Personal Trusted Devices, as mobile phones are well placed as identity tokens, they have dynamic authentication already proven in GSM, mass market, and secure communications.

Trust: Trust can be viewed as a cognitive and social device able to reduce complexity, enabling people to cope with the different levels of uncertainty and sometimes the risks that, at different degrees, permeate our life. Without trust and individual would freeze in uncertainty and indecision when faced with the impossibility of calculate all possible outcomes of a situation. From a social perspective trust permits the necessary knowledge sharing of delegation and cooperative actions (Luhman, 1979).

Trust Chain: A solution for addressing trust is to build a chain of trust, where each link is strong but also connects to its neighbor by verifying its trustworthiness.

Trustworthiness: The ability to attain and maintain a "Trusted State," which is definable, measurable, validatable, and demonstrable over time. Digital Trustworthiness means a verifiable level of electronic process integrity, security, control, authenticity, and reliability, that captures, preserves, retrieves, verifies, renders and makes available in human readable form; the essential transaction content, context, notice, intent and consent, to meet the electronic forensic evidence requirements necessary for legal admissibility and regulatory compliance.

Trust in E-Technologies

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INTRODUCTION

When reflecting the term *trust*, there are two main hypotheses which can be found in most of the literature: First, trust is presented as an amorphous phenomenon, which is difficult to measure empirically (Endress, 2002). Second, the characteristic of trust is rather fragile. Trust as a mediator of social interactions cannot be quantified precisely, it has to be generated and recreated at any time varying with its social context. Volken summarizes this particular connection between trust and the context in which it is created: "Trust is a complex construct with multiple dimensions, and their relative effects on innovative actions may be highly dependent on their respective social context" (Volken, 2002).

In the age of globalization trust is particularly important when one operates in the areas of e-commerce, e-government, and mobile commerce, or develops IT-systems which are touching the interface between technical innovation and its application by users. The latter live and work in a certain social context in which trust can be established in various ways. This necessarily has consequences for IT-solutions and IT-security which this article tries to explore. Giddens (1990) pointed out that "mechanised technologies of communication have dramatically influenced all aspects of globalization since the first introduction of mechanical printing into Europe [Johannes Gutenberg, 16th century]" (p.77).

Without Johannes Gutenberg, there would have been no Reformation, without information technology, there would have been no global information age. Both historical developments, as different as they may be, took place in a certain social context, of which technical innovation became a part. At the same time every society depends on the key ingredient, which is a requirement for social interaction: Trust.

As a reader of the Gutenberg *Bible* trusted that his book is complete and correct, any user of information technology trusts that the applied system functions properly and is reliable. The following questions arise: How does trust which basically is part of most social interactions fits within information technology using "0" and "1" to enable any sort of interaction? How is trust created, maintained and developed in the information age? Which forms of trust exist and are necessary to operate in an interconnected world?

The article will explore these questions by describing current definitions and concepts of trust outside and inside a context of information technology. After exploring the link to concepts of trust in social science and culture a new concept of trust in e-technologies such as e-commerce, e-government, and mobile commerce will be developed. Important trust-building factors such as transparency or participation will be analyzed in order to conceptionally deal with the increasing importance of trust in a virtual world.

BACKGROUND

As a background, an overview is presented about trust from the social science perspective. While trust is defined in various ways, this article concentrates on the most relevant definitions influencing e-technologies.

Trust in Social Science

Trust as a concept of social science was firstly written down by Georg Simmel, who differentiates three trust phenomena in the context of the "Philosophy of Money" (Simmel, 1989):

a. Microlevel ("natural trust" in direct, intuitive social relationships)
b. Mesolevel ("rational trust" in professionals and the role of a person)
c. Macrolevel ("systemic trust" in interactions which are mediated through symbolic tokens such as social subsystems, e.g., money)

Trust, its creation, presence and its maintenance extends through all three levels. By focussing on the meso- and macrolevel, this can be outlined as the first impact on the view of trust as a concept for e-technologies. Discussing trust regarding e-technologies means to clarify the relation of trust and virtual systems of information technology (IT systems). Thus, the circle of trusted dependencies is enhanced concerning e-technologies, and this creates sustaining trust of a wider scope considering more subsystems within the macrolevel, such as contracts, system hardware and several types of system software.

Further in this context, Simmel (1992) developed a second distinction of the term *trust* and positioned three hypotheses:

1. **Trust as a general confidence and as a "weak inductive knowledge":** Trust is the confidence in certain, constant elements in the human life or as a type of unspecific expectations, or alternatively, general hopes. But it has to be distinguish that "trust presupposes awareness of circumstances of risk, whereas confidence does not" (Giddens 1990, p. 31)
2. **Trust as a form of knowledge. Trust in somebody (or something):** Trust is the hypothesis of future behaviour, which is certain enough for establishing practical acting. Trust is the medium state between knowledge and ignorance. The one who has complete knowledge does not need to trust, and the one who does not have any knowledge cannot even develop trust. (Simmel, 1989)
3. **Trust as a feeling. Trust as a belief or faith in somebody. Trust as an inner *unreservedness* towards someone else:** Although trust is always partly determined through feeling and emotion, these aspects have no purpose in the debate about trust and IT-systems. When looking at IT-systems one proceeds from the assumption of an average participant and trust can be treated rationally compare to Giddens and Luhmann. Both are grounded in Simmel's statement of trust as a "week inductive knowledge" (Simmel, 1989).

Based on Simmel, Niklas Luhmann similarly differentiates between personal trust (trust in persons) and systemic trust (trust in social or technical systems). As professional knowledge is required to control systemic trust, it isn't for personal trust. (Luhmann, 1968) Luhmann, as a leading voice of modern sociology and father of the *system theory* (*Systemtheorie),* defines trust as a vital mediator between different systems. Therefore, trust is able to lower or bridge complexity to manage expectations and to increase space for action. (Luhmann, 1968)

The differentiation between personal and systemic trust is further supported and enhanced by Fukuyama's (1995) "radius of trust" with the goal to resume different types and contexts of trust to capture its whole concept. The greater the radius the more complex the concept of trust gets. The systemic trust in expert or abstract systems in relation to trust in products, absent others and organizations and institutions is the focus of this article.

Giddens as an extension of Simmel provides the major impact on trust regarding e-technologies. He characterizes trust as "a distinct from confidence based on weak inductive knowledge." (Giddens, 1990, p. 54). Besides other hypotheses of Giddens, the following are considered here: (1) Trust is related to absence in time and space. (2) Trust is not the same as faith in the reliability of a person or in a system; it is what derives from that face. (3) Trust may be defined as confidence in the reliability of a person or system, regarding a given set of outcomes or events, where that confidence expresses a faith in the probity or love of another, or in the correctness of abstract principles (technical knowledge). (4) Danger and risk: What risk presumes is precisely danger. The "acceptable" risk—the minimizing of danger—varies in different contexts, but is usually central in sustaining trust. (5) Risk is not just a matter of individual action. In his last point he indicates the relation of trust and security which will be referred to later.

James S. Coleman's logic of trust as a rational decision making model also fits the statement of this article and can be summarized as follows in four structured patterns (Coleman, 1990): (1) Placement of trust allows actions that otherwise are not possible. (2) If the trusted person (trustee) is trustworthy, the trusting person (trustor) improves his or her position; otherwise, he or she worsens it. (3) Trust is an action that involves the voluntary placement of resources (physical, financial, intellectual, or temporal) at the disposal of the trustee with no real commitment from the trustee. (4) A temporal delay exists between the extension of trust and the result of the trusting behaviour. These four patterns can be applied to trust in relation to e-technologies as it is later described in chapter three. According to Coleman's outlined relation between trust and rationality, the decision on trust is related to the trusting person's state of knowledge about possible surplus and loss. Following this, individuals as rational actors give trust in a rational way if the expected advantage (proof) is higher than the expected possible disadvantage (disappointment). Individuals rationally calculate and evaluate the win and loss based on the available information (Coleman, 1990). Coleman's second pattern is affirmed by Sztompka who says: "If the grounds for trust come down to a certain knowledge acquired by the trustor about the trustee, then it would make sense to accumulate such knowledge to arise the probability of wellplaced trust" (Sztompka, 1999, p. 70). In addition to the rational attribute of trust, the reflexiveness of trust needs to be outlined. "Reflexiveness" is defined as people acting on beliefs, knowledge, memory and interpretation of past experiences (Sztompka, 1999). Both, the rational and the reflexive attribute of trust are interdependent and must both be considered when exploring trust.

Similar to Simmel, Sztompka (1999) outlines three dimensions (cultural, rational, and psychological) of trust and completes the impact of trust for e-technologies. Culture is not only an essential focus in social science, but also acts as a key figure in terms of the acceptance of and participation in e-technologies.

He defines rational trust as reflected trustworthiness which is specified through "trust ratings." Trust ratings are divided. Primary trust bases on reputation, performance and appearance (personality, identity and status) and is analytically determined. "We tend to trust people who show such a control: who are more orderly, neatly, dressed, groomed, clean, and look healthy and fit" (Giddens, 1991, p. 57). Secondary trust bases on the external context and determined through derived trustworthiness. Psychological trust is defined by Sztompka (1999) as the inner trusting impulse. The cultural trust implies sediments of historically accumulated collective experiences of a given society, community or social group.

Considering trust as a social relationship the following statement can be referenced: "Trust … is a particular level of the subjective probability with which an agent assesses that another agent or group of agents will perform a particular action, both *before* he can monitor such action … *and* in a context in which it affects *his own* action" (Dasgupta, 1988, similar to Luhmann 1988 and also to Gambetta 1988, 2001). Trust is a condition for any social interactions. At the same time it is not of a natural character, it continually has to be created and reconstructed. Hence, its character is rather fragile. Trust is an inner persuasion of other individuals which either execute certain actions or don't. The trustor is aware of the risk the trustee's actions imply. Trust is a presumption. … The dynamic of the creation of trust can be displayed on a time axis. Trust is a balancing state when all necessary and sufficient conditions are fulfilled. This stage is further influenced by the perception of prediction, consistence and stability of the relevant trustees (Eisenstadt, 2001; Offe, 1996). The emphasized characteristic of trust as being fragile is additionally intensified by the nonavailability of resources of information. Interaction with other identities (individuals or systems) always includes risk, which has to be minimized. As it can be derived from the following statements, trust can act as a reducer of risk. "The clues employed to form trust do not eliminate the risk, they simply make it less. They do not supply complete information about the likely behaviour of the person to be trusted. They simply serve as a springboard for the leap into uncertainty" (Luhman, 1979). Sztompka described trust in relation to risk as follows: "Placing trust, that is, making bets about the future uncertain and uncontrollable actions of others, is always accompanied with risk. … Placing trust means suspending discounting, 'bracketing' the risk, acting as if the risk were not existent" (Sztompka, 1999).

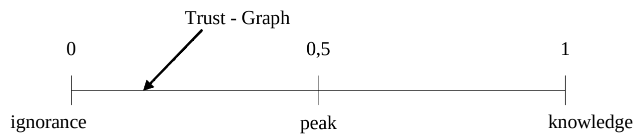
The difficulty of developing trust towards less tangible entities or expert systems like e-technologies is caused by the incalculable *risk* of the systems virtual characteristic. This problem is amplified through the sparse knowledge an average user of an IT-system has "enter other expert systems, of which my own technical knowledge is at best rudimentary" (Giddens, 1990, p. 28). Since "all interactive media require trust as a condition to operate efficiently," (Parsons, 1980, p. 215) trust needs to be generated. But to create trust in an IT-system, the risk has to be reduced to an acceptable level. This can be gained though "regulatory agencies over and above professional associations, which are designed to protect the consumers of expert systems" (Giddens, 1990, p. 29) and through transparency.

Trust, Culture, and Globalization

In times of *globalization* where e-technologies are the connecting mediator between communicating entities (persons or systems), the relevance of trust is even more apparent and additional factors in the creation and maintenance of trust have to be considered. Since networked entities can be located anywhere in the world, their interactions can span the globe. Therefore, "the ongoing process of global interdependency will only increase the demand for trust as an essential condition for cooperation" (Misztal, 1996, p. 269). Coping with strangers is part of globalization. But this turns out to be problematic since trust is rarely given to strange and unknown persons or things. "The stranger is the representative of the unknown … the unknown culturally defined space in which separates off the outside from the world of the 'familiar', structured by the traditions with which the collectivity identifies" (Beck, 1994, p. 81).

Local environments are globally connected through e-technologies. "Technology is eliminating the 'place'" (Tapscott, 1997). But a time-space distanciation negatively influences the creation of trust. "The conceptual framework of time-space distanciation directs our attention to the complex relations between local environments (circumstances of co-presence) and interaction across distance (the connections of presence and absence)" (Giddens, 1990, p. 64). He follows, that time-space distanciations are "stretched" in modern societies with networking expert systems and "the modes of connection between different social contexts or regions become networked across the earth's surface as a whole"

Figure 1. Trust-graph



(Giddens, 1990, p. 64). Thus, Giddens defines Globalization "as the intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa."

"Access points" of abstract systems as a meeting ground of facework commitments (Giddens, 1990, p. 83) are necessary for the creation of trust, participation and acceptance of E-technologies. Trustworthiness is given through an establishment of these access points.

The creation of trust, the acceptance of, and the participation in e-technologies are controlled by *culture*. Culture constitutes features of social life such as cultural norms, values, attitudes and identity of persons which enable and facilitate the generalization of cooperative actions. Hence, e-technologies have to fit a culture's identity, their norms, standards and needs. "Trust depends on cultural resources" (Sztompka, 1999). When globally connecting local systems, trustworthiness has to be granted. Local norms and values which vary with the culture of a society and its governing structures have to be matched. Hence, the creation of trust in global connecting systems is a domestic matter.

MAIN THRUST: TRUST

Discussing trust as a concept for e-technologies, Bishop (2003) provides a precise definition: "In the field of computer technology containing hard- and software implementations trust is a belief or desire that a computer entity will do what it should to protect resources and be safe from attack" (p. 477). This definition acts as a fundament but has to be enhanced considering aspects of social science.

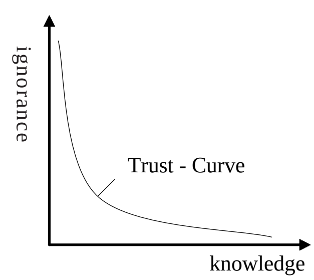
Trust and E-Technologies

Exploring trust in relation e-commerce, e-government and mobile commerce, Simmel's definition of trust in chapter two as a "weak inductive knowledge" and as a "medium state between knowledge and ignorance" is considered. The concept of trust in regard to e-technologies can be characterized as follows in Figures 1 and 2.

Two graphical presentations (Figure 1 and Figure 2) are introduced to capture the full dimension of trust. Figure 1 demonstrates the Trust- Curve, whereas Figure 2 demonstrates the Trust-Graph. Both are equivalent. Figure 1 illustrates the one-dimensional view of trust similar to a timeline on which trust dynamically varies over time influenced by certain factors. A threshold presents the probability of trust. The peak, as it is marked in Figure 1, indicates the point of balance at which a person ranges between trust and no trust. Full trust (trust = 1) is knowledge. No trust at all (trust = 0) is ignorance. Figure 2 is the two-dimensional view in which the Trust-Curve represents trust as a floating state between two limits. One limit is marked as knowledge, identical to Figure 1 (trust = 1), the other limit is signed as ignorance (trust = 0 in Figure 1). The Trust-Curve converges to either one limit or the other, but never reaches them. Both figures can be mapped on each other.

Trust is changing dynamically based on the accumulated experiences a participant of an e-technology system has and develops. Individuals as rational actors give trust in a rational way if the expected advantage (proof) is higher than the expected possible disadvantage (disappointment) (Coleman 1990). Based on his or her experience and the calculation of loss, the potential participant develops trust and decides at one point (above the threshold 0, 5 in Figure 1) that he or she participates in the system which he or she then counts as trustworthy. But at the same time, trust is not a stable state, its characteristic is rather fragile. The individual's participation can be disrupted at any time with an unexpected happening which disappoints the participant. These happenings can have

Figure 2. Trust-curve



variable causes. For example, a system (hard- or software) crashes, an IT solution is not comprehensive, or the interface is too complex. Trust also can be negatively influenced by disappointing entities such as a person in a virtual community like eBay, or established organizations such as partners in e-commerce and e-government. Also the not existing immediate result and nearby identity can be named as a factor negatively influencing trust towards an IT-system as Simmel (1978) described it. According to the fourth component of Coleman's logical definition of trust (Coleman 1990), a temporal delay exists between the extension of trust and the result of the trusting behaviour. In other words, to access the appropriateness of trust implies a temporal delay until the time when trust pays off.

Trust, Identification, and Participation

The achievement, as well as the condition for the acceptance of and participation in expert or better "abstract systems" like e-commerce and e-government is, as mentioned before, the *trustworthiness* of these systems. Generating and maintaining trust towards e-technologies depend on the trustworthiness of it, but also acts as a condition for the *participation* in the system. This reflects the dilemma of being informed and participating in something: "There is a merge between being informed and participating in the world.…You can't really be informed unless you participate, and you can't really meaningfully participate unless you're informed." (John Seely Brown, cited in Tapscott, 1997, p. 267). Trustworthiness is built on *reputation* and reputation, only can be gained to and through informed and participating identities. Hence, identification is a prerequisite for building trust.

In times of globalization, where IT-systems act as globalizing communication mediators, participating identities can be anywhere in the world. Due to this fact, the term *identity* implies certain characteristics which are of a gender, religious, national, ethnic, territorial, socio-biological nature. "Identity is people's source of meaning and experience….For a given individual, or for a collective actor there may be a plurality of identities" (Castells, 2004, p. 6).

For creating and maintaining trust towards e-technologies, identities have to be provided. In e-technology systems not only the identity of the partners (company, government) has to be known by a reliable reputation but also the identity of the particular used technology.

Systems which appear more transparent to the participant increase their trustworthiness and hence their reputation and acceptance. The more a customer understands and is able to crosscheck a certain process at any time an IT system or an IT solution is executing, the less trust needs to be created up front. If a banking customer sees how a system works, if he or she can check ratings of the bank and customer reviews of their internet banking division, for example, the less "blind trust" is needed. He or she develops trust in transparent systems from the start because he or she sees and can check if and how it works. When a customer (potential participant) believes that the system is reliable he or she feels confident using the system because his or her trust is on a higher level regarding the Trust-Graph in Figure 1 or the Trust-Curve in Figure 2. Considering these aspects, transparency has to be the goal of any IT system or any IT solution.

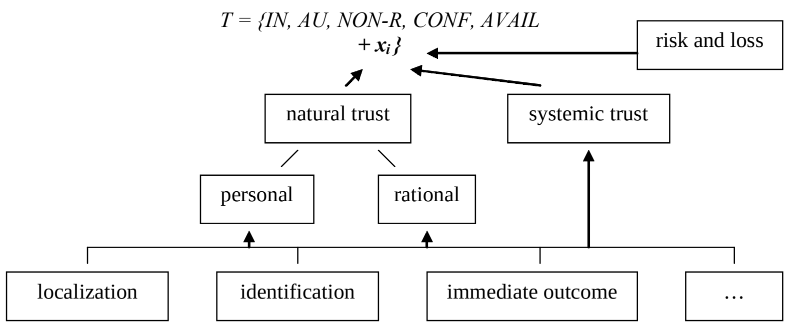
Trust and IT Security for E-Technologies

"An entity is trustworthy if there is sufficient credible evidence leading one to believe that the system will meet a set of given requirements" (Bishop, 2003, p. 478). These requirements determine the assurance to predict the level of trustworthiness of an entity.

As described below, the main security requirements for IT systems and their techniques can act as a basis for the further exploration of their effects on generating trust (see also Dittmann et al., 2001; Marotzki, 2003) These *security requirements* only concern the software as well as the information, which is displayed by and communicated through the medium. Furthermore, there are security measures which either pertain to the hardware, or have an external character such as physical locks, regulations concerning employees' behaviour, guidelines for actions, user training and security policy definition, or standardizations (Bishop, 2003; Stallings, 2003). These measures do not influence the generation of trust in terms of e-technologies and security. Influencing security measures are confidentiality, data integrity, data origin authenticity, entity authenticity, non-repudiation, and availability as defined in the key terms.

In this context, trust also acts as a security requirement, but in the way that it is determined through all other five requirements. Although the first five are mainly static challenges in terms of technical solutions, from passwords and digital signatures to watermarks or suitable soft- or hardware, the concept of trust is far more dynamic and complex in the sense that it is an underlying attitude which needs to be communicated to any user in order to convince them to even accept or buy a technical solution in the first place. For example: A credit card (*credit*, from the Latin *credere*, to trust) provider can possess the most modern IT security systems, but he has to build trust in order to attract clients. Therefore, trust can be seen as the result of the accumulation of the first five aspects of security assurance.

Figure 3. Determination of trust in IT systems regarding IT security and x_i factors



The effects of the five rather static IT security requirements for generating and maintaining trust in e-commerce and e-government systems can be demonstrated through a further enhancement of the Trust-Curve/Trust-Graph in form of factors which influence trust in IT systems like it is given in form of the following equation:

$$T = \{IN, AU, NON\text{-}R, CONF, AVAIL + x_i\}$$

Trust (T) is determined through the five static requirements of IT security, integrity (IN), authenticity (AU), non-repudiation (NON-R), confidentiality (CONF) and availability (AVAIL) plus x_i factors, which have been elaborated earlier in the first three paragraphs of this chapter. Depending on the context and the purpose of the IT system the factors and security requirements have to be weighted. This aspect of weighting belongs to the future work and has to be investigated in more detail. The outcome of this equation is a status between 0 (*ignorance*) and 1 (*knowledge*) as it is presented in the first paragraph of this chapter. Thus, the level of trust can be determined, and subsequently, the trustworthiness of an IT system can be estimated.

IT-security technologies and techniques have a remarkably positive influence on developing trust, trustworthy systems and participation in them.

FUTURE TRENDS

The focus of future work has to be on the development of techniques to ensure the requirements of IT security. Thus, an IT system can be designed and presented transparently which increases trust and the acceptance of and participation in the system.

Further future work is affecting the presented equation. Future developments have to consider a recursive iteration of the equation and an elaboration of the weighting of the influencing factors. This aspect of weighting has to be investigated in more detail.

The focus in future investigations is the achievement of accepted standardizations for IT systems and IT security techniques. In addition, security techniques have to be perpetually watched, evaluated and improved. The following listed problems have to be overcome:

- High costs of implementing secure and transparent systems, since establishing security is a never ending process, according to Schneier (2004), which underlies action and reaction. Therefore, one has to accept that designing transparency and developing absolutely secure digital systems can never be achieved. But, it can be approximated and that should be the aim.
- The lack of standards and policies, especially security policies to prevent attacks on IT systems and grant a sure and stable working solution or platform for e-commerce and e-government.
- The unrealiability of identities who participate in an IT system.
- The uncertainties. There are always events happening within an IT system, which can not be predicted.
- The difference in standards and needs depending on culture.

CONCLUSION

Summarizing this article and the relevance of trust for e-technologies such as e-commerce, e-government, and mobile commerce the following aspects can be specified:

Trust is a medium state between knowledge and ignorance and its characteristics are rather fragile. Trust is a dynamic status which varies over time influenced by certain factors. Trust acts as a condition for building trustworthy systems, while trustworthy systems act as a condition for creating and developing trust. Trustworthy systems are based on reputation and reputation can only be given through participating identities. Hence, trust is the key for generating acceptance of technological systems and the participation in them.

Delp (2004) emphasized the importance and relevance of trust in the 21st century considering multimedia and security in digital networking systems. IT security in digital multimedia systems is determined through security requirements such as confidentiality, integrity, authenticity, nonrepudiation and availability which can be directly fulfilled through certain techniques.

To access the appropriateness of trust implies a temporal delay until the time when trust pays off. The decision of a system being trustworthy is not given before that temporal delay.

Accepting the assumption that the creation of trust in global connecting systems like IT systems is a domestic matter, it is possible to develop trustworthy solutions for e-commerce and e-government. Thus, a virtual world can be established which is nearly as tangible as a piece of paper.

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KEY TERMS

Assurance: Statement, indication, or presumption that inspires confidence while excluding doubt. Assurance is an aspect of trust. Given the fact that trust cannot be quantified precisely, assurance provides a basis for quantitatively or qualitatively specifying the level of trust towards a system.

Authenticity: is divided in two sections: Data origin authenticity and entity authenticity. Data origin authenticity is the proof of the data's origin, *genuineness*, *originality*, truth and realness. Entity authenticity is the proof that a person or other agent has been correctly identified, or that a message is stored and received as transmitted.

Availability: Availability indicates the assurance that resources, like information, services, or equipment, are working adequately and available at a specified time to authorized entities. An available system has to be safe and secure from attacks.

Confidentiality: Nonoccurrence of the unauthorized disclosure of information. The term confidentiality indicates aspects of secrecy and privacy. It implies the ensuring that information is accessible only to those authorized to have access.

Data Integrity: Preventing of forgeries, corruption, impairment or modification of resources like information, services or equipment. Data integrity is the quality or condition of being whole and unaltered, and it refers to the consistency, accuracy, and correctness of data.

Safety: Quality, state, or condition of being prevented of and/or protected against danger, risk, or injury, caused by accidental and unintentional effects or actions. Safety further includes the recovery from such accidental and unintentional effects or actions.

Security: Quality, state, or condition of being prevented of and/or protected against danger, risk, or injury, caused by intentional effects or actions such as access to information by unauthorized recipients and the intentional but unauthorized destruction or modification of that information. Security further includes the recovery from such unauthorized destructions or modifications.

Nonrepudiation: Service that provides proof of the integrity, origin of data, and the identity of a person, all in an unforgeable relationship, which can be verified by any third party at any time. Hence, it determines, wether or not a particular event occurred or a particular action happened.

Privacy: Right of the individual to be protected against intrusion into his personal life or affairs and the individual's right to decide what personal data of him or herself can be accessed and used publicly by others.

Trustworthiness: Ability to create and develop trust. Trustworthiness is the assurance that a system deserves to be trusted.

Unexpected Outcomes of Lean E-Collaboration

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INTRODUCTION

Over the years, many theories have been used to understand e-communication and e-collaboration behavior (Kock, 2004; Markus, 2005). Arguably, the most widely used among those theories has been media richness theory (Daft & Lengel, 1986) even though there has been mounting evidence that its predictions do not hold in a number of situations (Markus, 1994).

One key prediction of media richness theory is that communication media of low richness (e.g., e-mail as opposed to face-to-face) consistently leads to a decrease in the quality of the outcomes of group tasks. One of the complicating issues associated with media richness theory is that there is abundant evidence that low media richness leads to perceived obstacles to communication (Kahai & Cooper, 2003; Kock, 2004), which is consistent with the theory, yet it is obvious that media of low richness like e-mail are widely used, sometimes even when richer media are easily available (Kock, 2005; Lee, 1994; Markus, 1994).

Even though media richness theory was proposed a long time ago, well before the emergence of modern e-collaboration technologies and the Internet as we know it today, it addressed topics that are highly relevant now. It addressed the notion that characteristics of a communication medium may affect group work, which has been a recurrent issue in recent research (Alge, Wiethoff, & Klein, 2003). Media richness theory and its nonverbal-cues-suppression perspective set the stage for the study of behavioral e-collaboration phenomena at the individual level of analysis, such as "flaming" (Alonzo & Aiken, 2004), and at the group level of analysis, such as group decision making (Baker, 2002). The theory has also motivated research into technological solutions to the problems associated with lean media (Briggs, 2002; Briggs, De Vreede, & Nunamaker, 2003).

In spite of the large amount of research in connection with media characteristics and their impact on group tasks, there has been little empirical evidence that the adoption of a lean medium can lead to increased group outcome quality: a counterintuitive finding that goes squarely against predictions based on media richness theory (Daft, Lengel, & Trevino, 1987; Lengel & Daft, 1988; Markus, 1994). This article provides such evidence based on the study of five process-improvement groups in a New Zealand university.

BACKGROUND

E-collaboration technologies are broadly defined as electronic technologies that enable collaboration among individuals engaged in a common task (Kock, Davison, Ocker, & Wazlawick, 2001). The e-collaboration literature is filled with mixed findings (Orlikowski, 1992), where success in the introduction and use of e-collaboration technologies has been as commonplace as failure (DeSanctis, Poole, Dickson, & Jackson, 1993; Kock, 2004). A number of theories and theoretical frameworks has been proposed that provide a basis for the understanding of these mixed findings.

Among the many theories devised, media richness theory (Daft & Lengel, 1986) stands out for its influence as a deterministic theory of communication-media adoption and use since its development in the mid-1980s. The theory claims that different communication media can be classified as lean or rich according to their ability to convey knowledge and information. The classification scheme proposed by media richness theory places face-to-face as the richest communication medium, and e-mail as a relatively lean medium (Fulk, Schmitz, & Steinfield, 1990; Lee, 1994). Media richness theory claims that lean media are not appropriate for knowledge and information communication (i.e., equivocality and uncertainty reduction), and that the adoption of media and the outcomes of their use will usually reflect this fact (Daft et al., 1987; Lengel & Daft, 1988).

Other factors have been shown to influence group outcomes, and related evidence has been presented to show that those factors influence group outcomes in ways that are either compatible with media richness theory, or in ways that expand and refine the media richness perspective. For example, past research has shown that the nature of the collaborative task (e.g., whether it is simple or complex) can have a strong effect on its outcomes when certain e-collaboration technologies are used. Task-technology fit theory (Zigurs & Buckland, 1998; Zigurs, Buckland, Connolly, & Wilson, 1999) proposes a typology of tasks and e-collaboration technologies, as well as predictions regarding the pairing of certain tasks and technologies, and the impact of that on group outcomes.

Part research has also suggested that the mental schemas (also referred to as knowledge or background;

see, e.g., Kock, 2004; Kock & Davison, 2003) possessed by individuals may influence the impact of e-collaboration technologies on the individuals. This includes socially constructed schemas that may induce the individuals to interpret information in a particular way (Lee, 1994). Particularly, the degree of similarity among the task-related mental schemas possessed by different individuals engaged in a collaborative task (e.g., whether task experts are interacting with other experts, or novices) may significantly affect the amount of cognitive effort required to successfully accomplish the task using certain types of e-collaboration technologies. Kock (2004) argues that the higher the degree of schema similarity, the lower cognitive effort is likely to be required.

GROUPS STUDIED

Five process-improvement groups were studied. Those groups were conducted at a New Zealand university over 7 months. The groups had from 7 to 13 members, and took on average 41 days to be completed. Each group selected, analyzed, and conceptually redesigned one or more business processes; redesign proposals were later implemented and led in most cases to process-quality and productivity improvements. Forty-six structured interviews addressing perceived technology effects were conducted with group members within two weeks of the completion of their groups.

All groups voluntarily adopted an e-collaboration system, namely, an e-mail conferencing system developed by the author, as their main communication medium. The system allowed group members to post e-mail messages and attachments to their groups. The decision as to whether the system would be used or not, and how much, was completely left to the groups themselves.

CHOICE OF MEDIUM

All five groups voluntarily chose the e-collaboration medium for the vast majority of the group interactions, that is, those interactions in which the communication mode was many to many. Phone and face-to-face media were used predominantly for one-to-one communication. That is, the groups consistently favored the e-collaboration medium as their main medium for communication in spite of it being perceived as a leaner medium than the phone and face-to-face media.

When asked to explain their choice, the overwhelming majority of the interviewees assigned a reduction in disruptiveness, typically linked with the possibility of interacting with the group at the most convenient time for them, as the main reason for the choice of the e-collaboration medium.

ADAPTATION TO THE LEANER MEDIUM

Several members pointed out that they had perceived the e-collaboration medium as likely to add undesirable ambiguity to their discussions. The main reasons given by members were the lack of immediate feedback and the filtering of verbal cues inherent in the e-collaboration medium. These perceptions are highly consistent with predictions based on the media richness theory (Daft & Lengel, 1986).

Plausible predictions based on the media richness theory for future scenarios involving the five groups would have been (a) the perception by group members of an increase in ambiguity in individual member contributions, and (b) either a move to richer media (such as face-to-face) or the discontinuation of the groups, both as a consequence of the higher perceived ambiguity.

None of these scenarios became reality. On the contrary, not only did the groups continue using the e-collaboration medium for most of the group interactions, but also, somewhat to our surprise, most respondents spontaneously reported a perceived increase in member contribution quality.

The perceived increase in member contribution quality can be explained by an adaptation of the members to the leaner medium, an adaptation that was primarily aimed at overcoming obstacles posed by the e-collaboration medium due to what could be characterized as its inherent lack of naturalness when compared with the face-to-face medium (Kock, 2004). Two main pieces of hard evidence strongly suggest this adaptive behavior and some traits of its dynamics. First, members spent more time preparing their individual contributions, which is evidenced by a dramatic decrease in member contribution speed through the e-collaboration medium in comparison with face-to-face meetings.

The mean contribution speed in the e-collaboration medium was approximately 6 words per minute. In face-to-face meetings, this contribution speed has been estimated at 113 words per minute (McQueen, 1991; McQueen, Payner, & Kock, 1999). The contribution speed in the e-collaboration medium was calculated based on group members' estimates (as well as direct measurements) of time spent preparing and posting contributions to their groups and the actual word count of their postings. The low contribution speed through the e-collaboration medium could not be explained only based on the fact that typing is slower than speaking, as average typists are expected to be able to type between 60 to 70 words per minute, which points to a better preparation of the postings as an alternative explanation for the low speed observed.

Second, group members seemed to have provided much longer contributions (in terms of total number of words) through the e-collaboration medium than they would have usually done in face-to-face meetings, which suggests that e-collaboration-mediated contributions may have had more information and knowledge content than equivalent oral contributions in typical face-to-face meetings. An aggregate analysis of word counts per posting provides support for this perception. According to this analysis, the mean contribution length (per posting) was 297 words through the e-collaboration medium. In face-to-face meetings, this mean contribution length has been estimated at 18 words (McQueen, 1991; McQueen et al., 1999).

The two pieces of hard evidence presented above, based on estimates of member contribution speed and contribution length, suggest that the adoption of an arguably less natural e-collaboration medium by the groups led members to adapt their group communication behavior in a way that seems to have led them to overcome the limitations posed by the e-collaboration medium. This adaptation apparently led group members to prepare longer and better-thought-out contributions than in typical face-to-face meetings.

MEDIUM LIMITATIONS ARE PARTIALLY OVERCOME

Given that members perceived an increase in member contribution quality as a consequence of the adoption of the e-collaboration medium, it seems plausible to expect that group outcome quality—that is, the quality of process redesign proposals—would also be seen by members as being increased. This was indeed the trend of the perceptions gauged in interviews with group members after their groups completed their process redesign tasks. Forty-eight percent of the interview respondents perceived an increase in group outcome quality, and 22% perceived a decrease. The remaining respondents perceived no variation in quality.

One of the two main reasons given by members for the increase in group outcome quality was an increase in member contribution quality; the other reason was higher departmental heterogeneity enabled by the low disruptiveness inherent in the e-collaboration medium used (an asynchronous communication medium). The main reason given by the respondents who perceived a decrease in outcome quality was higher ambiguity in the discussion, also seen as directly caused by the unnaturalness of the e-collaboration medium used, when compared with the face-to-face medium. These explanations partially confirm our hypothesis that group members perceived the e-collaboration medium as a relatively unnatural medium, but they nevertheless decided to use it for the majority of their group interactions and adapted their behavior to overcome the limitations posed by a high medium equivocality.

FUTURE TRENDS

While the initial perceptions of group members of the e-collaboration medium were consistent with predictions based on the media richness theory (Daft & Lengel, 1986), the adaptive behavior displayed by the groups in this study was not so. This behavior is, nevertheless, remarkably consistent with that of groups in similar circumstances in different organizational settings (Kock & McQueen, 1996), and partially consistent with previous studies in which the adaptive power of groups has been illustrated (Majchrzak, Rice, Malhotra, King, & Ba, 2000; Markus, 1992; 1994; Orlikowski, Yates, Okamura, & Fujimoto, 1995). The final and somewhat surprising conclusion of this study is that the existence of media constraints to group communication led to an improvement in group outcome quality!

No single existing theoretical framework provides a solid basis for explaining the adaptive behavior observed in the groups in this study. Two emergent theories that go some way toward accomplishing that explanatory goal are the psychobiological model (Kock, 2004) and compensatory adaptation theory (Kock, 2005). These two theories allow us to predict that unnatural media will lead to perceived obstacles to communication, and that group members will compensate for those obstacles. However, the theories do not allow us to fully understand why that happens.

Future research should expand the basic tenets of the psychobiological model (Kock, 2004) and compensatory adaptation theory (Kock, 2005) so that a better understanding is achieved of what really goes on in groups performing knowledge-intensive tasks using e-collaboration technologies. One thing seems to be sure, however: Contrary to what media richness theory predicts, it seems that those types of groups can be quite successful in spite of what may seem as shortcomings associated with lean communication media.

CONCLUSION

The groups in our study had initially chosen the less natural e-collaboration medium for group communication because of some of its advantages, notably, low disruptiveness. Immediately after they had begun using the new medium, group members perceived the medium as likely to lead to more communication ambiguity. They then adapted their behavior in order to overcome the limitations posed by the new medium rather than moving to a richer medium such as face-to-face. This adaptation involved members preparing longer and more elaborate messages, which partially offset the higher equivocality perceived as inherent in the e-collaboration medium.

Another more established theory that may help us understand the behavior of groups in response to communication-media constraints is the adaptive structuration theory (DeSanctis et al., 1993; Wagner, Wynne, & Mennecke, 1993). This theory tries to explain media adoption and use by groups as an adaptation process, and it arguably could be combined with the psychobiological model and compensatory adaptation theory to provide a more complete view of e-collaboration behavior. However, the adaptive structuration theory assumes that adaptive behavior emerges based on social and cultural norms existing prior to the introduction of the new medium (Poole & DeSanctis, 1990; Poole & Jackson, 1993).

The adaptive behavior of the five groups in this study does not seem to have been caused by social and cultural norms of the group members prior to the introduction of the new medium. It rather seems to have been motivated by more general human cognitive patterns that are independent of such norms as, although groups had a heterogeneous departmental composition, they reacted in a very similar way. Although this study does not clarify the nature of such cognitive patterns, it clearly suggests the need for more research on the origin and structure of these patterns and perhaps the development of alternative theoretical frameworks to explain media adoption and use.

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KEY TERMS

Business Process: A set of interrelated activities performed in an organization with the goal of generating value in connection with a product or service.

E-Collaboration Technologies: Electronic technologies that enable collaboration among individuals engaged in a common task.

Media Richness Theory: Theory that claims that lean media are not appropriate for knowledge and information communication (i.e., equivocality and uncertainty reduction), and that the adoption of media and the outcomes of their use will usually reflect this fact.

Medium Naturalness: The degree of similarity between a given communication medium and the face-to-face medium.

Medium Richness: The degree to which a communication medium can support knowledge and information communication among individuals.

Process Redesign: A task in which a group selects, analyzes, and conceptually redesigns one or more business processes.

Process Redesign Group: A temporary group of a certain size engaged in a process redesign task. In this study, groups had 7 to 13 members and took on average 41 days to be completed.

Category: Concepts, Trends, and Challenges

Universal Approach to Mobile Payments

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INTRODUCTION

An old saying coming from the telecom world states that nothing can be really considered as a service unless you are able to charge for it. The last several years have seen a boom in interest in mobile commerce, mainly due to the high penetration rates of mobile phones. Furthermore, there is evident the need for a real-time, open, and trusted payment service that can be used any time, anywhere, and that can handle any transaction in any currency. Such a service would promote not only content creating activities but would empower the electronic and mobile commerce area and kick-start new innovative services. The time is right for such a mobile payment service, because the infrastructure, the business models, and other conditions that favor its existence are realistic and in place (Vilmos & Karnouskos, 2004). Up to now, we have witnessed the rise and fall of several efforts in the area, ranging from realizing simple intangible good purchases, up to interaction with real points of sale (POS) and person-to-person (P2P) transactions. Day by day, new trials are initiated, targeting different sections in the MP area; however, there is still no solution that is open and widely accepted. In this article, we first introduce the reader to the mobile payment area, present the guiding forces behind it, and subsequently examine such an open, secure mobile payment approach that has been successfully designed, implemented, and tested. Furthermore we identify some midterm future trends that we consider will be of high importance to the further development of the area.

BACKGROUND

Payments are the locomotive behind the business domain and heavily depend on trust and security. A global study by Little (2004) estimated that m-payment transaction revenues would increase from $3.2 billion in 2003, to $11.7 billion in 2005, and to $37.1 billion in 2008 world wide. Mobile payments are seen as the natural evolution of existing e-payment schemes that will complement them (Heng, 2004). The increasingly popular ownership of mobile personal, programmable communication devices worldwide promises an extended use of them in the purchase of goods and services in the years to come (Mobey Forum, 2003). Security in payment transactions and user convenience are the two main motivation reasons for using mobile devices for payments.

The context of mobile payments can be defined as follows: Any payment where a mobile device is used in order to initiate, activate and/or confirm this payment can be considered as a mobile payment. A mobile payment solution can be used in multiple applications and scenarios. The simplest scenario involves only the user, the device and a single payment processor, such as a mobile operator, bank, broker, or an insurance company. The user identifies himself or herself to the mobile device through secure identification mechanisms, including physical possession and password or even via biometric methods; the device then authorizes the transaction to the payment processor for the money transfer. More complex transactions involve at least one additional party, the merchant. In this case, the merchant may be affiliated with a different payment processor; therefore the two payment processors must be able to interoperate.

Based on the amount to be paid we can have different categorization of mobile payments. Generally we have:

- **Micropayments:** These are the lowest values, typically under $2. Micropayments are expected to boost mobile commerce as well as pay-per-view/click charging schemas.
- **Minipayments:** These are payments between $2 and $20. This targets the purchase of everyday's small things.
- **Macropayments:** These payments are typically over $20.

Currently, there are several efforts at the international level to accelerate and solidly support emerging mobile payment solutions. Most of the heavyweight companies that deal with hardware or software products for the mobile market and companies such as the mobile network operators (MNO) and financial service providers try via international fora and consortia to define the guidelines to which such a system should comply. The aim is to produce an approach that is widely acceptable and that would reach a global audience and not address just a specific customer base or isolated scenario. Towards this end, several consortia have aroused such as Simpay (www.simpay.com—ceased operation in summer 2005), Starmap Mobile Alliance, Mobey Forum (www.mobeyforum.org), Mobile Payment Forum (www.mobilepaymentforum.org), Mobile Payment Association (mpa.ami.cz), Paycircle (www.paycircle.org), Mobile electronic Transactions (www.mobiletransaction.org), and so forth. Apart from these "pure" mobile payment consortia, whose work directly affects the mobile payments, there are also other actors that indirectly are evolved with the mobile payment area and come from the financial/banking sector. Karnouskos (2004) provides an overview of these consortia.

For mobile payments to succeed, several requirements need to be addressed. Simplicity and usability largely determines whether users will use a service. This includes not only a user-friendly interface but also the whole range of goods and services one can purchase, the geographical availability of the service, and the level of risk the user is taking while using it. A promising mobile payment service should be offered widely and in a transparent fashion covering the biggest range of mobile payment transactions such as person to person (P2P), business to consumer (B2C), and business to business (B2B), domestic, regional and global coverage, low- and high-value payments. It should be based on open standards that will allow it to interact with other systems and easily scale. It should also be secure by means of technology and processes, and preferably be built on existing trust relationships. The new systems should be, at the end, more cost effective than the legacy approaches (e.g., the technology used may cost more, but if the fraud is minimized, at the end of the day, it is a cost-saving solution). Furthermore, they should also create new revenue flows or better tackle existing ones in order to justify their existence. Finally, understanding the nature and key rules of each local market as well as providing integration with existing approaches (e.g., reuse existing infrastructure and legacy billing systems) may also lead to its rapid acceptance. It should also be kept in mind that, apart from the technology part, the right legislation framework must be in place and ease approaches, especially when we refer to a global payment service. Experience has shown that even when a common directive exists (for instance within the European Union), its full interoperable implementation at per country level still remains a challenging task (Merry, 2004).

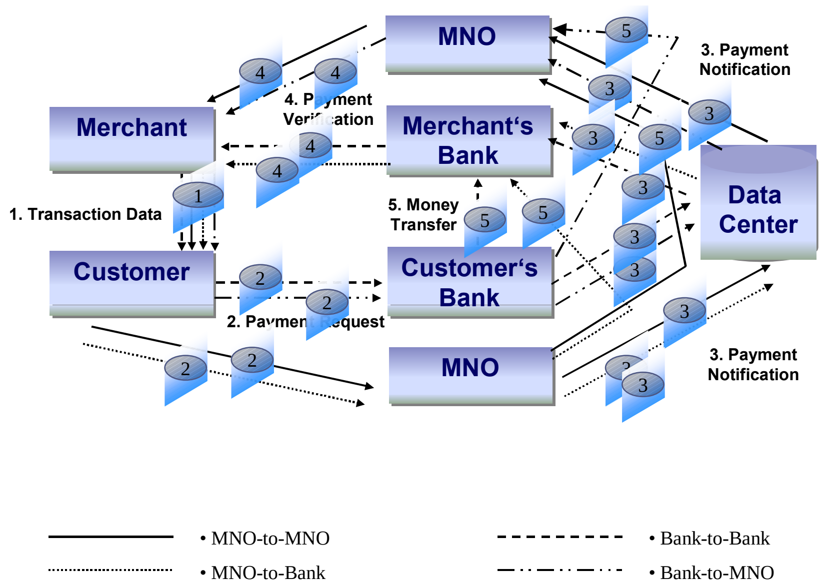
Within the past years, several mobile payment solutions have been developed. Some of them even managed to leave the prototype level and enter the commercial market. A detailed insight on these payment approaches is provided by Henkel (2001), Krueger (2001) and Karnouskos (2004). The mobile payment area is an active one and is rapidly changing. However still existing approaches have done little to fully address all of the requirements needed to establish a global, widely accepted open and secure mobile payment service. For instance regarding security in such services; most MP procedures today use SMS or IVR (interactive voice response) as a method to verify user's identity, methods that have been proven to be insecure. Furthermore, users are usually asked to provide their personal information to a third-party service provider in order for them to be able to register and get the service. Therefore they are asked to place immediate trust of their money and personal data on a previously unknown party. This third party is able to have the complete set of data for any transactions users make, therefore it is able to monitor users' private lives and of course do indirect profiling. It must be kept in mind that user-perceived security (the combination of technical security and trust in the procedures of the approach) is a critical factor (Heng, 2004) that decides on the success or failure of a payment service and therefore it has to be done correctly from day one. Generally existing solutions today are either not trusted, not available to a large enough audience, not speedy enough, not user friendly, not secure enough, tailored for special applications and transaction types, are only available to a limited closed circle of customers and merchants, or have a limited business model. SEMOPS, which we shortly present here, has designed and implemented an approach that realizes a secure, universal, real-time electronic payment service, which effectively covers most of the requirements such a global service poses. To our knowledge past and current mobile payment approaches (Karnouskos, 2004), address only fractions of the mobile payment domain needs, while SEMOPS takes a holistic approach, therefore complementing any existing system.

SEMOPS: A SECURE MOBILE PAYMENT SERVICE

SEMOPS is a mobile payment solution that is capable of supporting micro, mini as well as macro payment transactions. It is a universal solution, being able to function in any channel, including mobile, Internet and POS; it can support any transaction type, including person to person (P2P), business to consumer (B2C), business to business (B2B) and of course person to machine (P2M), with a domestic and/or international geographic coverage.

As in every payment system, SEMOPS is capable of transferring funds from the customer to the merchant or, in more general terms, from the payer to the payee. Typi-

Figure 1. SEMOPS transaction flow



cally, this transfer is realized via a payment processor, such as a bank or a mobile operator. The SEMOPS payment solution, however, is novel in that it enables cooperation between different payment processors (e.g., cooperation between banks and mobile operators), in achieving a global, secure, real-time, user-friendly, and profitable mobile payment service that can be used in both electronic and mobile commerce transactions. The payment service designed, developed, and currently in trial within the SEMOPS project establishes a customer-driven transaction flow and follows a simple credit push model. Basic principle of the business model is that it is based on the cooperation of banks and MNOs. This situation has two consequences (a) actors' resources can be combined and (b) revenue has to be shared. This is quite a challenge but SEMOPS proves that this is a win-win situation for all participants.

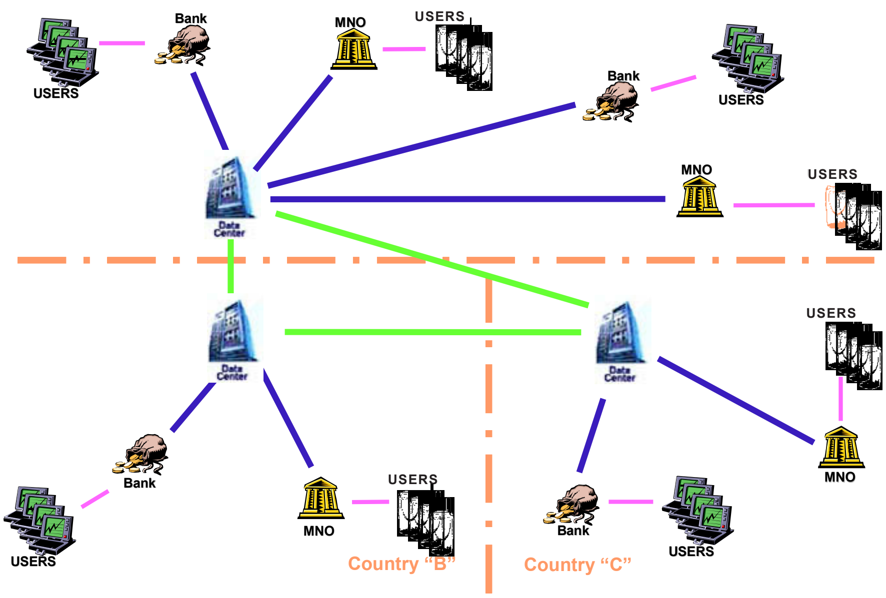
In Figure 1, one can distinguish the main players and components in a mobile payment scenario. Each user (customer or merchant) interacts with his or her payment processor (e.g., home bank or mobile network operator (MNO)) only. The banks and MNOs can exchange messages between them via the Data Center (DC). We should mention that the legacy systems of the bank and the merchant are integrated in the SEMOPS infrastructure and are used as usual. A typical scenario assumes that:

1. The merchant (generally any real/virtual POS) provides to the customer the necessary transaction details, invoices.
2. The customer receives the transaction data and subsequently initiates the payment request, authorizes it and forwards it to the payment processor (at the customer's bank or MNO).
3. The payment processor identifies the customer, verifies the legitimacy of the payment request, checks the availability of funds and forwards this request to the merchant's payment processor via the DataCenter (DC).
4. The merchant's bank receives the payment notice, identifies the merchant, notifies him or her about the payment being made, or requests from him to confirm or reject the transaction.
5. Once the merchant side confirmation comes, the fund transfer is done and all parties are notified about the successful payment.

There can be different combinations, depending on whether the user (customer or merchant) uses his or her bank or MNO account and whether the merchant accepts the payment in his bank or MNO account. The SEMOPS model (Karnouskos, Vilmos, Hoepner, Ramfos, & Venetakis, 2003) is extensible, therefore any third service provider that can offer the customer an account (e.g., credit card or financial service provider, even a utility company) can also easily slip in the role of the bank. It is however important to note, that although SEMOPS enables any account managers to play the role of a payment processor, the actual participation may be limited by legal constrains.

The new payment solution only has a chance to be accepted on the market if it makes good economic sense for the key players to promote the service. All the fea-

Figure 2. Distributed MP service architecture



tures, offered to the end users, the security, the comfort, the wide reach may be in vain if there is no economic incentives for the service providers. However it is obvious also that the service providers alone cannot make a success story of the service if the users are dissatisfied with either the service or the terms of the usage. The SEMOPS approach is based on decentralization. In each country where the service is introduced there is a local entity, the license holder, who organizes the service, contracts with the banks and mobile operators, contracts with the local service providers, ensures that local regulations are complied with, makes sure that the general service requirements are followed.

The flexibility of the model and its capability of integrating quickly new payment processors are critical for its survival. As it can be seen in Figure 2, the customers of any new financial provider that connects to the infrastructure can immediately transact with all other customers of the other providers in a transparent for them way. That will lead to a rapid expansion of the service that can establish it as a global payment service. SEMOPS follows a trust-delegation model. The new customers added do not have to place any trust into the SEMOPS approach itself; they need to trust the service that their banks and MNOs are providing to them (therefore extend the existing trust they already have placed to these institutions). The banks and MNOs are connected via a financial infrastructure with its own rating system and its own trust relationships that exist today. As a result, in a transaction scenario, user A does not have to know personally or trust directly user B to perform the transaction. The SEMOPS approach has several features, including means to secure transactions, notify in real-time its users and protect their privacy by even allowing anonymous payments to be made. Further info on the approach can be found in (Karnouskos, Vilmos, Ramfos, Csik, & Hoepner, 2004). Beyond using existing trust relationships among banks/MNOs and their customers, SEMOPS deploys also state of the art security (digital signatures and encryption) as well as processes that protect the user privacy (Karnouskos, Hondroudaki, Vilmos, & Csik, 2004).

FUTURE TRENDS

Currently, almost all existing approaches focus on 2G or 2.75G infrastructures in order to achieve the critical mass once they are commercial. However, the mobile network infrastructure itself is rapidly evolving. The début of UMTS, wireless LAN, WiMAX and other 3G and beyond technologies will provide new capabilities that will free MP from some its current limitations and allow more sophisticated approaches to be developed. Once this infrastructure becomes mainstream, we will witness also solutions that take into account the new security capabilities, which are nonexistent today, offered by such infrastructure for security, privacy and trust management.

The device manufacturers continue to bring on the market mobile phones that have advanced capabilities and host their own execution environment. It is a matter of time until advanced cryptographic services are integrated in these devices that will make possible diverse secure communication and authentication procedures. Mobile public key infrastructure (mPKI), mobile digital signatures, encryption, and biometric authentication are expected to be widely available in the near future. Furthermore Identity Management efforts are ongoing for the Internet community and several standardization consortia such as Liberty Alliance (www.projectliberty.org) work toward federated identity in the virtual world. If such efforts are successful, they will have a catalytic effect on MP domain, as they will provide a homogeneous identity framework capable of bridging universally the real and virtual world.

With the rise of technological approaches, other communication channels will flourish. Today the basic channels of payment services are the SMS, Voice, and lately IrDA and communication over GPRS/EDGE. However, other innovative approaches seem also promising such as instant messaging (IM) and near field communications (NFC). The IM will not only allow bridging together the Internet and mobile services and payments but will also make trivial P2P payments, where the two or more parties are not in the same physical space (Karnouskos, Arimura, Yokoyama, & Csik, 2005).

Digital Rights Management (DRM) is an integrated complex context covering not only technologies that limit or prohibit the unauthorized copying or distribution of these products but include also laws, contracts and licenses that regulate and restrict the use of such material (Becker, Buhse, Günnewig, & Rump, 2003). As content generated for mobile devices is increasing, mobile DRM systems are expected to play a significant role in the future (Beute, 2005). Standardization initiatives like the Open Mobile Alliance (OMA; www.openmobilealliance.org) work towards developing an advanced mobile DRM standard with the ability to support richer content business models. However rich payment capabilities also need to be in place and the existing MNO billing schemes will not be enough. In the future coupling content management with a global payment capability, preferably real-time (e.g., via instant messaging), will result in a powerful combination, where the mobile user any time anywhere can access legitimately content and instantly pay for it according to his preferences (Karnouskos, 2004).

CONCLUSION

Mobile payment has sparked a lot of interest in research and commerce communities and is viewed as an integral part of our future life. The area is an extremely active one, and rapid commercial evolvement is expected in the short and mid term. The need for a mobile payment service that can address in a global way existing needs is evident, and the first steps have already been done. However, although several mobile payment services have been designed, implemented and even commercialized, up to today there is no such service that can be widely accepted and cover adequately most of the transaction spectrum that we have referred to. For any service to evolve and reach the critical mass, several issues including business as well as technology aspects have to be approached in the right way.

SEMOPS (www.semops.com) presents a promising approach as it integrates state of the art technology, a flexible cooperative business model and builds over trust relationships that exist in the real world today. SEMOPS demonstrated a fully functional service with live users in the premier computer industry event CEBIT 2005 (www.cebit.de). Currently we are in the process of setting several pilots mainly in Europe, but later also in Asia and the United States, while the aim is to make SEMOPS a successful commercial service within the short-term future.

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KEY TERMS

Authorization: Granting of rights, what includes granting of access based on access rights or privileges. It implies the rights to perform some operation, and that those rights or privileges have been granted to some process, entity, or human agent.

DRM: Digital Rights Management (DRM) is a concept for managing and controlling the access and utilization of digital assets.

Macropayment: These payments are typically over $20.

Micropayment: These are the lowest values, typically under $2. Micropayments are expected to boost mobile commerce as well as pay-per-view/click charging schemas.

Minipayment: These are payments between $2 and $20. This targets the purchase of everyday small things.

Mobile Payment: Any payment where a mobile device is used in order to initiate, activate, and/or confirm this payment can be considered as a mobile payment.

POS: Point of Sale is a location where a transaction occurs. This may be a realPOS (e.g., a checkout counter), or a virtualPOS (e.g., an e-shop in the Internet).

Category: Applications of E-Technologies

Using an E-Book for Learning

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BACKGROUND

The vocational education system in Hong Kong is seen as changing in step with the development in industry (O & Chu, 2003). At the beginning of the '50s until the late '60s, Hong Kong was an entrepôt trade economy. However, skills and technology transferred from Shanghai, a steady immigration came from Guangdong, and increasing amounts of local investment had promoted Hong Kong's industrial foundation. By the early '50s, the Education Department of Hong Kong began to recognize "the increasing importance of Hong Kong as a manufacturing and industrial center," and time and effort were being devoted to the development of technical education. During this period of time, we witnessed the building of a vocational school (1953) and technical college (1957); they had aimed at providing vocational education and training for post-Form 3 and -Form 5 leavers. Successful textile manufacturing, followed by new international investments in other infant industries including electronics through the 1960s and 1970s contributed to the socialization of the workforce. By the early 1960s, there was a widely recognized link between industry and technical education. By the mid-1970s, education discourse and documents professed the need to increase the proportion of the curriculum devoted to "practical education" in general secondary schools (*White Paper: Secondary Education in Hong Kong over the Next Decade*, 1974).

Government land sales, efficient infrastructure planning, and the setting up of the economic zones in China all had contributed to a growth rate averaging 10% each year throughout the 1980s and the early 1990s; these achievements had further improved the investment climate. During this period of time, Hong Kong further expanded technical education at the tertiary level. The link between vocational education and training, and the newer infrastructure and high-technology-related forms of industrialization were clearly outlined in the *Report of the Advisory Committee on Diversification of the Economy* in 1979. All these changes in the economic environment had been well served by the corresponding changes in the vocational education system as evidenced by the rapid and high economic growth in the '70s, '80s, and the early '90s.

The VTC (Vocational Training Council) was established in 1982 under the Vocational Training Council Ordinance to provide and promote a cost-effective and comprehensive system of vocational education and training to meet the needs of the economy. Under VTC, preemployment and in-service education and training are provided by the Hong Kong Institute of Vocational Education (IVE), VTC School of Business and Information Systems (SBI) and its training and development centers. The mission of VTC is to provide cost-effective alternative routes and flexible pathways for school leavers and adult learners to acquire skills and knowledge for lifelong learning and enhanced employability (VTC, 2004).

Since the late '90s, the volatile employment market, declining industry, and desire to become a knowledge-based society have triggered yet another education reform. Two important documents have been published by the Hong Kong government to paint out the education reform and the blueprint for the education system in Hong Kong for the 21st century: *Reform Proposals for the Education System in Hong Kong* by the Education Commission (2000), and the *Report on Higher Education in Hong Kong* by Chairman Lord S. R. Sutherland (2002) of the University Grant Committee.

In response to the Sutherland report (2002), the Vocational Training Council formulated a strategic plan for the change. The plan is to increase e-learning within the VTC to

- promote an e-learning culture and to identify teaching staff who make effective use of the Web for teaching,
- encourage staffs to build a learning community on their Web sites,
- encourage staffs to provide students with an active Web site, and
- encourage staffs to conduct virtual (online) tutorials and virtual help desks.

USING E-LEARNING SYSTEMS

Textbooks may not fulfill all the requirements of fast-changing syllabi in this information era. This statement is especially true for those needing computer or IT knowledge for which information written in a textbook can be quickly outdated. Further drawbacks of textbooks are that they do not provide interactive learning but rather one-way knowledge transfer without any feedback that would train students to think in a deeper way. This learning approach does not fit the current student-centered learning model and does not meet the future career requirements ("Cathay Employees," 2004).

Decision makers also need to understand the fundamental differences in teaching approaches that are required in order to implement online training successfully. Otherwise, they risk implementing a high-content system that does not engage and retain students, and will make their organizations uncompetitive in the global educational market. The successful use of online learning is probably the biggest opportunity and challenge that universities are currently facing (Prendergast, 2004).

However, most distance learning development programs are focused on online lectures, tutorials, and assessment. Practical training systems that allow instruments to be monitored and controlled over the Internet leaves a lot to be studied. This type of training system can easily be turned into an online experiment that allows students at remote locations to control and obtain real-time measurements or experimental data (Tan & Soh, 2001).

Actually, some students like to read books to gain knowledge while others prefer to understand theories deeper through experiment (Chu, 1999; Whelan, 1997). Both of these knowledge-based and investigative types of learning styles have profound and different effects on the delivery and acceptance of engineering education. A virtual laboratory developed by using a simple matrix-assembly Java applet provides instrument simulators that form a powerful auxiliary, didactic tool to give students a basic idea of the instruments, control, and operation (Cabell, Rencis, & Grandin, 1997). Another laboratory running remotely via a Web interface allows users to conduct experiments in the Control Engineering Laboratory at Oregon State University (Shor & Bhandari, 1998). The Bytronic Process Control unit at Case Western Reserve University can also be accessed remotely via the Internet (Shaheen, Loparo, & Buchner, 1998).

The teaching of engineering subjects is bound to include a variety of rules, theorems, and devices, which involve primarily knowledge-based learning and must be understood by the students. But at the same time, students must also learn how to apply the learned knowledge through problem-solving and design exercises (Ericksen & Kim, 1998). This provides another good reason to support remote-access practical work for virtual learning.

A study at East Carolina University also finds that virtual laboratories help students to understand the concept and theory of those online courses (Yang, 1999). Compared with the traditional laboratory, a virtual laboratory is particular useful when an experiment involves equipment that may cause harmful effects to human beings. The laser virtual laboratory developed by the physics department of Dalhousie University (Paton, 1999) shows how to perform in real time with dangerous lasers, experienced by commanding equipment through the Internet.

E-BOOK SYSTEM

This e-book system provides a self-learning environment for students to learn an automation programming language called LabVIEW through the Internet. The main body of the e-book is produced by Flash. It looks like a book and contains dynamic actions on the final Web page (Figure 1). Animation, graphics, and videos for interactive learning are linked to the content of this e-book. If students cannot understand the explanation by means of text, they can learn clearly by watching those video demos, downloading data sheets, and trying the virtual laboratory.

The content of this e-book is shown in Figure 2. This content page contains links for pointing to the corresponding page of each topic. Visitors can choose any items that they find interesting and want to study deeper.

There are seven topics inside this e-book.

- **Syllabus:** Describes the details of the syllabus and assessment scheme
- **Introduction:** Introduces different automation applications in our daily life
- **Programming Technology Fundamental:** Introduces different types of programming techniques
- **Graphical Programming:** This section is the core knowledge of the e-book. Students can learn from this section how to build up a LabVIEW program
- **Industrial Communication and Control:** Describes the applications of the LabVIEW program in industrial communication and control
- **Web and Mobile Programming in Control:** Describes how LabVIEW can be applied in Web and mobile control
- **Reference:** Provides reference books to this subject

If this e-book was just constructed like a common Web page, it would not attract students to continue to read. Additional educational techniques are added to keep

Figure 1. Dynamic actions in the e-book

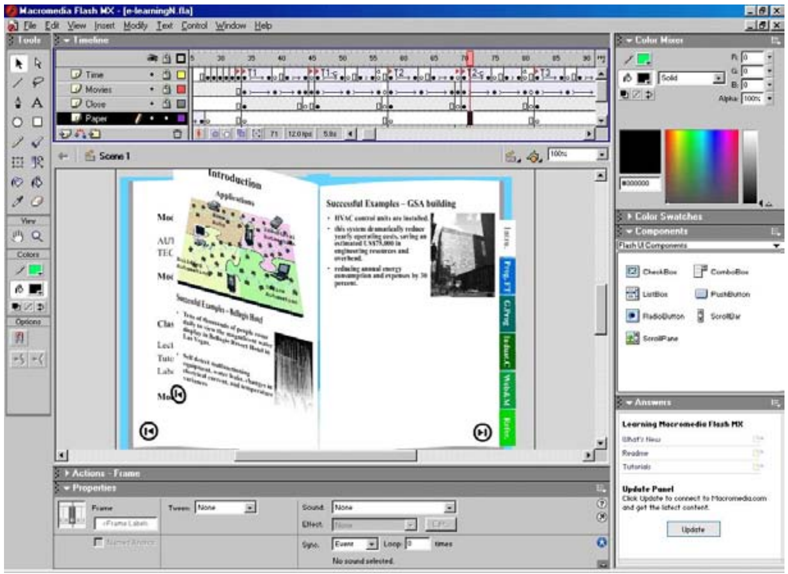
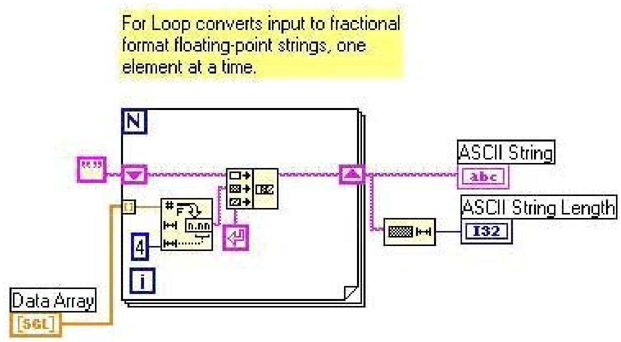


Figure 2. Content page of the e-book

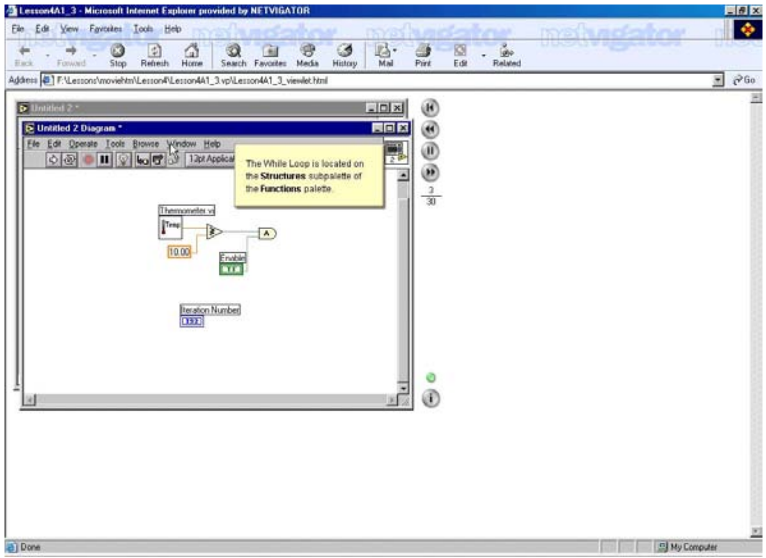
Figure 3. SBL for LabVIEW programming



students' interest to browse through different pages and to learn in a better way. These educational techniques include the following:

- **Scenario-Based Learning (SBL):** SBL was originally used to simulate a scenario that is close to the students' learning or future working environment (Chu & Leung, 2002). Using up-to-date information and multimedia technology, it can simulate issues and conditions similar to those encountered in the real world. Students can use this virtual environment to understand deeper the operation and the theory behind them. Further explanation will be displayed in a hierarchical way to suit the different backgrounds of the students.
  Different examples of LabVIEW programming (Figure 3) are placed in this e-book to help students understand how to use LabVIEW icons in different applications. Students simply click on those SBL links inside the e-book, and new windows will display the corresponding programming example. If students do not know what the icon means or want to know more about the icon, they just click on the icon and it will jump to the right place inside the e-book for further information.
- **Video Explanation:** Video is an important element for interactive e-learning. Students must find it

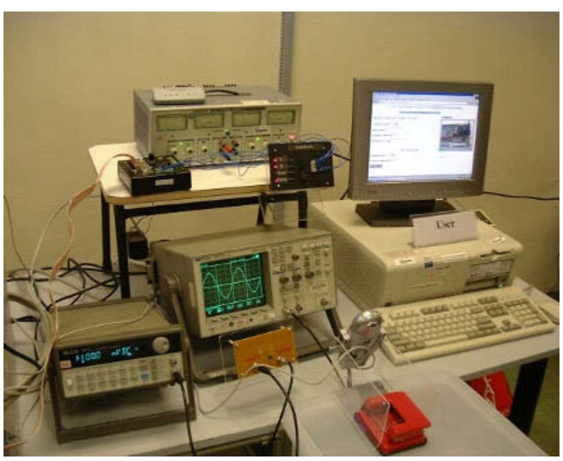
Figure 4. Video explanation for LabVIEW programming



boring if they are only given large amount of text without any figures, animation, sound, or video. This interactive video is even good for those students missing the normal class. Detailed step-by-step, verbal explanation will be found inside this video for every use of the LabVIEW software.

- **E-Lab:** Engineering students really like to experiment in order to enhance their understanding and practical skills. To fulfill this requirement, an e-lab is set up at our college (Figure 5) that allows students to control and monitor it from home. Students are also taught how to write this kind of remote control and monitoring of LabVIEW software in the e-book. For simulating the real signal generator and oscilloscope, animated ones (Figures 6 and 7) are created to allow students to have a feeling of control of the real signal generator and to monitor the result through the oscilloscope.

Figure 5. E-lab equipment setting



IMPACT OF THE E-BOOK SYSTEM

Sixty year-two subdegree engineering students at the Hong Kong Institute of Vocational Education (Tsing Yi) joined the pilot test of this e-book system. The e-book system was implemented to provide supplementary learning for a module called "Automation Programming Techniques."

Most of the students are male and all of them had their own computers or computers shared with their families. In this study, students were divided into groups with around 20 students each. A demonstration for each group about how to use this e-book system was arranged in a computer laboratory. After that, they could freely access this system at home.

In order to assess the students' views of this e-book system, a questionnaire was given to each student immediately after their first experience of using this system. In addition, students could freely write down their feedback to this study on the back of the questionnaire. Also, the more focused feedback was obtained through short discussions with some groups of students after using this system for 1 week.

The questionnaire aims mainly to obtain students' views toward existing functions of the system: about

Figure 6. Animated signal generator

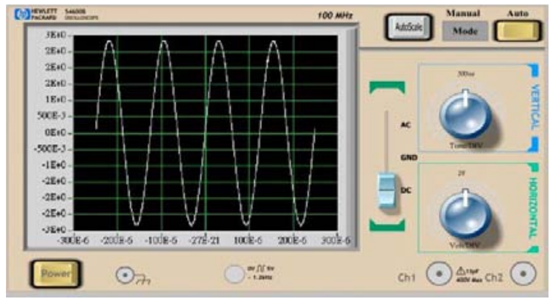


Figure 7. Animated oscilloscope

learning using the e-book, the user interface, and the needs of the students for this kind of e-book. All the students (N=60) responded to the questionnaire, and the results were analyzed. From the overall results of the questionnaire, most students show a positive attitude toward this e-book system.

When compared to the traditional book printed on paper, most students (98%) agree that this system is easier to read than the traditional one. The overall organization of the e-book lets students search for required materials easier, and the voices and animation also enables them to understand the content better. The tree-like links for each subtopic give students an overall picture of the content and make it easier for them to obtain the necessary information that they want to further investigate. These interactive facilities cannot be provided by the traditional paper book. Many students (85%) even reflected that they were encouraged to spend more time studying by using this e-book system.

Similarly, for the e-lab provided by this e-book system, students gave positive feedback, too. They found that it was faster and easier to work in the remote-control environment. The animated environment is so close to the real environment that they can operate the equipment without the necessity to read the user manual. Control parameters in the animated environment can be changed easily until the optimum solution is obtained. That is why students reported that this system is better than the normal laboratory environment in learning design work (78%) and learning concepts (76%).

CONCLUSION

Nowadays, e-learning is becoming a prevailing trend in education under the highly efficient and multifunctional computer-oriented environment. The virtual laboratory is an especially beneficial tool of e-learning for technical subjects, and it provides opportunities for students to conduct lab experiments at home and even be involved in dangerous experiments in a virtual situation.

In an e-learning approach, another widely used tool will be the e-book. The e-book system can be used for any topic in a self-learning environment. It is interactive and action oriented, which will make study more interesting. E-books particularly attract students who get bored when reading traditional text-dominated books. Educational techniques like scenario-based learning and video explanations are important features used in an e-book system.

Encouraging results from using an e-book were collected from 60 year-two subdegree engineering students. Positive feedback includes that the e-book is easier to read, that it is easier to search for information, and that voice and animation enables students to understand the content better. The e-lab provided by the e-book system also generated positive feedback, including that the learning of design work and concepts was better than in a normal laboratory environment. It is concluded that e-books will become popular learning tools in e-learning environments. Further development of the e-book assumes convenience, efficiency, and effectiveness in e-learning.

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KEY TERMS

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Distance Learning: Learners receive learning materials through CD-ROMs, the Internet, or satellite broadcasting. This saves learners' traveling time and promotes learning anywhere and anytime.

E-Lab: The same as a virtual lab, but is mainly delivered through the Web.

E-Learning: The same as virtual teaching.

LabVIEW: The graphical development environment for creating flexible and scalable test, measurement, and control applications. With LabVIEW, users can interface with real-world signals, analyze data for meaningful information, and share results and applications.

Scenario-Based Learning (SBL): SBL simulates a scenario that is close to the students' learning or future working environments. Using up-to-date information and multimedia technology, it can simulate issues and conditions similar to those encountered in the real world. For example, students can virtually experience an actual computer working environment. They can also take this opportunity to study how different accessories of a computer interconnect together, and how signals flow between different units. Students can use this virtual environment to gain a deeper understanding about operations and the theories behind them. Further explanation will be displayed in a hierarchical way to suit different student backgrounds.

Virtual Lab: An experiment is set up in the remote laboratory for users to access through the Internet at anytime and anyplace. Compared to the traditional laboratory, a virtual laboratory is particularly useful when an experiment involves equipment that may cause harmful effects to human beings. Another meaning of virtual lab is implementing a laboratory by means of software simulation.

Virtual Teaching: Students in the virtual teaching environment are given instructions by the lecturer on the requisite technology necessary to accomplish the virtual format of instruction. This technology includes instruction through accessing Web pages, e-mail, the World Wide Web, and newsgroups. To assure student competency, the virtual class may meet sometimes to review the previous instructions, thereby maximizing the ability to carry out the class in the virtual setting.

Category: Applications of E-Technologies

Using Collaborative Transportation Management in Global Supply Chain

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INTRODUCTION

Due to escalating global competition and a decline in profit margins, most multinational corporations pursue global sourcing through a *global supply chain (GSC)* in order to secure market share and improve profits. The practice of e-commerce and the business trend of mass customization force both manufacturers and retailers to shorten cycle time by managing GSCs more effectively. Successful applications of GSCs, such as that by Dell Computer, have been widely discussed and publicized in the supply chain literature. However, the physical distribution of GSC execution is recognized as its weakest link and can result in inefficient and unreliable product delivery. The collaborative integration with global *third party logistics (3PL)* to execute physical distribution dictates the success of any GSC application. This article introduces an application of logistic collaboration, namely *collaborative transportation management (CTM)*, which is a new business model that includes the carrier as a strategic partner for information sharing and collaboration in a supply chain.

BACKGROUND

The key reasons for the globalization trend are overcapacity in highly industrialized countries, significant disadvantages with respect to labor costs, and the emergence of worldwide information networks that connect corporate information systems (Arnold, 1999). An increasing number of firms are combining domestic and international sourcing through GSCs as a means of achieving a sustainable competitive advantage (Bonarth, Handfield, & Das, 1998). A GSC is currently viewed as a strategic weapon in the quest for improved performance and profitability through greater availability, quality, delivery and price advantage (Lee, 2000; Smith, 1999).

The principle and methodology of GSC management are similar to those of traditional *supply chain management (SCM)*, except that multiple countries are taken into consideration. Traditional SCM is the integration of functions from the procurement of raw materials to final customer delivery. The GSC model is more complex than SCM, as it includes different taxes and duties, differential exchange rates, trade barriers, customs clearance, and a sophisticated international transportation network (Vidal & Goetschalckx, 1997). Most companies establish a virtual integrated enterprise with their suppliers by implementing an e-business model in order to address the information and the finance flow of a GSC. However, the integration of physical distribution in a GSC appears to be the weakest link, due to the high level of investment required when construct in a global distribution network.

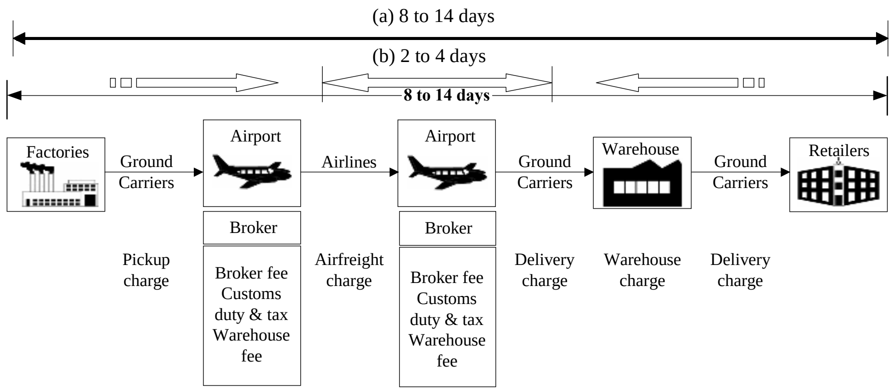
The traditional international shipping practice with extensive consolidation operations (Crainic, 2000) takes 8 to 14 business days, exclusive of manufacturing cycle time. The new economy calls for alliances to be made with 3PL providers in order to manage GSCs effectively by focusing on each player's core competencies (Lieb & Randall, 1999). Most high-tech companies select global door-to-door 3PL providers such as FedEx, UPS, and DHL in order to streamline logistic operations and to reduce delivery cycle times.

The typical benefits of a global *door-to-door delivery* service are shorter delivery cycle times, more reliable transit times, less complex customs clearance procedures, and real-time global tracking and tracing systems (Christopher, 1998). While the unit transportation cost is higher than that of traditional consolidated airfreight service, the total logistics cost is lower as a result of inventory and cycle time reduction throughout the GSC. The success of these integrated 3PL providers is determined by its global transportation network, warehousing network, and information network. Figure 1 depicts the international distribution cycle time by traditional consolidated airfreight model and a door-to-door service provided by a global 3PL provider can compress the distribution cycle from 8 to 14 days to 2 to 4 days.

DESCRIPTION OF COLLABORATIVE TRANSPORTATION MANAGEMENT

The level of collaboration amongst all players in the chain, determines the success of a GSC. Classic supply chain collaboration is found in retailer-supplier partnership programs (Tyan & Wee, 2003) such as quick response, U

Figure 1. International distribution cycle time of (a) a traditional international consolidated airfreight model and (b) a global door-to-door service model



continuous replenishment policy, and vendor managed inventory, which aim to reduce inventory and provide a quick response to consumer demand. The most recent developments in collaborative planning, forecasting, and replenishment (CPFR) is designed to further improve the retailer-supplier relationship. However, the carrier relationship with supply chain players was not considered until the introduction of CTM, which extends the supply chain collaboration to physical distribution partners (Strozniak, 2003).

CPFR, developed by the Voluntary Interindustry Commerce Standards Association (VICS), is a nine-step business process model permitting value chain partners to coordinate sales forecasting and replenishment processes in order to reduce the variance between supply and demand (Aichlymayr, 2000). Under CPFR, each party share information and compares calculations. Manufacturers and retailers exchange forecasts, including point of sale, on-hand and delivery data. They review the data and collaborate to resolve forecasting discrepancies. A VICS subcommittee recently initiated a new shipper-carrier partnership strategy, known as CTM, in order to reduce cycle times and inventory carrying costs for the retailer and its suppliers, while increasing asset utilization for motor carriers (Cooke, 2000; Tirschwell, 2004).

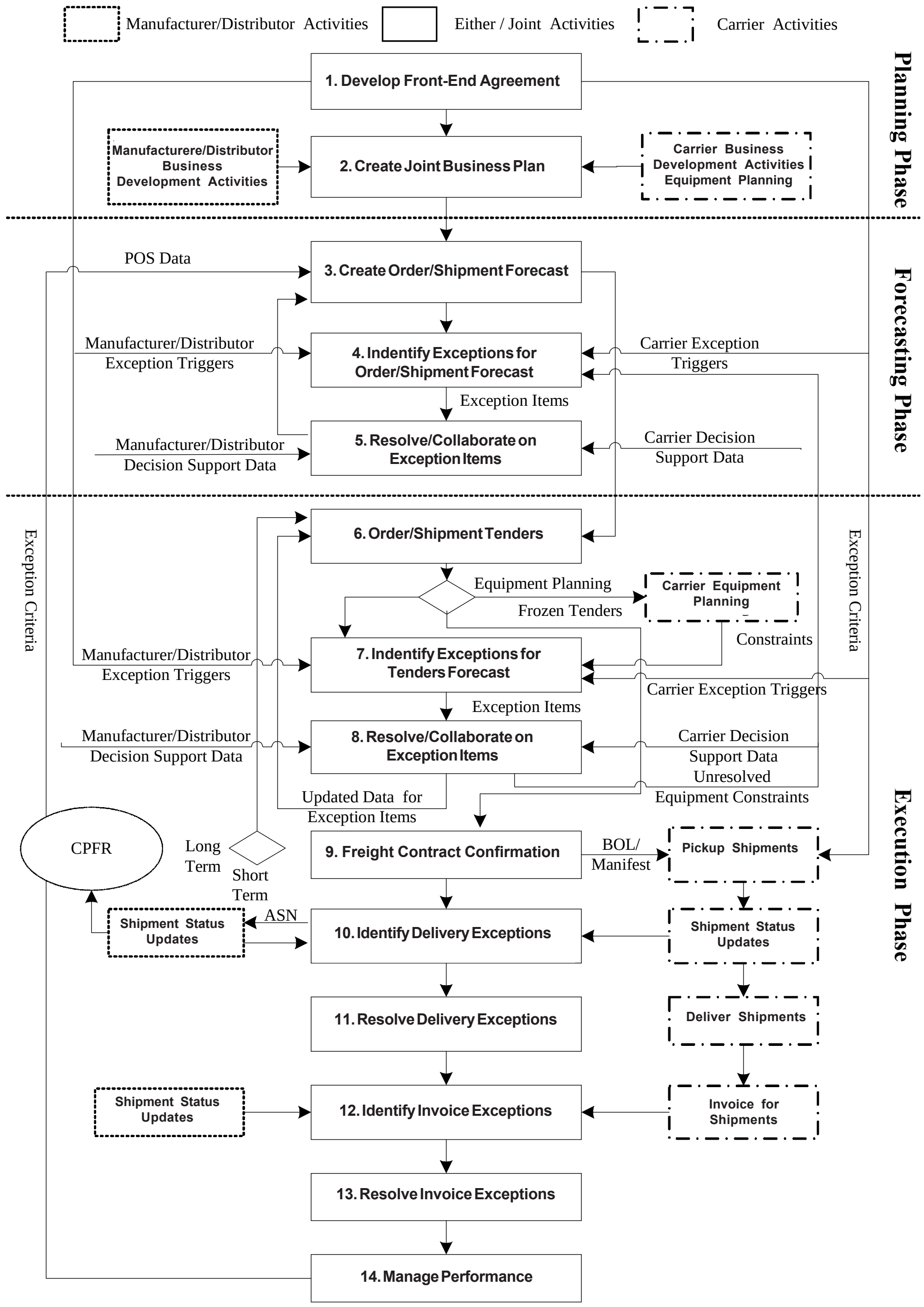
CTM Business Model

CTM is a new process for carriers, involving them in five key business activities: the creation of a joint business plan, order forecasting, order generation, freight order confirmation, and carrier payment processes (Browning & White, 2000). The CTM business model was proposed by VICS and consists of 14 steps. The CTM process can be further divided into three distinct phases: planning, forecasting, and execution, as shown in Figure 2.

The planning phase makes up steps 1 and 2. In step 1, the trading partners establish a collaborative agreement to define the relationship in terms of freight shipment, exception handling, and key performance indicators. Step 2 involves aggregative planning to determine resource and equipment requirements by matching the planned shipment. The forecasting phase includes steps 3 to 5. By sharing order and shipment forecasts in step 3, the carrier gains an insight into the planned volume changes and adjusts equipment requirements accordingly. Any exceptions caused by the manufacturer, distributor, or carrier are generated in step 4 and resolved collaboratively in step 5. Unlike the traditional 1- to 2-day advance notice of potential shipments, the carrier has ample time to handle the revised volume—1 to 4 weeks, depending on the forecasting horizon.

The execution phase consists of four stages: shipment tenders, distribution, payment, and a review in order to manage the entire distribution cycle. The shipment tenders stage covers steps 6 to 8 of the CTM. Step 6 is the creation of order/shipment tenders, based on the revised order forecast. Any exceptions based on the latest equipment availability or pickup and delivery requirements, are identified in step 7 and resolved collaboratively in step 8. The distribution stage—steps 9 through 11—involves the physical distribution and shipment status visibility. Step 9 is the creation of the final shipment contracts outlined in the collaborative tender acceptance and shipment terms. Shipment status is continually updated throughout the distribution cycle and any exception is identified during step 10. Step 11 is the resolution of delivery exceptions. The payment stage is covered by steps 12 and 13. Step 10 ensures that invoicing discrepancies between carriers and shippers are greatly reduced by the exchange of shipment attributes, such as weight, freight class, and destination. Any payment exceptions

Figure 2. Generic CTM business model (From Browning & White, 2000)



identified in step 12 are collaboratively resolved in step 13. Finally, the review phase in step 14 involves measuring the distribution performance against the key performance indicators and seeking opportunities for continuous improvement.

CTM Implementation Issues

The proposed CTM model is generic and can be modified to fit a specific supply chain application. We are interested in the application of CTM in GSC from the perspective of logistic operations. The benefit of CTM is the first issue to be addressed. The most obvious benefit to 3PL providers is the ability to develop business plans with their key customers in order to better fulfill distribution requirements. This is achieved through proactive participation in the planning, forecasting, and execution phases of CTM. The manufacturers and distributors, consequently benefit from better transportation transit times, shipment status visibility, and the payment process. The collaboration in execution between trading partners creates supply chain competitiveness and value. Other benefits include reduced costs, increased revenue, an improved service level, improved customer satisfaction, and increased asset utilization (Browning & White, 2000).

CTM technology requirements for are the next issue to be discussed. In order to foster collaboration, new information technology (IT) is needed to link between the carrier and the manufacturer/distributor. The CTM IT requirements proposed by VICS are vendor and platform independent, so that any trading partner entering into a collaborative relationship will not be hindered by technical limitations (Browning & White, 2000). The CTM information system integration across the entire supply chain can be achieved by the development of IT standards, IT infrastructure, e-commerce, and a supply chain system (Esper & Williams, 2003).

Organizational infrastructure is another CTM implementation factor, and is identified as the most important enabler of successful SCM implementation (Marien, 2000). It sets commitments and regulates all parties so they accept their responsibilities and share both the gains and risks, as outlined in step 1 of the CTM. GSC is a highly dynamic system and any changes may impact logistic activities. The core concept of CTM is to resolve these transportation exceptions collaboratively. In order to achieve the benefits of CTM, empowered designated personnel from each party are essential.

Case Study

This study discusses the case of a global 3PL provider that provides door-to-door distribution services for major notebook (NB) manufacturers in Taiwan. Manufacturing capability as well as cost and quality advantages enables Taiwan to be one of the most competitive strategic NB computer suppliers for many of the major personal computer manufacturers, such as Apple, Compaq, Dell, HP, IBM, and Toshiba. About 50% of the world's notebook computers are manufactured in Taiwan. In order to reduce cycle times and total costs simultaneously, Taiwan NB manufacturers transformed their international transportation from a consolidated airfreight mode to a door-to-door service. This practice is also called Taiwan-direct-shipment. In order to enter the Taiwan-direct-shipment distribution market, the global 3PL provider aligned with each NB manufacturer and formed a specific GSC with its retailer. The representative GSCs and transportation network are shown in Figure 3.

The NBs are delivered to customers throughout North America using a door-to-door guaranteed service, with a cycle time of 3 to 5 business days. The partnership was started in late 1999. In the beginning, the 3PL provider experienced a major challenge in attempting to manage service levels and aircraft capacities due to the volume

Figure 3. Transportation network of the notebook computer global supply chain

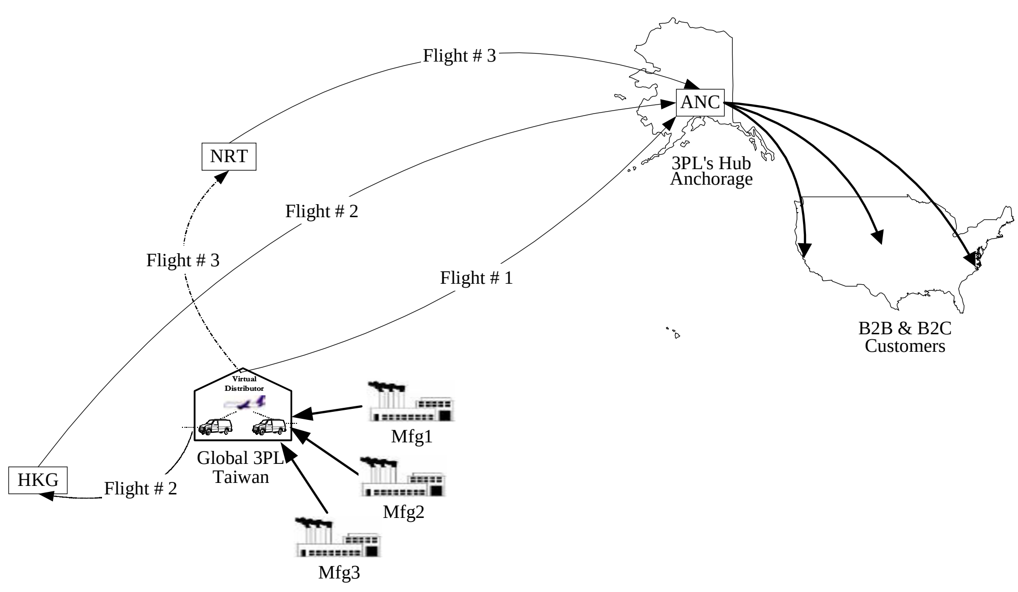
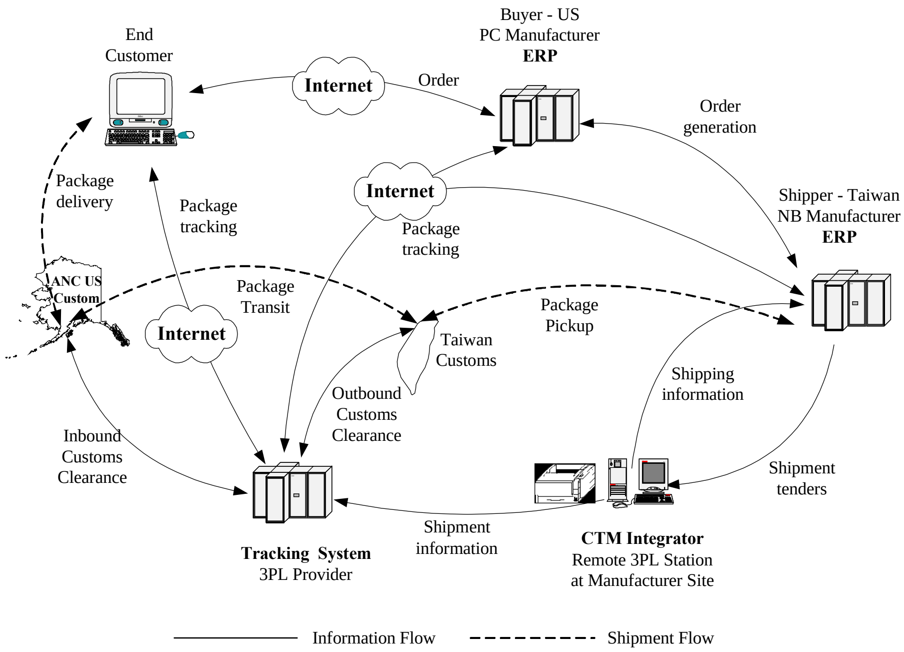


Figure 4. Architecture of integration IT and CTM in a NB GSC



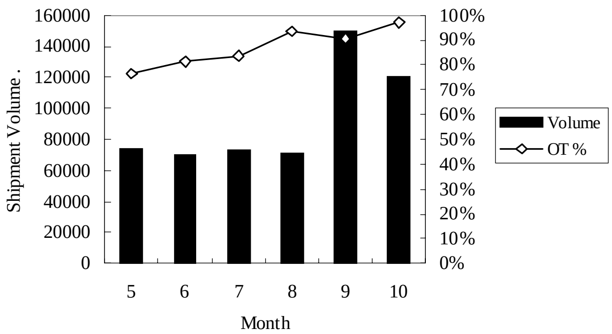
fluctuations of NB demands. For example, the aggregated daily shipment to the 3PL provider varied from 600 to 6,799 with a mean of 3,368 and a standard deviation of 1,535. The daily available aircraft capacity, on the other hand, could only accommodate about 4,000 shipments in that particular month.

In order to resolve the service level issue, the 3PL provider initiated a project to establish CTM partnership with key NB shippers in early 2000. The project objective was to achieve a 95% service level by the end of 2000 for all NB shipments. The project team—which consisted of personnel from sales, technology, engineering, customer service, and operation fields—was responsible for CTM implementation with respective NB shippers. In the CTM planning phase, shipping agreements were outlined to include rate, expected delivery cycle time, pickup cutoff time, and maximum daily guaranteed volume. If shipments were over the daily guaranteed volume, an additional transit day was added to the delivery cycle time. The 3PL provider performed capacity requirement planning based on the planned demands from shippers. In the forecasting phase, shippers updated monthly and weekly shipment forecasts to the 3PL provider for aircraft capacity planning. As a result, the 3PL provider gained sufficient time to acquire additional aircraft capacities for month-end and quarter-end peak shipment demands.

In the CTM execution phase, IT integration was first identified to facilitate the collaboration. A new CTM integrator was developed by the 3PL provider to link manufacturer ERP system in order to retrieve shipping information in the shipment tender stage. Outbound and inbound customs clearances are required processes for international shipping. The shipment manifest and commercial invoice were transmitted to the 3PL provider through the CTM integrator before the actual shipment pickup in order to process preclearance (i.e., to prepare and submit customs clearance before the actual shipment arrived at Customs) so as to eliminate customs delay. Once the shipments were picked up, a pickup confirmation notice was sent back to the manufacturer through the CTM integrator. A Web-API provided by the 3PL provider enabled the manufacturer to access the real-time tracking status via the Internet. The shipper would be notified of any delivery exceptions through e-mail and phone. The customer, as well, could then check the delivery status via the Internet or through customer service. The IT integration of the CTM model in the GSC is shown in Figure 4.

The CTM project was implemented progressively and three key shippers had entered into collaboration with the 3PL provider by June 2000. Through an aggregate planning process, the 3PL provider acquired additional aircraft capacity in October in order to accommodate volume growth. The key performance indicator identified by the 3PL provider was the delivery service level, measured by percentage of on-time deliveries. The delivery volume and

Figure 5. The 3PL provider shipment volume and delivery performance in the year 2000



delivery performance of the 3PL provider in 2000 was shown in Figure 5. Apart from September 2000, the service level achieved a progressive improvement.

This case also reported other findings such as the CTM implementation cost, total supply chain cost, and business growth. The CTM project incurred minimum cost for the 3PL provider by using existing IT systems and staff except for the CTM integrator that was developed by in-house development team. On the other side, the retailer and manufacturer brought in cost saving since their shipping activities were taken over by the 3PL provider partially. Moreover, the total supply chain cost was reduced with a significant improvement in delivery cycle time. The shipment volume growth indicated the CTM approach was a positive business strategy for all parties.

IMPACT OF COLLABORATIVE TRANSPORTATION MANAGEMENT

E-collaboration has emerged as the new focus for supply chains to seeking additional business and cost savings. Early adopters of e-collaboration such as retailer chains apply CPFR and CTM to synchronize manufacturing and shipping activities. *Drug Store News* (2001) reported a CPFR case that inventories for retailers have been reduced as much as 14%, whereas business has increased about 32%. Dutton (2003) reviewed a CTM application between Procter & Gamble and J. B. Hunt to include shipping into the supply chain. Carrier J. B. Hunt reported a 16% decrease in unloading time and a 3% drop in empty miles because of information sharing.

The success of e-collaboration in retailing chains motivates other industries to follow. This application examines the case of a global 3PL provider engaging in e-collaboration through CTM in global supply chain across continents. The improved service level implies the CTM is a successful logistic alliance to both distributor and manufacturer. At the same time, this alliance also implies that 3PL provider can attain multiple cost saving opportunities such as improved fleet utilization through various freight consolidation policies and reduced labor cost by automating shipping operations. A maximum of 18% cost reduction was reported by the 3PL for a particular month after the implementation of the CTM (Tyan, Wang, & Du, 2003).

The principles and process of the CTM application discussed can be generalized to cover other applications. A full scale CTM implementation as illustrated in the case requires a prerequisite of a well established IT infrastructure and streamlined business processes amongst supply chain participants. However, a reduced CTM model by eliminating unnecessary steps can be adapted to Small and Medium-sized Enterprises.

CONCLUSION

The trends of globalization and mass customization challenge the traditional single enterprise to respond and meet market demand. The new economy calls for alliances to be made with 3PL providers in order to form a GSC that focuses on the core competencies of each player. Companies that have implemented a GSC, such as Dell and Compaq, have gained a higher market share, improved profit margins and services, and increased response times. GSC management has become a strategic tool for reducing costs as well as enhancing a company value.

With the introduction of the CTM model, the carrier is able to establish collaboration with the manufacturer and retailer during the planning, forecasting, and execution phases of the GSC execution process. CTM brings to the carrier the benefits of better strategic capacity planning, increased asset utilization, and an improved delivery service level. In return, the manufacturer enjoys reduced costs, improved delivery reliability, increased visibility, and increased revenue. The illustrated NB GSC case shows that CTM is an effective approach for 3PL providers to deliver benefits to all parties in the supply chain.

Freight consolidation is identified as another opportunity for the global 3PL provider to realize the full benefits of CTM application. In an attempt to minimize the system-wide cost, the global 3PL provider can apply various consolidation policies in order to maximize aircraft utilization while simultaneously maintaining their service commitments. With real time logistic information exchange of CTM model, the global 3PL provider gains the benefits by selecting an optimal consolidation policy to minimize the total cost under capacity and service requirement constraints.

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KEY TERMS

Distribution Cycle Time: The span of time between the beginning of the shipment pickup and the end of the shipment delivery.

Door-to-Door Delivery: Shipping service from shipper's door to receiver's door.

Freight Consolidation: The combining of small shipments into a composite truckload or other unit of volume that is sent to a destination point.

Inventory Carrying Costs: The costs associate with carrying the storage of supplies and final products.

Physical Distribution: A transportation service that accepts a shipment from a shipper and at destination separates and sorts the packages and distributes them to many receivers.

Taiwan-Direct-Shipment: A distribution practice that Taiwan manufacturers sends their notebooks to buyers through door-to-door service in order to reduce distribution cycle time.

Third Party Logistics: The activity of outsourcing activities to an independent company that perform client's management function of the logistic operations.

Using Failure to Develop a Successful Business

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INTRODUCTION

Can failure play an important role in developing a successful e-comm, dot-com, or Internet-based venture? This chapter shows that testing the firm's business model provides quick feedback concerning what works and what does not. Often the only way to test the assumptions of a business model is through implementation. Failure can (and should) be a learning experience, whereby a venture confirms or modifies components of its business model and moves forward. This article starts with a review of business model literature, considers a recent start-up, and concludes with lessons learned. References and a glossary of key terms follow.

DEVELOPING A SUSTAINABLE BUSINESS MODEL

There are three broad pillars upon which a new venture is built (Timmons & Spinelli, 2004). These are an attractive opportunity, a capable venture team, and sufficient resourcing. The opportunity must include a viable marketplace (customers, distribution channel, sales and service support, etc.). High-tech ventures usually start with a concept, which needs to be developed into an actual product/service. This requires significant time and effort, with risk that the market may reject the product/service, or a competitor may get there first. Secondly, a team is needed. This team must capably cover both technical and business sides of the venture, from conception to launch to successful market penetration. An ideal team has prior experience in successfully launching a venture. Without this experience, the likelihood of wrong decisions and the time required to determine appropriate action steps can increase. Finally, sufficient resources (including financing) are required to carry the venture through the development phase and into active marketing, to the point of positive cash flow. Venture capital sources will fund high growth potential ventures using successive rounds of financing.

These three pillars support the venture's specific business model. There has been considerable confusion about the terms business plan, business model, e-business model, Internet business model, and business strategy. Sometimes the terms are used interchangeably, and other times they are used in a broad or narrow sense. As Rayport (1999) states, "In the end an e-business is just another business." In this article, the business model answers the question, "What is our business and how do we make money?"

An excellent discussion of business models is provided by Chesbrough and Rosenbloom (2002). They identify six functions:

1. Articulates a customer value proposition
2. Identifies a market segment (*who* will use the technology for *what* purpose; specifies the revenue generation process)
3. Defines the venture's specific value chain structure
4. Estimates the cost structure and profit potential
5. Describes the venture's positioning within the value network linking suppliers and customers (includes identification of potential complementors and competitors)
6. Formulates the venture's competitive strategy

Magretta (2002) articulates a less detailed view of business models. She states, "A good business model begins with an insight into human motivations and ends in a rich stream of profits." To her, a business model contains a story (narrative) that explains how the enterprise will work. A financial model (pro forma P&L, etc.) supports this narrative and shows the numbers side. There are two tests to apply to any proposed business model:

- **Narrative Test:** Does the business model tell a logical story, explaining who the customers are, what they value, and how the venture will successfully provide them with that value?
- **Numbers Test:** Does the pro formal P&L make sense? Are the assumptions reasonable?

Others have suggested alternatives. Clarke (2004) succinctly states a business model answers the question, "Who pays what, to whom, and why?" Hoppe and Breitner (2004) apply business models to e-learning, distinguishing three interdependent submodels (market, activity, asset), which comprise the holistic model. Mahadevan

(2000) sees three streams: the value stream (value propositions for various stakeholders), revenue stream (plan for assuring revenue generation), and logistical stream (addressing various issues related to supply chain design). Weill and Vitale (2002) identify eight different 'atomic e-business models', each describing a different way of conducting business electronically and supported by various IT infrastructure capabilities. Singh (2002) defines a business model as a method of doing business, and provides a taxonomy of current and emerging e-commerce models (emphasizing technology and participants).

Porter (1996) provides several frameworks to guide firms in selecting their strategy and business model. His '5-forces' model, physical value chain network, and generic strategies are useful frameworks. Rayport and Sviokla's (1995) virtual value chain framework is particularly useful for firms using the Internet. Porter (2001), in response to the question of whether or not the Internet renders established rules of strategy obsolete (as some proposed), answers that it makes strategy more vital than ever. He concludes, "In our quest to see how the Internet is different, we have failed to see how the Internet is the same."

Several frameworks that segment evolution of a new firm provide a complementary approach to viewing venture creation and growth. Kaulio (2003) identifies four perspectives: (i) milestones and time-pacing, (ii) venture capital financing, (iii) growth stages, and (iv) market entry focus. Depending upon one's purpose, any (or all) of these frameworks can be useful. For purposes of this chapter, a growth stages model is considered: conception, start-up, growth, maturity; our emphasis here is on the first three stages, whereby the venture establishes itself and its business model.

Building upon this introduction, the following section tracks the recent history of an entrepreneurial team and their venture. Planned failure during execution of the business plan provided a means of refining their business model. Using a 'shotgun' approach to product development, the firm investigated four initial products, developing two and introducing them to a particular market. One product turned out to be much more financially attractive.

BACKGROUND OF THE BUSINESS

On August 31, 2000, Cisco Systems announced they had agreed to purchase PixStream Incorporated, a Canadian privately held provider of hardware and software solutions to distribute and manage digital video across all types of broadband networks. Founded in 1996, and situated in Waterloo, PixStream ranked 22nd on ProfitGuide's 2000 list of 'Hottest Start-Ups'. With 1999 revenues of $7.2 million Canadian, the firm experienced two-year growth of 812%, and was getting ready for an IPO. Cisco paid, in shares, the equivalent of $550 million Canadian.

Only eight months later, with Cisco in considerable financial difficulty, the new owner announced that PixStream would be shut down. This sudden reversal of fortune could have demotivated the PixStream team. Yet, having previously experienced the exhilaration of starting and successfully developing a high-growth business, the core group of managers and engineers considered their options and looked for new opportunities. From this, Sandvine was born. The team not only developed a plan for a new business and found venture funding, but also negotiated a phase-out contract with Cisco to assist current customer migration from the PixStream/Cisco product. This provided start-up money and time.

DESCRIPTION OF THE BUSINESS

Sandvine's history is chronicled in Table 1. Some four years after start-up, Sandvine's Web site describes their product as "award-winning network equipment (that) helps broadband service providers characterize what really happens on their networks, enabling policies that improve customer satisfaction, reduce operational costs and increase revenue per subscriber." Their target customers are broadband service providers, and their customer value proposition is to characterize, control, and secure broadband traffic, thereby increasing network profitability. Initially their product focused on managing the bandwidth consumed by peer-to-peer (P2P) file swapping, and then added the capability of managing worms, viruses, spam, and DOS attacks. Worldwide, these problems add up to hundreds of millions of dollars in extra costs for broadband providers and degradation of service for users. For the typical ISP customer, payback is 12 to 18 months.

MANAGING THE BUSINESS

Unlike most high-tech ventures, Sandvine did not start with a defined product concept. Hence, the company's start-up phase focused on identifying market opportunities and testing these. It took some two-and-a-half years to develop a viable product and become established as a leader in managing bandwidth activities. Based on the founding team's knowledge of video networking, and their previous experience at PixStream and Cisco, four potential product areas were investigated: (1) voiceover IP (VOIP) equipment, (2) enterprise storage area networks (SANs), (3) fibre to the home (FTTH) systems, and (4)

Table 1. Chronology of events for Sandvine

Date	**Event**
Q2, '01	Prospective firm makes initial contact with VCs
Q3, '01	Start-up; VCs fully subscribe ($19.5M); management owns significant minority
Q1, '02	Defined product area as "specialized equipment to provide ISPs with additional recurring revenue opportunities, and cost reduction through traffic shaping"; still operating in stealth mode; about 60 employees
Q2, '02	Products introduced at trade show; Revenue side—content filtering, virus checking; Expense side—traffic management; have initial customer/test site
Q4, '02	Several trials underway; one product ready for commercial sale, another in beta testing
Q1, '03	Customers (ISPs) not spending on capital equipment; decision made to stretch cash resources and seek government funding; waiting for market to recover
Q2, '03	1st U.S. telco sale; many field trials underway (North America, Europe)
Q3, '03	Receive $9.5M Technology Canada Partnerships investment
Q4, '03	Win "best of Next Generation Networks" award; half a dozen paying customers and more than two dozen trials underway; too much competition among subscriber services offerings—leave market and focus on traffic management and security solutions
Q2, '04	Increasing market penetration; over 50 customers (not all generating revenue); difference found between North American and European ISP markets
Q1, '05	Solid pipeline of customers and trials; surpass 20 million subscriber mark

network equipment for residential high-speed Internet service providers. Having negotiated an eight-month contract with Cisco for support of PixStream's former customers, along with taking over the office lease and acquiring all furnishings, the team was confident of its ability to find an excellent market niche. For most of the first year, the new venture operated in stealth mode, quietly searching for an attractive market and developing beta products while not publicly announcing its existence.

By late 2001, the extensive analysis of potential business opportunities was complete, and the decision was made to focus on service offerings for broadband ISPs. For the value proposition, both a revenue-enhancement and a cost-reduction approach were chosen. One product provided the ISP with incremental revenue via additional services (such as virus protection). The other product reduced network costs via traffic shaping. These became known internally as their service cluster and P2P products. With some 60 employees now, the firm worked hard on product development. The June 2002 Supercom trade show was targeted for product introduction, and a local ISP agreed to provide a test site.

By the end of 2002, the P2P product was ready for commercial sale, having proven itself in field trials. Sandvine moved into the growth stage, with management putting much greater emphasis on sales and marketing. The service cluster product (virus scanning, content filtering, etc.) was ready for beta testing. One obstacle with the P2P product arose due to P2P software migration to dynamic ports protocol to become more evasive; Sandvine was quickly able to incorporate this capability into its product and use it to competitive advantage. Its service cluster product was network based, unlike most competitors whose product was desktop based. The target customers were large telcos and cable providers, and this business segment had continuing restrictions on capital expenditures, so significant revenue was not expected for some time.

During 2003, major sales were made in both Canada and the United States. Product development continued on the P2P product, with many enhancements. Recognition for product superiority included a World Communications Award and Communications Technology Journal Readers Choice Award. By year end the market environment made it easy for Sandvine to decide to drop their subscriber services offering. There was growing competition in this market and little potential for significant profit. In contrast, Sandvine was recognized as a leader in the P2P field, and sales were gaining traction (evidence of a reasonable business model). Indications were that 2004 would be the first time in four years that telco and cableco capital expenditure budgets would not be reduced. This turned out to be true, and prospects for 2005 looked even brighter.

A European subsidiary was established in England early in 2003 to concentrate on the EMEA (Europe, Middle East, Africa) markets. A PixStream alumnus, with proven start-up experience, was hired as managing director. A little over a year later, offices were opened in France and Germany, and three sales managers hired.

With increasing market traction, management and financial backers can now start thinking more seriously of an exit strategy. It will be interesting to see whether a buyout or an IPO (initial public offering of stock) results.

SUCCESS/FAILURE FACTORS

A major contributor to Sandvine's success was the experience of its team. This is evident in the company obtaining financing and determining the product (two of the three venture foundations detailed earlier). Based on the team's past success, the VCs that funded PixStream were eager to support this team again. Sufficient funding was raised for the anticipated go-to-market process, without the usual steps of seed funding (initial funding which is often used to develop a business concept before the venture really starts), plus additional investment rounds. The founding team's equity contribution was limited to members' knowledge (both technical and market) plus the PixStream/Cisco wind-down contract.

Use of a funneling approach to settling on a particular product and market was another success factor. The team took the necessary time to identify several potentially attractive markets and products, narrowing this down to two product opportunities. When one product showed much greater potential than the other did, the team quickly made the sensible decision. Most new ventures start with a single product/service concept, which yields an all or nothing result.

With an experienced team, Sandvine experienced no turnover among senior management. The group knew each other's strengths and weaknesses before the venture started, and took on responsibilities that matched personal abilities. Together, the team members' expertise covered the technical management and business management needs of the venture. They knew what had to be done, when to start particular initiatives, and how to accomplish their goals. To an outsider the business was being managed smoothly, with no apparent problems; on the inside, management 'knew what they didn't know' and knew how to discover solutions and test assumptions. Their product selection process and ultimate market focus show discipline and depth. Failures along the road to success were expected and dealt with appropriately as learning opportunities.

LESSONS LEARNED

This case illustrates the opportunities and challenges of a start-up high-tech venture and shows creative approaches to both product development and financing. Starting with only one of the necessary three foundations (a team), Sandvine worked on the other two (resources, plus a viable opportunity within the company's field of expertise). With the team's successful record of accomplishment, it was easy to attract financing. The team's shotgun approach, investigating several products and potential markets, greatly increased its likelihood of success. Not many new ventures can choose this route, although it is an attractive one.

Sandvine illustrates an exception to the usual high-tech financing approach, one that is usually only available to venture teams with a proven success record (serial entrepreneurship). Financing is commonly obtained on an iterative basis of "rounds." Success in moving forward with the business model leads to additional financing, which in turn allows further refinement of the business model. When progress is slow, the next financing round may value the venture less (a "down round"). When progress supports the viability of the business model, an 'up round' is more likely. Moreover, if additional financing is unavailable, the venture must curtail its activities or even close down. Sandvine was able to obtain sufficient initial financing to carry the firm through the formative years without the usual additional rounds of financing every 6 to 18 months. A repayable government investment became available and was used to defer the potential need for further venture financing (also allowing the financial backers to maintain their proportional interests without injecting additional funds).

Kanter (2001) shows that dot-coms can be categorized in terms of style and substance. The former focuses on personality and style of the founder(s), and their ventures tend to follow an evolutionary path (the 'learn by doing' approach advocated by Gumpert (2003)). In contrast, the latter focuses on execution of a clear business model, with strong attention to the bottom line. Sandvine shows that these two dimensions are not necessarily mutually exclusive. At a macro level, Sandvine followed the latter approach (starting with a basic business plan and emphasizing the bottom line). At a more micro level (developing the company's product/market focus), Sandvine experimented and learned from the results. The feedback received during product development and beta testing allowed refinement of the business model—developing a fuller understanding of the market (whether or not it exists, and in what form; what it values; and how much it will pay for the product/service), clarifying the value proposition for customers, and ultimately clarifying the firm's competitive strategy.

The value-added services (or potential lack thereof) from VCs are usually significant. Developing a successful high-tech venture is difficult, and firms need all the support available. Investors who can add significant value to the firm's development, beyond their financial investment, are one of the keys to success. Methods of adding value include identifying key management members to round out the team (especially as the firm grows), linking the firm with support organizations (lawyers, accountants) and potential suppliers and/or customers, and assisting with future rounds of financing (including government grants). VCs will take a more active role if they perceive their investment to be at risk. In Sandvine's case, because of the experienced team and continued progress, there was much more of a hands-off approach. Members of the VC consortium did provide advice and assistance, but on an 'as-needed' basis.

A final lesson pertains to development and refinement of one's business model. In mature industries, there are one or more standard models to follow, and much is known about success/failure factors and best practices. In contrast, dot-com and e-comm pioneers developed new models, which followers could then emulate or build upon. The Sandvine team, using a generic high-tech venture creation model, and drawing upon previous experience, worked from the general to the specific. Over the course of four years, as the business moved through the concept, start-up, and into the growth stage, its business model was continually refined. Consequently, Sandvine now commands a strong position in a growing market.

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KEY TERMS

Business Model: Means by which a new venture will attract and serve customers, in order to generate revenue and profit.

Financing Rounds: Successive stages of financing received by a new venture (seed, first, second, etc.); also called tranches; may be an 'up round' or a 'down round' (in an up round, the value of the venture has increased since the previous round).

IPO: Initial public offering; first sale of a venture's common shares to the public; usually results in large profits for early stage venture investors.

Serial Entrepreneurship: Starting a new venture, after having done so at least once previously; serial entrepreneurs have start-up experience.

Stealth Mode: Operating a start-up venture quietly, so competitors and the general business community are unaware of it.

Traction: Successfully putting a business model into operation, proving its viability.

Venture Capitalist: To provide funds and other assistance to start-up ventures.

Using Hospital Web Sites to Enhance Communication

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INTRODUCTION

A large number of patients currently utilize the Internet to access healthcare-related information (Tobin, 2002). Many physician and health-related Web sites have been information portals lacking interactive services that could benefit healthcare partners through decreased costs, increased convenience, and communication. Patients typically visit Web portals to learn more about medical topics, often discussing this information with physicians.

Emerging Internet technologies can be a strategic asset for hospitals to impact physician bonding, patient self-service, and overall enterprise performance efforts. We conducted an investigation of Web sites of 10 hospitals listed in *U.S. News and World Report*'s Best Hospitals of 2004 Honor Roll, as well as a random selection of seven other hospital sites. An examination of each hospital's site was performed to determine what features were provided to enhance communication between the partners in healthcare. Partners are defined as patients and their families, referring physicians, insurance companies, vendors, pharmacies, job seekers, and the media. Communication-enhancing features are any features that have the potential to increase communication between the hospital and its partners. We focused on patient communication-enhancing features, since patients are the primary partners of healthcare entities.

BACKGROUND

Healthcare Basis

A medical Internet Usage Survey conducted by the Health on the Net Foundation (2002) found that 57.95% of the respondents had used the Internet for more than four years. Of the patients who responded, 21.62% correspond with their providers through e-mail and 75.52% have used online medical consultation services; 69.47% of physicians that responded stated that patients discuss information they found on the Internet with them, while 62.75% of those providers recommend specific information-based sites to their patients.

Healthcare can be improved through e-health services such as online patient pre-registration for admission, access to test results and medical records, insurance referrals and eligibility, access to reputable links for accurate healthcare information, patient forms and brochures, online support groups, access to clinical trial information, appointment scheduling and reminders, refill requests and authorizations, and e-mail capabilities. In implementing e-health "there is an urgent need for healthcare organizations to re-engineer their processes" (Wickramasinghe, Fadlalla, Geisler, & Schaffer, 2004), and physicians face obstacles such as "technologic barriers, resource priorities, and privacy issues" (Zingmond, Weilim, Ettner, & Carslile, 2001) that are secondary to providing excellent healthcare. Hospital and medical office sites can be enhanced to offer patient-centered services, while informing patients of their strongest services/specialties, convincing the patients that their organization is better than any general Web portal for accessing health-related information (Anonymous, 2001).

The drive for e-health initiatives can be patient driven, physician driven, or government mandated. "What is less clear is whether or not the services offered by healthcare organizations and the services that patients desire are the same" (Wilson & Gustafson, 2003). Government-driven initiatives include electronic health record implementation within the next 10 years which serves a dual-purpose: to allow hospitals and healthcare providers to access patient records in a standard format, and to decrease medical care errors. Veterans Affairs Secretary Anthony Principi stated that "one in every seven hospital admissions and 20% of lab tests occur because health records are not available to the clinician. More than one of every seven hospitalizations is complicated by medical prescription errors" (CNN, 2004). Thus, comprehensive electronic medical records which the patient, physician, or pharmacist can access are critical to reducing such errors. Access to these records may also be offered online so that patients can access them and check for accuracy or take them to a physician's office to which they have been referred for further tests.

In a related initiative, the National Quality Forum (NFQ) sponsored a National Summit on Information Technology and Healthcare Quality in March, 2002, to examine a national healthcare infrastructure. The design principles stated by NFQ to aid in the infrastructure development (NFQ, 2002) are:

1. Care based on continuous health relationships
2. Customization based on patient needs and values
3. The patient as the source of control—encourage shared decision making
4. Shared knowledge and free flow of information
5. Anticipation of patient needs

Theoretical Basis

The Internet can be considered a mass medium, and therefore, communications theories have been applied most frequently in this area (Merrill et al., 1996). Such theories applied include the learner-as-a-bucket theory in which the user searches for information and information is "poured" into the brain via a Web portal (Morris & Ogan, 1996). Another theory applied frequently is the critical mass theory, which states that the diffusion of innovation and adoption by about 20% of the population results in critical mass being achieved (Morris et al., 1996). Because use of the Internet, as well as other forms of electronic communication, is widespread now, it can be assumed that these are forms of media utilized by a critical mass.

In an article regarding physician communication skills, Kurtz (2002) outlines the domain of physician communication with patients. This could be expanded to any healthcare partners, and involves goals and approaches. Goals promote collaboration and partnership, and ensure increased accuracy of medical information, supportiveness, improving patient and physician satisfaction, and quality of healthcare. Approaches depend on the type of communication and can involve a well-conceived and delivered message versus communication for interaction, feedback, confirmation, and relationship. Kurtz (2002) also states that effective communication requires planning and should reduce unnecessary uncertainty—a critical factor in healthcare communication. Examples of Internet communication include e-mail, listserv, discussion forums/support groups, chat, and interactive site features (December, 1996). Features that enhance the communication between the doctor and the patient have not been explored. Prior studies analyzed sites of specialty practices (Smith-Barbaro, Licciardone, Clarke, & Coleridge, 2001), one specific type of communication such as e-mail (Moyer, Stern, Dobias, Cox, & Katz, 2002), Web portal information (Zhang, Zambrowicz, Zhou, & Roderer, 2004), or healthcare support groups or forums (Zrebiec & Jacobson, 2001). Our study specifically examines communication features offered on hospital Web sites.

WEB SITE ANALYSIS

Seventeen hospitals were chosen, with 10 of the Top Honor Roll hospitals (Group 1) selected from *U.S. News and World Report's* Best of Hospitals 2004 Report. Our premise was that the top 10 hospitals will be more likely to utilize technology to communicate better with patients, vendors, and insurance companies. Seven additional hospitals (Group 2) were randomly chosen from the *American Hospital Directory* (2004) for comparison of size and specialty, and site technology. Tables 1 and 2 display the selected hospitals.

Background information regarding bed sizes, hospital type, specialty areas, and accreditation were verified through the *American Hospital Directory,* the individual hospital sites, and the Directory of America's Hospitals (*U.S. News,* 2004b). Web site addresses listed in the *Directory of America's Hospitals* were selected as the URL locations to be examined.

Sites were examined in August 2004. Criteria chosen were adopted from related surveys by Zingmond et al. (2001) and Kind, Wheeler, Robinson, and Cabana (2004), and supplemented with features determined to be communication enhancing. The Zingmond et al. (2001) and Kind

Table 1.

	Top 10 from Best Hospitals 2004 Honor Roll List (GROUP 1)	Bed Size
1	Johns Hopkins Hospital, Baltimore, MD	886
2	Mayo Clinic/St. Mary's Hospital, Rochester, MN	797
3	Massachusetts General Hospital, Boston, MA	875
4	Cleveland Clinic, OH	999
5	UCLA Medical Center, Los Angeles, CA	552
6 TIED	Duke University Medical Center, Durham, NC	758
	University of California, San Francisco Medical, CA	544
8	Barnes-Jewish Hospital, St. Louis, MO	906
9 TIED	New York-Presbyterian Hospital, NY	2,163
	University of Washington Medical Center, Seattle, WA	410

Table 2.

Randomly Selected Hospitals (GROUP 2)	Bed Size
Loma Linda University Med Ctr, CA	658
Miami Valley Hospital, Dayton, OH	848
Moses Cone Health Center, NC	1,141
High Point Regional Health System, NC	368
Univ of Maryland Med Center, MD	601
St Vincent Hosp & Hlth Ctr, Indianapolis, IN	806
Yale-New Haven Hospital, CT	808

Table 3. Feature coding

	Coding	
Feature not present	0	No link to form to complete
Basic feature was present	1	Downloadable or printable form to complete manually
Weighted Feature*--Increased functionality of feature	2	Ability to fill out information online

et al. (2004) studies examined only the type of content and quality of information in the sites, not specific features offered.

The criteria for Web site communications are listed in Table 3. Weighted features are noted by * in the descriptions of pertinent features discussed as follows.

1. **HIPAA* (Health Insurance Portability and Accountability Act):** Coding: 1 if there was a HIPAA statement only on the homepage, and 2 if the HIPAA statement was found on more than one page.
2. **International Patient Information/Languages*:** Some hospitals have an international presence and include such information as traveling, hotel information, specialty information, and so forth, as well as offering Web pages or forms in different languages. Coding: 1 if international patient information page was offered in different languages, 2 if additional pages or forms were offered in different languages.
3. **Support Groups*:** 56.34% of doctors that responded to the Medical Internet Usage HON survey recommend support groups to their patients (Health on the Net, 2004). Coding: 1 if support groups were listed and phone numbers given for a contact, and 2 if a support group was offered online, even if through a linked affiliated site.
4. **External Web Sites:** The availability of links to external sites, further information, or discussion groups was analyzed.
5. **Insurance Accepted:** Physicians' offices are frequently asked about the insurance companies with which they participate. Having this information available online could enhance communication by giving patients a list to refer to if their insurance companies change.
6. **Appointment Scheduling*/Fill Out Patient Information Online*:** These features would allow for great efficiencies in the check-in process for patients. If an appointment has been scheduled online or patient information has been filled out online, the check-in process for a patient is more efficient. Patients may be allowed to fill in their information online (Code 2) or they may be able to download a form to print (Code 1), fill out, and take to the physician's office at the appointment time. Appointments were coded as 1 if only requests for appointments were offered, and 2 if appointments could be made online.
7. **Patient Access to Records:** With mandates for Electronic Medical Records evolving, accessing patient records online will be important for partners. Often, patient records and lab test results are copied and/or faxed to a physician, and this may be more time consuming than allowing appropriate partners access.
8. **E-Mail Doctor:** Disadvantages of offering the physician's e-mail are privacy issues, timeliness of the response, liability issues, filing insurance on e-consults, and volume of e-mail that could be received, especially for large hospitals with international presence. Advantages are that the doctor can answer at his convenience and provide pa-

tients an avenue to ask embarrassing questions or clarify instructions. The limitations are most likely from the disadvantages of offering widespread access to physicians, including a patient's inappropriate use of e-mail (in lieu of office visits), security issues, and that physicians may be inundated with e-mails from not only their patients, but others seeking advice (Mandl, Kohane, & Brandt, 1998).

9. **Referring Physician Online Access*:** Allowing physicians to fill out a form online for patients who have been referred for tests, x-rays, or admission would save time and money, as well as decrease medical errors and medication interactions. Coding: 1 if contact information was given for the referring physician to call, and 2 if the referring physician could fill the patient information online.
10. **Intranets:** These serve the purpose of communicating between internal partners of the hospital. Policies, procedures, and other hospital information can be available through the intranet. Intranets may possibly include the capability for physicians to enter prescriptions directly to the hospital pharmacy.
11. **Interactive Content:** This includes features such as virtual tours, interactive maps, and videos.

One issue to be considered was that hospitals often operate underneath an umbrella of a parent organization, which also includes other medical centers and often educational organizations. Generally, there is a seamless navigation between hospital entities, therefore the extensiveness of sites was an advantage to the user, and no differentiation between the parent organization and its entities was made. All sites examined had search features which would search anywhere within the site for requested information.

Findings

Results of the site evaluation are in Table 4. All sites included general information and features such as a search feature, information about the organization, mission, services, privacy policy, parking and directions, news, employment, support groups, and general phone contacts. The following is a summary of the findings:

1. **HIPAA (Health Insurance Portability and Accountability Act):** It was expected that the sites would offer a main link, probably in the privacy policy, that explained HIPAA and its regulations regarding patient confidentiality. However, only five offered a direct link to HIPAA information through a HIPAA link or through the privacy policy. Searches of some sites found no results of "HIPAA."
2. **International Patient Information/Languages:** Group 1 offered more information in different languages. This is understandable, since hospitals on the Honor Roll list are larger and have an international presence. The top four of the Honor Roll list (Johns Hopkins, Mayo Clinic, Massachusetts General, and Cleveland Clinic) allowed a user to select a language in which to view the International Patient Information page.
3. **Support Groups:** Of the Honor Roll hospitals, 40% provided a main link for access to support group information, while 85.71% of the Group 2 hospitals provided a main link. However, all sites provided at least a link to support groups in each specialty area (cancer, etc.).
4. **External Web Sites:** 82% of the sites provided external links. Links to outside sites were generally to government or health organization sites. Sometimes the information given by hospital sites was generated by a purchased knowledge database, and it was difficult to determine if the information was generated by an outside site or a knowledge database. Knowledge database information was considered as internal information and not as a hyperlink to an external site. Only one hospital, New York Presbyterian, required the user to read a disclaimer and click to accept before accessing external health information.
5. **Insurance Accepted:** 70% in Group 1 provided insurance participation information as compared to 28.57% in Group 2. Many sites allowed searching for a doctor according to the insurance with which they participated.
6. **Appointment Scheduling:** Since the intricacies of appointment scheduling are vast, and result from specialty variations as well as individual physician preferences, some hospitals allowed requests for appointments in which someone would contact the patient to set up the appointment. Hospitals from Group 1 were more likely to offer appointment requests online, with 80% providing the service, as compared to 28.5% in Group 2.
7. **Patient Access to Records:** Only three hospitals (Cleveland Clinic, Duke University Medical Center, and Barnes-Jewish Hospital) allowed some type of access to the patient's records, including prescription refill requests, appointment requests, patient information updates, appointment reminders, online payments of balances, and self-assessments of healthcare.
8. **E-Mail Doctor:** None of the hospitals in Group 1 and only three in Group 2 had the capability to e-mail physicians directly.
9. **Referring Physician Online Access:** 71% of all sites allow referring physicians to fill out patient

information online. This would allow the hospital time to verify insurance information and send materials and brochures to patients before being admitted.

10. **Intranets:** The presence of an intranet was difficult to determine, since the intranet may be a different URL than the hospital URL. Of all hospitals, 41% had some type of intranet available. The intranet at Cleveland Clinic was confirmed to have physician access to medical records online.
11. **Interactive Content:** The two groups had equal participation in offering interactive content, which was in the form of audio, video, or Web tours of facilities.

Table 5 shows some of the interesting interactive and weighted features.

FUTURE TRENDS

Availability of comprehensive patient information and other hospital services will improve the efficiency and effectiveness of patient care through better communication among healthcare partners. Some hospitals which were contacted regarding intranet availability were in the process of electronic record conversion. EMRs (electronic medical records) would provide a concise map of a patient's medical history, and, if accessible by various healthcare partners, including the patient, could offer a means of communication by clarifying questions or documenting previous medical problems and medications.

Blogs such as those offered on the Cleveland Clinic and High Point Regional sites are being tested as a type of forum for patients to support one another. Blogs allow personal expression and diary-type entries for those who want to share health-related experiences. Ideally, communication could be customized by allowing the user to enter a username and password which will allow specific access to that person's information and personal preferences—a patient portal. Messages and reminders from physicians may appear, as well as charts showing, for example, one's diabetic sugar level readings for the past few months. Very few hospital Web sites offer the capability to pay bills online, and access to one's medical bill history online may decrease calls to the billing department regarding

Table 4. Analysis of results

	TOP 10 HOSPITALS (GROUP 1)		SELECTED HOSPITALS (GROUP 2)		
FEATURE	% with features	% with weighted features	% with features	% with weighted features	% of ALL hospitals with features (1 or 2)
Patient Services					
HIPAA Information	80%	40%	57%	14%	71%
International patient information	90%		29%		65%
Different languages	70%	40%	29%	0%	53%
Health-related information (Diagnosis, Procedures, etc.)	90%		100%		94%
Links to online resources/outside web sites	80%		86%		82%
Access to support groups	100%	40%	100%	86%	100%
Events and classes	90%		86%		88%
Find a doctor	90%		86%		88%
Information about the physicians and staff	90%		71%		82%
Clinical Trial Information	100%		71%		88%
Insurance Accepted	70%		29%		53%
Check-in information	90%		57%		76%
Fill out patient information online/Download form to fill out	20%	10%	29%	0%	24%
Appointment Scheduling--Phone/OnlineRequest/OnlineForm	80%		29%		59%
Access to Test Results	10%		0%		6%
Access to medical records	30%		0%		18%
Access to billing information	20%		14%		18%
Email a Patient	20%		43%		29%
See pictures of newborns	10%	0%	57%	43%	29%
Contact Information					
Email availability					
Doctor	0%		43%		18%
Specialty/Dept.	10%		29%		18%
Billing	10%		29%		18%
General	70%		71%		71%
Phone Contact					
Doctor/Dept.	100%		86%		94%
Billing	100%		86%		94%
General	100%		100%		100%
Physician Services					
Referring Dr	70%	30%	71%	57%	71%
Physician/Nurse Training (CME)	100%		71%		88%
Intranet	40%		43%		41%
Access to patient records via web	0%				6%
On-call schedules (hospitals)	0%				
Special Features:					
Interactive content	70%		100%		82%
Web tours of facilities	10%		71%		35%
Videos	20%		57%		35%
Extranet	0%		0%		0%

Table 5. Sample of interactive features

Hospital	Features
Massachusetts General	Live surgery webcasts and e-consults for second opinions
Cleveland Clinic	e-clinic for second opinions
University of California, SF Medical	Sample bills available online
Loma Linda	e-cards and radio shows
Moses Cone Health System	Excellent library sources
High Point Regional Health System	Request callback; Extensive search feature--can search for a physician by name, specialty, gender, insurance accepted
University of Maryland Medical Center	Webcasts
St. Vincent Hospital	MyStVincent--access to personal information; can update insurance information online
Yale-New Haven	Call Me Later feature

balances owed. Patients may opt to receive automatic e-mails from physicians and healthcare partners for appointment reminders, test results, prescriptions, or to inform the patient if the pharmacy has the medication in stock. Telemedicine and videoconferencing are popular in other countries such as Australia and New Zealand, and could provide healthcare to those patients in remote areas, if the technology were provided.

CONCLUSION

Communication between physicians and healthcare partners, specifically patients, is critical to the quality of care provided. Forms of online communication need to be identified and researched further so that efficiencies and effectiveness can be gained for healthcare organizations' quality of care goals. Because patients are active in their medical care, healthcare organizations need to be aware of patient needs and preferences in their communications. What needs to be determined is how users decide to search for information on a specific hospital site. Which features are preferred by both physician and patient? As Bohn (1999) stated, "As sites grow ever more central to successful healthcare business, analysis of the way they are used becomes a fundamental issue." In this respect, the functionality of sites needs to be addressed—is it enough to offer such interactive features and anticipate that they will be found and utilized, or does this interactive functionality become part of emerging culture of healthcare? The opportunity to utilize Web technology to communicate with partners allows hospitals to become more strategically competitive while also increasing efficiency and effectiveness, and ultimately improving patient care.

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KEY TERMS

Blog: A Web log which allows for a diary-style forum for posting one's personal thoughts and experiences.

E-Health: A concept in which Internet-based technologies are used to enhance access, delivery, quality, and effectiveness of health services, as well as information utilized by patients, physicians, healthcare organizations, and related partners such as pharmacies, vendors, and insurance providers.

Extranet: Allowing an organization's external partners (i.e., pharmacies, insurance companies, vendors) to access a computer system via a username and password.

HIPAA: The Health Insurance Portability and Accountability Act (1996) regulates the electronic exchange, privacy, and security of one's health information.

Intranet: Allowing access to a hospital's computer system to internal users via a username and password.

Privacy Policy: A disclaimer placed on Web sites informing users about how the organization handles one's personal information.

Telemedicine: The delivery of healthcare through the Internet or other computerized means such as videoconferencing.

Category: Concepts, Trends, and Challenges

Vehicular Telematics Systems

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INTRODUCTION

In the last 15 years, connectivity and communications have increased dramatically. As a matter of fact, from 1990 to 2Q of 2004, the number of mobile phone subscribers has growth from a few million to over 1.5 billion. In the same period, the number of Internet users worldwide raised from 2 million to 810 million (IWS, 2004; Juliussen, 2003). This means that today a large section of the population is dependent on communications and content, and wants to be connected any time and any place, even in their cars (Comunicar, 2002; Microsoft, 2005). To answer this requirement, telematics are being fitted into cars, giving rise to *vehicular telematics systems* (VTS). Indeed these systems represent the in-vehicle convergence of mobile communications and information processing, allowing drivers and passengers to stay in communication with the world outside their automobile. Vehicular telematics market is projected to be about $17 billion by 2006, equaling a growth by 280% since 2000 (Juliussen, 2003).

From a technological point of view, a VTS is composed of three basic components:

1. A two-way wireless communication (voice/data) system;
2. Some location technologies able to identify current geographic position;
3. Some computing technologies, to handle data and manage information flows from/to the user.

By fully exploiting the features offered by these systems, exciting new usage scenarios, opportunities, and markets are being available for both end-users and automotive manufacturers. As an example, drivers can receive contextual services, such as updated route calculations, basing on traffic alerts for the selected route, or can perform remote diagnosis of electronic car components, while passengers can access to e-mail and Web sites.

In the meantime, new business opportunities are being available for automotive manufacturers, since VTSs allow them to sell “services” and after-market upgrades, to have an open communication channel with buyers during the whole car life-cycle, and to understand their customers’ individual needs, thus providing an exceptional marketing link. This obviously is requiring deep changes in the business model for vehicular original equipment manufacturers (OEM). However, telematics is also affecting their design model, posing challenging technological issues, ranging from embedded real-time aspects, to context-aware ones, to the definition of innovative and safer human-machine interfaces.

In this article, we will provide an insight on the new mobile-commerce opportunities offered by telematics, together with the posed technological challenges. In particular, after a brief outline on the evolution of VTSs, we will analyze the services, the business challenges, and the opportunities that next-generation systems will offer. Subsequently, we will describe the technological difficulties posed by VTSs, with particular interest on human-machine interaction (HMI) and the safety issues. Finally, we will depict the future trends on this fascinating scenario.

BACKGROUND

A lot has happened since the first wireless technology (AM radios) was fitted into cars dashboards. Complex electronic systems began to be installed into cars in the 80s, with electronic injection, anti-lock braking system (ABS), etc. … Since then, the number of functionality provided to the driver/passengers by electronics constantly raised, and nowadays computing technologies are so massively present in vehicle’s interiors that top-class cars embed more than 1 Gigabyte of code (Pretschner, Salzmann, & Stauner, 2004).

In this scenario, telematics appeared only ten years ago, and still five years ago most advanced VTSs offered only limited navigation and entertainment (Tuner, CD) characteristics. Now almost all systems in production allow drivers to exploit a plethora of features, such as multiple audio sources (MP3, digital audio broadcasting, DVD), Web browsing, e-mails, phone calls, voice control, and so on. However, most advanced commercial VTSs (e.g., BMW *iDrive*, Fiat *Connect+* or GM *onStar*) are deeply changing the definition of product: they are starting to provide *services*, i.e. advanced functionalities involving interaction with a support centre. Typical examples are remote vehicle diagnosis, dynamic route calculation (taking into account contextual information about road, vehicle, traffic, and weather conditions), tele-aid, or hotel reservation.

Thus, VTS are opening new and exciting business opportunities. Automakers have to change their “mission” and business model, no more selling exclusively hardware but also services, shifting from the age-old one-time sale into an ongoing service-oriented revenue stream. In the meantime, there is the necessity to design and deliver context-aware services and information, creating great opportunities also for third-party content providers.

DEVELOPING EFFECTIVE TELEMATICS SYSTEMS

The definition of a vehicular telematics system is a very challenging task, involving substantial investments and a number of different skills, ranging from information and communication technologies (ICT) to marketing and psychology. In the following we will detail the posed business and technological challenges and opportunities.

Business Challenges and Opportunities

We can outline three main branches of business opportunities offered by VTSs: service selling, upgrade selling, and warranty claims reduction.

Service Selling

The main revenue opportunities can come from service-oriented businesses. With telematics, for first time car manufacturers have the opportunity to stay constantly in touch with their customers during the life of the car, and to understand clients’ individual needs. Thus OEMs and/or content providers can provide them with a plethora of pay-per-use or subscription services, such as traffic advices, hotel information/reservation, etc., limited only by the imagination of creative marketers. In the following we describe some push/pull services that are (or will be) part of VTSs, and that can generate attractive revenue streams:

- **(Dynamic) Navigation Systems:** Current VTSs offer localization and navigation features. In next generation systems, these will be improved with dynamic routing instructions, basing on real-time information about traffic or other infrastructure situations, provided by some data-centers, through wireless data connections.
- **Infotainment:** This can still be considered the crucial feature of a VTS, since people like to listen music during their commutes. Current systems provide a huge amount of entertainment sources, such as tuner (even digital or satellite), CD, MP3, TV, DVD players, etc… In perspective, future systems will be able to connect to Web-stores, such as *iTunes* (iTunes, 2005), to purchase and download further digital entertainment contents, such as audio tracks, video-games for kids on rear seats, movies, etc…
- **Communications:** VTSs include wireless voice communication features, based on 2,5-3G cellular infrastructure. So, they can exploit most of the services offered by mobile phone carriers, such as calls, SMS, MMS, voice-activated e-mail service, and high bandwidth downloads (even for data or software/service upgrades).
- **Remote Diagnostics:** A valuable new characteristic will be the ability to extract critical data from onboards electronics and transmitting them to the OEM, in order to perform remote vehicle diagnostics. Customers can pay an annual subscription to have their car’s health constantly monitored. This will significant reduce breakdowns, thanks to early problem detections. For example, a faulty sensor that could go undetected for months could be discovered almost immediately. In perspective, another exciting future scenario considers (controlled) interaction between vehicle and service centers. For instance, a tire sensors detecting flats could alert towing services, or in the event of an airbags opening, the system can automatically notify road assistance and physicians (Tele-aid).
- **Contextual Information Services:** By exploiting wireless communication and location awareness, VTSs will deliver a vast selection of customized information, ranging from weather news to stock price, traffic advices, movie show times, etc… Moreover, it is easy to extend these functionalities with traditional e-commerce services, for instance allowing driver to buy theatre tickets.
- **Location-Based Services:** such as assistance in case of breakdowns and stolen car recovery, can be easily provided in charge of a subscription.

In addition, the possibility of location and customer-based advertising could provide additional revenue for automakers.

The challenge however is about getting customers to pay for services. Currently, with new service-oriented systems, only a fraction of customers are willing to pay for premium services, even if marketing researches show that consumers are eager to pay $20/month for services like anti-theft security, road assistance, and Internet connectivity. It stays on marketing experts to design new content and services, able to attract buyers and to convince them to signing up annual agreements.

Upgrades Selling

With modular infotainment systems, designed keeping in mind easy replacement and upgrades, automakers can gain ongoing revenue opportunities, selling systems that can be upgraded or extended through the life of the car. For instance, features such as emergency roadside assistance, MP3Pro audio player, video games, or enhanced diagnostics could be purchased in aftermarket at gas stations. In the same way, systems can be extended with personal productivity applications (such as calendar, address book, etc.), as well as with new personal area network (PAN) wireless protocols, such as Bluetooth. To this aim, next-generation VTSs must be made extensible to allow and encourage consumers to frequently buy new upgrades.

Warranty Claims Reduction

The possibility to collect key operational data from on-board electronics, such as engine status and usage, braking, transmission system or catalytic converter status, allows automakers to perform trend analysis of vehicle performance, leading to early problem detection. For instance, if some values from sensors predict an incoming breakdown, OEM can inform the customer to get service prior the fault happens, with significant warranty costs reductions. Moreover this infrastructure will allow car manufacturers to diagnose faults not just in a single car, but also across entire model years of cars, eventually using data-mining approaches. Cost savings inducted by these reduction of warranty claims and improved operational efficiencies will be measured in tens of billions of dollars in 15 to 20 years (Juliussen, 2003).

Technological Challenges

The above depicted amount of offered applications is posing severe technological challenges to information and communication specialists. Designers have to embed many different (and often innovative) technologies into one device, possibly adopting a modular and plug-and-play architecture, to encourage future upgrades, and adopting specific user interfaces, to minimize driver's visual and cognitive workload. Moreover, to make things trickier, they must meet very strong industrial constraints (i.e., reduced available computing resources) both in terms of memory and CPU capacity.

About adopted technologies, current systems are exploiting most advanced solutions available on the market. About wireless connections, PAN typically exploits Bluetooth, while the wireless Internet access is based on the GPRS standard (new systems are about to exploit UMTS). Furthermore, location awareness is provided by the GPS satellite system (in perspective there will be a migration towards the European Galileo system, guaranteeing more precision and improved QoS).

Both Microsoft (Windows, 2005) and SUN (Java Automotive, 2005) are developing specific software platforms for automotive telematics, with a built-in support for the above depicted technologies. Nevertheless, there is still a lot of work to do, especially in the field of software engineering, to improve flexibility and modularity of those systems. Indeed, the problem is that current VTSs are usually built into devices specifically designed for one (or few) vehicle model(s). As a result, they are embedded, monolithic systems, characterized by high coupling between modules. This approach presents many drawbacks. It limits the possibility to easily add/remove features (i.e., middle-class cars can offer only some services, while top class the whole set). Moreover, future system upgrades are not permitted, as well as it does not allow car manufacturers to successfully demand the implementation of the various ITS subsystems to different suppliers (Costagliola, Di Martino, Ferrucci, Risi, Oliviero, & Freni, 2004a).

At the same time, deep improvements are also required for OEM's back-end technological and business infrastructures, which must be overhauled to provide new services, implementing flexible architectures that will allow for the integration of emerging applications and technologies.

Automotive Human-Machine Interaction Challenges

The diffusion of VTSs is posing profound safety concerns, because they can distract the user from the main task of driving the car, with potentially fatal effects. Since distraction is the most prevalent cause of crash (Wang, Knipling, & Goodman, 1996), many institutions have identified as a short term priority the research on HMI for the vehicular domain, to define new interaction devices and paradigms taking very carefully into account driver's visual and cognitive workload.

However, the definition of UI in the automotive field is an open and demanding research field. It is widely recognized that traditional techniques and approaches established for desktop applications turn out to be inadequate for the automotive domain (Cellario, 2001). This is due to many factors. First, the user/driver can dedicate only few bursts of his or her attention to interact with the VTS, because he or she is mainly focused on the primary driving task (Gellatly, 1997). Moreover, vehicular hardware has very firm limitations. Displays can show only a reduced amount of information, since they usually are between 5" and 7" and have a poor resolution, as well as Voice Recognition engines cannot rely on significant computational or memory resources. Finally, VTSs cannot use an input pointing device such as a mouse or a trackball, making the point-and-click paradigm no longer adequate.

As a result, the interaction with these systems is somehow far to be a well-established issue, being instead an open and active research field (Communicar, 2002), (Costagliola, 2004b). New interaction devices, paradigms, and metaphors are required, which carefully take into account the "safety" issue, not only considering the user interaction with the interface, but also understanding the effects of this interaction on driver-vehicle performances. Many studies indicates that a good solution can come from the use of multimodal interfaces, intended both as complements or alternatives to the visual channel, and able to exploit the other user's sensorial channels (Gellatly, 1997), since they do not require the user removes the glance from the road to interact with the system. In particular, considerable benefits can be gained from making greater use of the tactile channel as a complement to the visual one, especially for older people, because visual and auditory capabilities decrease noticeably with age (Burnett & Porter, 2001). However, great care must be posed with multimodal interfaces. Indeed, graphical user interfaces (GUIs) offer several benefits with respect to vocal or tactile ones which make them still one of the most important component of vehicular human interfaces. In particular, GUIs are definitely the best way to present graphical information, also allowing driver for a "self-pacing" of interaction, because data are shown in a parallel and persistent fashion, differently from auditory and tactile interfaces, which can further load human memory and attention due to their non static nature (Cohen, 2004). Moreover, tactile and auditory interfaces are characterized by a dynamic modality of interaction. Since this communication is serial and transient, user is not allowed to decide when interpret information and how long to spend for it.

FUTURE TRENDS

The VTS market is steadily growing. Analysts concord that a wide percentage of middle and top cars in 2010 will fit some kind of on-board telematics system. Today, electronics account for 18-40% of a vehicle's cost, and it is expected that in the future these numbers will significantly grow, through the integration of an ever increasing number of features. Compared to today's in-vehicle electronic systems, the list of capabilities that drivers and passengers will soon have at their fingertips may be limited only by the imagination.

But next VTSs have to change the definition of product, since three main problems must be addressed: road safety, life-cycle duration, and privacy. About the former issue, the availability of even more complex telematics can heavily affect driver's visual workload. As stated before, advanced user interface designs will be required, which carefully exploit multimodal interfaces, encompassing auditory and tactile sections, as well as heads-up displays, which project relevant information directly on the windscreen in front of the driver (as on military aircrafts). This eliminates the highly distracting task of taking out the glance from the road and looking at the vehicle dashboard.

The second fundamental issue is to reduce the difference of life-cycles between electronics and vehicles. Presently, a car is typically designed in 3-4 years, being in use for another 10 years. In comparison, electronics devices are designed in 6-12 months and are in use for 2-3 years (Fuchs & Spaur, 2004), with a high rate of obsolescence. To provide updated services through the whole car life-cycle, future VTSs will have to be delivered on plug-and-play platforms, whose functionality can be upgraded through software downloads or simple module replacement, or alternatively they will be akin terminals, where heavy computation is ran on remote servers (for example, offboard navigation), accessed through a wireless network, with significant reduction of production cost for automakers.

Finally, there are big challenges about privacy. A VTS-equipped vehicle collects a plethora of information about driver's behaviors, and it is technically capable of giving out these data, which could be potentially misused. For instance, service providers may sell customers' data to third parties without permission, or law enforcement agencies could use localization information to track individual movements.

To avoid that privacy concerns cause consumers to not want VTSs, end-users should be reassured about the safeguard of their own data. A possible strategy might be to pass laws imposing controls on the collection, usage, and storage of telematics-generated information. To this aim, European regulations yet provide strict rules on these data, as well as pending U.S. statutes may soon enforce this (Duri, Gruteser, Liu, Moskowitz, Perez, Singh et al. 2002).

CONCLUSION

The combination of computers and telecommunications has transformed our home and work environments, but in the automotive domain the application of these powerful technologies is still evolving. VTSs however can provide valuable new business opportunities for ICT and automotive industry, coming from the possibility to sell customized services, to deliver upgrades and to further reinforce customer loyalty.

However, as we depicted in this chapter, new and exciting challenges and issues are posed both to ICT and human-machine interface specialists by VTSs.

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KEY TERMS

Context Aware Computing: A system that have information about the circumstances under which it is operating and can react/make assumptions accordingly. A VTS has a lot of information about its context, such as localization, user behaviors, vehicle operative state, etc.

GPS (Global Positioning System): A satellite-based system used for determining geographical positions, with a precision of 10 meters. It uses a constellation of 24 satellites and is controlled by U.S. Department of Defense.

GPRS (General Packet Radio System): A wireless data protocol suited for data transmission, available to users of GSM mobile phones. It's theoretical bandwidth is 170 kbit/s, while the realistic one is 30-70 kbit/s. Sometime it is referred as "2.5G", (i.e., a technology between the second (2G) generations of mobile systems), like GSM, and the third one (3G), like UMTS.

Infotainment: Word formed from information and entertainment. In the automotive domain, it identifies a set of features provided by a VTS, such as audio module, Web browser, etc…

Multimodal Interface: Human-computer interface able to exploit different user sensorial channels, to provide/gather information. For instance, user can vocally ask for a service and then read the results on the display.

PAN (Personal Area Network): A computer network used for communication among personal devices, such as cell phones, headset and PDA. The reach of a PAN is typically a few meters.

VTS (Vehicular Telematics System): An electronic on-board system with wireless communications and location technology, integrated by some computing technology, to handle data and manage information flows from/to the user.

Category: Applications of E-Technologies

Veteran Service Management and E-Government Service Delivery Performance

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Veterans Service Office, USA

INTRODUCTION AND BACKGROUND OF ORGANIZATIONS

The importance of electronic service delivery was recognized at the beginning of the emergence of the Internet (Huang & Hu, 2004); thereafter much attention has been devoted to it as a solution to the issue of the traditional service delivery system (Cetiner & Ryan, 2004; Gassan, De Boer, Mourshed, & Rea, 2001). Too often there is little or no congruence between the image of the service communicated by the service firm and the service actually delivered. This leads to unmet customer expectations and probably to non-satisfied customers, who have lost their faith in the firm and its ability to keep its promises.

Governments also invest in veteran service management (VSM) and e-government to increase their service delivery performance. Veterans are the nation's population who have been discharged or retired after serving on active duty with the United States Armed Forces. E-government refers to efforts in the public sector to use information and communication technologies to deliver government services and information to the public (Gant & Gant, 2002; Gefen, 2002). Government agencies face challenges in making veterans aware of the benefits of online services they are receiving. Anecdotal evidence shows the Internet's Web portal can enable governments to increase their e-service delivery performance. However, there is little existing research that has tested how the use of Web portals to strengthen existing VSM can increase e-government service delivery performance.

The primary objective of this study is to examine how VSM, using Web portal aggregation, may impact electronic service delivery performance. Specifically, the study examines:

- the theoretical foundation of VSM,
- the theoretical impact of VSM on government service delivery performance,
- theoretically and empirically how VSM, supported by Web portal aggregation, may impact e-government service delivery performance.

This research focuses on government Web portals that deliver electronic services to veterans. The Web portal of the North Dakota Government Rural Outreach (GRO) Initiative has been selected as the sample U.S. government Web portal for this research. That Web portal has been chosen because it has a component dedicated to veterans and county veteran service officers (CVSOs).

Data were collected through open-ended interviews with CVSOs. A total sample consists of 10 CVSOs. The study used content analysis to analyze data obtained from a sample of CVSOs, using the GRO Web portal, to test the hypotheses. The CVSOs assist all veterans and their dependents in obtaining all benefits to which they are entitled, both federal and state. The CVSOs are chosen because they play the role of intermediary between veterans, veteran service and benefits providers, and government agencies. CVSOs interact on G2G (government to government) and G2C (government to citizen) basis in order to serve veterans.

CVSO and Veteran Population in North Dakota

A total of 22 CVSOs have an office in the north eastern part of North Dakota while 12 CVSOs serve veterans in the north western part of North Dakota. A total of 16 CVSOs serve veterans in the south western part of North Dakota while 18 CVSOs assist veterans in the south eastern part of North Dakota.

In terms of location, 18% of CVSOs cover the north western part of North Dakota; 32% work in the north eastern part; while 24% are located in the south western part and 26% in the south eastern part of North Dakota.

There are 14,840 civilian veterans in the north eastern part of North Dakota while 11,387 reside in the north western part of the state. Most of the civilian veterans (about 22,783) are located in the south eastern part of North Dakota. Approximately 7,116 civilian veterans live in the south western part of North Dakota.

In terms of location, 21% of civilian veterans are located in the north western part of North Dakota; 22% are located in the north eastern part; while 13% reside in the south western part and 44% in the south eastern part of North Dakota.

THEORETICAL FOUNDATION OF VSM AND DESCRIPTION OF E-GOVERNMENT

Several theoretical perspectives from information systems (IS) reference disciplines are relevant for this study. One of these IS reference disciplines is marketing. We draw upon role theory (RT) and service encounter theory to explore and understand the theoretical foundation of VSM. Those theories have been adopted by marketing researchers for examining service delivery (Bitner, 1995; Solomon, Carol, Surprenant, & Evelyn, 1985).

A service encounter theory is a form of social exchange in which participants normally seek to maximize the rewards and minimize the costs of the transaction (Solomon et al., 1985).

Usually, an encounter is especially relevant in situations where the service component of the total offering is a major element of that offering. In e-government delivery service, governments do not sell goods to the public or business, compared to the private sector.

In the public sector, the total offering is relatively stable, offering such as social security and unemployment benefits do not almost change and are pure service. A service encounter remains important in government e-commerce application because in many government services deliveries there is a high level of service encounter between CVSOs and veterans or government agencies.

Role theory (RT) is based on a dramaturgical metaphor (Solomon et al., 1985). It is the study of the behavior associated with a socially defined position and role expectations are the standards for role behavior. Each role that one plays is learned (Solomon et al., 1985). In many routine service encounters, the roles are well defined and both the customer and employee know what to expect from each other (Bitner, 1995).

According to RT, each participant in government service delivery has a role to play. Through the lens of RT, CVSOs and veterans' role in these relations are well defined and both know what to expect from each other. The RT also helps understand that each role that one (CVSOs, veterans or government agencies) plays is learned.

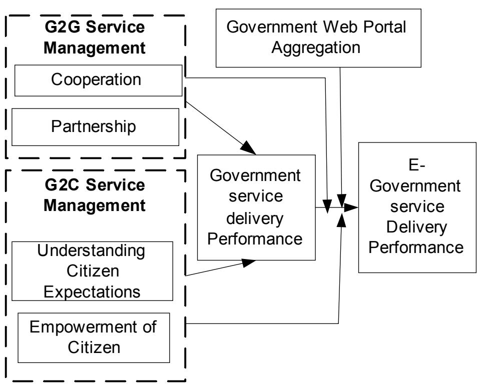
VSM, Service Encounter Theory, and RT

In fact, we build on foundational advances in RT and service encounter theory in examining VSM components.

In this study, a VSM is defined as the process whereby a CVSO understands veteran expectations, teaches veterans ways to secure services for themselves, develops partnerships of service, and cooperation with government agencies in order to serve veterans (Moon, 2002). The extent of VSM is split in two in this research: VSM from G2G perspective (G2GSM) and VSM from G2C perspective (G2CSM). The two major G2GSM components identified are: cooperation and partnerships of service. The two major G2CSM components identified are: empowerment of veteran and understanding veteran expectations. These components are analyzed through the lens of RT and service encounter theory. Further, we hope to test how the use of Web portals to strengthen existing VSM can increase e-government service delivery performance.

- **Cooperation:** It is defined in this study as coordinated actions taken by government agencies, veteran service providers, and CVSOs to achieve mutual outcomes. Cooperation promotes effective working relationship success. Wilson (1995) presented a cooperative model in which both parties achieve lower costs by working together to lower both buyer's and seller's operating costs. This enduring desire to maintain a valued cooperative relationship should, in turn, impact e-government service delivery performance.
- **Partnerships of Service:** Partnerships are created when CVSOs communicate and share information closely with veteran service providers or government agencies. In the management of service delivery, frequent quality communication needs to be in place to foster partnerships and cope with changing services needs (Moon, 2002). A partnership helps both parties stay on the course of mutual interests (Moon, 2002).
- **Empowerment of Veteran:** Empowerment of veteran generally refers to the process CVSOs adopt to educate, teach, encourage, and reward veterans who exercise initiative and make valuable creative contributions or do everything that is possible to help solve their problems. Most government agencies prefer to deal with empowered veterans because they are easy to serve, because they understand the

Figure 1. Research model



CVSO's preoccupations, and because they make only a few requests to government agencies.

- **Understanding Veteran Expectations:** This concept stresses the importance of CVSOs having the ability to identify their veterans' desires and to deliver to those veterans services which meet their expectation. Understanding veteran expectations is a strategy adopted by CVSOs and government agencies to generate more knowledge of veteran expectations and needs and to provide veterans with the best services.

E-Government Service Delivery Performance

Many authors have examined how governments can invest in e-commerce to improve their service delivery performance (Dufner, Holley, & Reed, 2002; Jain, 2004). After conducting six case studies and contacting over 50 government organizations, Cohen and Eimicke, (2001) found that e-government service delivery could change human resource deployment patterns and improve organizational performance. Another source of e-government service delivery performance is savings generated from reduced costs. When costs were assessed in the cases presented in their study, Cohen and Eimicke (2001) found that typically services delivered over the Internet were less expensive to deliver than those delivered in person.

Government Web Portals Aggregation

A portal is commonly defined as aggregated Web sites that offer a collection of services that help users, government agencies and their constituents navigate the Internet (Damsgaard, 2002). The dependency between government constituents and portal services is reciprocal or mutual (Damsgaard, 2002). Some portals cannot exist without a community of veterans or citizens, and the veterans will only visit the portal if there is a set of relevant services which they demand.

Research Model and Hypotheses

The key constructs of the research model, identified through the objective and the theoretical foundation of this article are as follows: the dependent variables will be drawn from government and e-government service delivery performance constructs, the independent variables will be drawn from the VSM construct and the moderating variables will be drawn from the Internet's Web portals aggregation construct.

This research model enables us to test the following hypotheses:

- **H1 (a, b, c, d, and e):** The VSM components (partnerships of service, cooperation, empowerment of veteran, and understanding veteran expectations) will have a positive effect on government service delivery performance.
- **H2 (a, b, c, d, and e):** The use of Web portal aggregation to strengthen existing VSM (partnerships of service, cooperation, empowerment of veteran, and understanding veteran expectations) will increase e-government service delivery performance.

PRELIMINARY STUDY AND IMPACT OF E-GOVERNMENT ON THE ORGANIZATION

Research Method

The study used content analysis to analyze the data obtained from a sample of CVSOs to test the hypotheses and analyze the research factors. The common response is obtained by using the generalized answer from all CVSOs. The procedure for data analysis was based upon totaling the overall counts of messages coded in each category and the analysis of the messages. Each research factor or variable has played the role of category. Occurrences of the messages in each category have been analyzed to determine relative importance. Higher relative counts reflected significance of the particular message within the specific category.

The objective of this preliminary study is to examine how VSM, using Web portal aggregation, may impact electronic service delivery performance. The Internet's Web portal aggregation can support the formation and maintenance of VSM because it facilitates the way CVSOs partner, cooperate, empower veterans, and understand veteran expectations. Content analysis techniques have been used to process and analyze data collected from a sample of 10 CVSOs using the GRO Web portal to serve veterans.

Highlights from the Findings of the Interviews

Impact of Cooperation Using Web Portals Aggregation on E-Government Service Delivery Performance

The following statement illustrates common responses from CVSOs:

We cooperate online with government agencies and we go back and forth. We try to keep a good relationship with the agencies. From the VA aspect, we discuss the cases because certain aspects of some cases need to be analyzed. Once you know these people they'll all go out of their way to help so it's the teamwork that really works. The CVSOs work pretty much together and we have an ability now with the Internet to assist each other. We work so close together and, we can use the Internet and get these things done for the veterans' benefit.

This part of the interview outlines that government Web portals must be extremely easy to use, since convenience and saving time (and consequently money) are the major thrusts for online cooperation. It is essential for CVSOs to offer online attractive services in order to convert potential veteran service providers to actual cooperators. Once potential veteran service providers are converted to cooperators, electronic service delivery performance will increase. CVSOs and veteran service providers cooperate when they use the same Web portal to maintain a working relationship (Moon, 2002). Both need to work together to identify all security risks and jointly develop measures for minimizing them (Moon, 2002).

Impact of Partnership of Service Using Web Portals Aggregation on E-Government Service Delivery Performance

The following statement indicates common responses from interviewees:

We keep government agencies updated about changes. Via the Internet, we can give them what they do not really know and make them aware of that. I guess, just to stay in online communication with government agencies, we share as much information as we can.

This part of the interview deals with monitoring service performance by collaborating on and sharing service problems, and negotiating for changing service needs. All require partnership and IT resources such as Web portals aggregation. Government Web portals bring together many services and agency Web sites onto one site (Stowers, 2001). Given the limited geographic scale of many public jurisdictions, using Web portals to develop projects in concert with other public and private entities is a sound strategy that creates both savings and productivity gains.

Impact of Empowerment of Veteran Using Web Portals Aggregation on E-Government Service Delivery Performance

The following statement exemplifies common views of CVSOs:

We help individual veterans fill out forms if they ask for the benefits. We tell them about what they are to do, and what social security may require, and get anything that way. A lot of individual veterans have been on the internet right now. Veterans may have to make the claims from their home. But they need to have the password. And may be if we make them more self sufficient as far as using technology that would empower them more. However they have to sign a lot more documents and digital signature is not available for them.

This part of the interview demonstrates that CVSOs are able, via the Web portal, to access information about their veterans. A Web portal then is a tool for veteran empowerment because once veterans are well informed about their government's Web portal, the veterans will most likely learn (Griffith, Sawyer, & Neale, 2003; Edgington & Chen, 2002) from CVSOs and be able to deliver government services and benefits to themselves. CVSOs often empower veterans to use Web portals for receiving service and benefits online. This veteran empowerment is carried out by e-mail or through online discussion (online conferences, forums, or chat rooms) and allows CVSOs and veterans to make the most of the online contact time provided by the Internet's portal to share their views. Government agencies and counties provide appropriate training for their CVSOs in order to be able to offer various services, solutions, or products during interactive online contact with veterans, and to modify on the screen the statements that governments use to deliver services to veterans on the basis of veterans' reactions and views.

Impact of Understanding Veteran Expectations Using Web Portals Aggregation on E-Government Service Delivery Performance

The following statement illustrates CVSO's common opinions:

We make sure we got the literature, and make sure many veterans come to the open house. We allow them to give feedback so we understand them better when they come back in for more services. We follow up with some veterans when we advise them some reference material that they can refer to and so on, such as Web sites. We take notes on everybody we talk to, what we talk about, then we open our notes up and say this is what we talked about.

This part of the interview shows that it is critical while improving government Web portals to clearly understand veterans' expectations (Cetiner & Ryan, 2004). Understanding veteran expectations is a continuous process, requiring CVSOs to solicit veterans' feedback to ensure that their needs are being addressed. A feedback system should let a government agency communicate with veterans and CVSOs. The feedback system shows its commitment to learning about and responding to veteran concerns.

Impact of VSM Using Web Portals Aggregation on E-Government Service Delivery Performance

The following statement indicates common responses from interviewees:

The use of the Internet will work out in the long-run. It will be cheaper when they get everything done. The Internet has obviously caught on, but it has not caught on to everybody because not everybody has access. The cost—I don't know how it would. If they don't come in here it's the only way it would decrease the cost. And many of them do not have the internet and I've had many of them come in—veterans and the dependents come in and say, "I tried internet. I can't get through it.

This part of the interview shows that usability of Web portal by veterans will reduce cost and increase veteran participation, therefore increased e-government service delivery performance will follow. When veterans help themselves at a Web portal instead of having to call a conventional help desk, reduced cost of veteran service delivery will follow. Good e-government service encourages veterans to use the Web portal more often, which means they become more likely to use it for transaction and support.

It is also important to be absolutely clear that e-government transactions within the government context do not replace face-to-face traditional government. If anything, it ensures that routine transactions can be handled more quickly and CVSOs have more time to devote to face-to-face interactions.

By automating the government service delivery process, electronic service relieves these CVSOs of having to perform many repetitive, yet critical time-sensitive tasks, thereby freeing them to support other strategic activities.

CONCLUSION

This article presents a theoretical discussion of how experts on IS and the Internet should inform government agencies, veteran service and benefit providers, and CVSOs about the theoretical impact of Internet network use on government service delivery performance.

The results reported are preliminary.

The result of this preliminary study shows that the challenge for a portal is to offer services that lock-in the government agencies, CVSOs, and veteran service providers. To increase e-government service delivery performance, veteran self-service needs to be promoted on Web portals. Then, e-government service delivery will free up CVSOs and allow them to focus less on routine tasks that could be easily handled by Web portals.

The way the application of RT to the public sector support the findings of this study may be explained as the following: if veterans or CVSOs play efficiently their role and adopt the appropriate behavior it ensures that routine transactions can be handled more quickly and CVSOs have more time to devote to face-to-face interactions. The application of RT to the public sector may let government reorganize its workforce or to enhance service delivery by redirecting employees to other activities.

The way the application of service encounter theory to the public sector supports the findings of this study may be explained as the following: because of the nature of government product (pure service), every time CVSOs interact with veterans or government agencies, a service encounter occurs. A service encounter in the context of e-government is a form of virtual exchange in which CVSOs seek to maximize service delivery to veterans or government agencies.

Even though the data we collected for this study focused on CVSOs, the research approach could be applied to any group of citizens. Further research is necessary as Internet technology evolves so rapidly. Finally, further research projects could be to apply the conceptual model used in this study to another category of government constituents. Quantitative analysis will be needed to perform more tests with the hypotheses developed in this study.

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Category: Concepts, Trends, and Challenges

The Virtual Agency as a New Force in the Promotions Industry

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INTRODUCTION

The virtual agency (VA) is a new form of advertising/promotions organization. By using technology to create ad hoc teams of promotions professionals, the virtual agency is changing the nature of the advertising business. In the following paragraphs, we (a) distinguish the virtual agency from traditional agencies and (b) explain why this is an important development for e-commerce and the advertising/promotion field.

Virtual agencies use the Internet as a means to redistribute the tasks traditionally performed at a single promotions firm. The completed work that the agencies perform for their clients is often similar to the work produced by traditional agencies. Virtual agencies, however, typically perform such work for a fraction of the traditional full-service agency's price

These new organizations are revolutionizing the promotions industry by the manner in which they distribute the tasks associated with creating a promotions campaign. To date, the agencies have not used the Internet to produce wholly new types of promotions. The virtual agencies instead use the Internet for simple communication; the Internet allows VAs to collaborate in a manner that was much more difficult prior to the widespread adoption of the Web.

BACKGROUND

Historically, full-service agencies have provided five key services to clients (a) account management and (b) creative, (c) financial, (d) media, and (e) support services. Limited-service (or "boutique") agencies offer only some of these services (Burnett, 1993). (To date, most scholars do not include electronic/new media services in the traditional definition of a full-service agency). Furthermore, the traditional advertising agency operates from a central geographic location with a "bricks and mortar" office that houses each of these respective departments.

Virtual agencies provide the same promotions services as traditional agencies, but in a very different manner. Specifically:

> *A virtual agency is a type of marketing communications firm formed by a collaboration of experts—typically from a pool of big agency expatriates experienced in creative development, account service, even the billing process. Just as ensembles of actors are carefully chosen for a film project, advertising freelancers band together for different advertising projects, thus creating the virtual agency.* (Bechard, 1999)

(Readers should not confuse the virtual agency with the cyber agency. A cyber agency specializes in providing promotions services through the Internet medium; a cyber agency may or may not also be a virtual agency; LORE, 2005).

SERVICE

The core personnel in a virtual agency typically form the virtual agency's account management team; in most cases, the VA's core personnel are owner-managers. Papsadore (1996) commented that "the account management team is your [i.e., the client's] single point of contact. They provide strategic direction, manage the project and provide all the financial services including estimating and billing." The owner-managers, then, address the strategic marketing issues related to creating a promotion while managing contact with the clients (Brandchannel.com, 2005). After the top personnel in the virtual agency have decided on an overall direction for a promotion, they may "then bring in, as required, excellence in advertising, design or PR" (Brandchannel.com, 2005).

By hiring the most appropriate members of the network for any given job, the virtual agency provides its clients with the full range of promotion services (Brown & Associates, 2005; Moscov, 2005). VAs' flexible organizational structure, advocates assert, allows these organizations to better meet customers' needs. The virtual agency "expands and molds to your [clients'] needs" (Blazic Design, 2005). Flexibility is important in today's customer-oriented "servicescape."

Virtual agencies claim that they have carte blanche when selecting the members of a client's creative team. "Creative teams can be matched to your project for several reasons—budget, style, industry expertise, or even history" [with the client] (Papsadore, 1996). To help craft effective promotions for clients, virtual agencies maintain an extensive network of contacts with various professionals, including "sculptors, musicians [and] directors" as well as "expert-level designers, artists, writers, photographers, video editors, and other independent creative professionals" (Feuer, 2000, Papsadore, 1996).

Some virtual agency clients maintain that the ability to "cherry pick" their promotions "team" actually provides them with better personnel than they would get at a traditional agency. One client glowingly described his virtual agency team: "If you went to an agency [i.e., a traditional agency], the chances of getting all this top talent in one room are slim. You're going to get a beginner in there somewhere. But you get the *crème de la crème* with the freelancers" (Bechard, 1999). Or, as Papsadore (1996) put it to would-be clients: "Maybe the best part of the whole [virtual agency] deal is that you will NEVER see a junior staffer ever again."

TECHNOLOGY

Although a virtual agency could use other means of communication (e.g., face-to-face, telephone), most VAs rely on the Internet as a key communication tool. Many virtual agencies have no formal headquarters. Prospective clients often learn about the agency and examine its work through the Internet and other forms of electronic communication. Many of the virtual agency employees provide client services without ever leaving their home offices. In lieu of meeting face-to-face, personnel at virtual agencies interact with each other and their clients through a variety of electronic communication channels. These include "phone, fax, and Internet… intranets, Web conferencing services, e-mail company newsletters, and conference calls" (Jarvis, 2002).

Virtual agency founder Scott Goodson explains how technology has shifted the balance of power among promotions providers: "The [Internet] technology for the first time is allowing us to have the same information and knowledge control as any of the big agencies. In the old economy, only the big corporations had the resources. Today, the Internet is democratizing information" (Koranteng, 2000). For consumers, however, the Internet may be associated with a digital divide between those with convenient, affordable online access and the rest of the world. In this sense, those who haves access to new technologies possess the means to advance socioeconomically. On the other hand, the "have-nots" (i.e., disconnected consumers) are continuing in a downward cycle due to a lack of timely information with which to make their everyday decisions.

As noted in the introduction, then, the virtual agency does not create new technologies (i.e., virtual agencies have yet to invent new forms of advertising). Instead, the virtual agency supplies its clients with traditional promotions. Virtual agencies create their promotions by parceling out the work involved among very loosely affiliated networks of promotions professionals.

The virtual agency, then, is consistent with the emerging phenomenon scholars label "computer-supported collaborative learning (CSCL)" (Borges and Baranauskas, 2003). CSCLs "…combine communications and computer technologies to support various activities involving groups in collaborative problem solving situations" (Borges & Baranauskas, 2003). Through these CSCLs, participants can accomplish a number of goals that would be much more difficult without the recent advances in information technology.

Virtual agencies not only form collaborative networks in a manner consistent with other CSCLs, these agencies also structure the work in a manner that is quite common among participants in these networks. "CSCL environments have a special participant, usually called a 'facilitator', who plays a fundamental role in coordinating and mediating the group discussions towards reaching the goals and learning objectives of the activities carried on" (Borges & Baranauskas, 2003). As noted earlier, virtual agencies generally have an account management team that makes the strategic decisions regarding the promotion and, subsequently, selects the other personnel who work on a given promotion. Virtual agencies, then, operate in a manner largely consistent with other CSCLs.

COSTS

By virtue of the fact that they offer a wide-range of services in a "bricks and mortar" office, traditional advertising/promotions agencies have to cover a high amount of overhead. The absence of costly office space and full-time personnel allows the virtual agency to offer a full range of services to clients at a low cost (Asheville Creative Services Group, 2005). Virtual agency clients note that "you're not paying for a whole agency; you're just paying for a person's expertise" (Bechard, 1999). Also, the diffusion of technology allows virtual agencies to create attractive advertising and promotional materials at a fraction of the cost required to create a campaign in the past.

As a result of these advantages, one virtual agency states that its prices are "30%-40% less than [prices charged by] traditional advertising agencies" (Blazic Design, 2005). Another virtual agency cites "30%-50% savings" over traditional agencies (PriMedia, 2005). As one VA CEO puts it: "The real key to a virtual agency is you can keep your overhead lower and pass that savings on to your clients" (Jarvis, 2002).

Advocates of the virtual agency maintain that these newer agencies' heavy use of technology and minimal bureaucracy can combine to offer clients another advantage: much faster service than they would obtain from traditional ad agencies. For instance, Amsterdam-based virtual agency StrawberryFrog won the account of printer manufacturer Tektronix from a much larger traditional agency. After obtaining the account, StrawberryFrog created a campaign for Tektronix in 18 days; Tektronix's old agency had required 8 months to accomplish the same task (Koranteng, 2000). This potential advantage is especially appealing to companies that are interested in being the first to market with a new product or service.

The advantages of the virtual agency have helped these upstart firms land a number of blue-chip businesses as clients. The well-known businesses hiring virtual agencies include: Nike, British Airways, Pharmacia, Volkswagen, the magazine *Elle*, and Heineken (Hammonds, 1999; Koranteng, 2000). While these well-known clients are impressive, some observers suggest that cost-conscious small businesses will be the biggest beneficiaries of the virtual agency phenomenon. Virtual agencies "are quickly becoming the preferred choice among smaller businesses that want to save money and get more bang for their advertising bucks" (Bechard, 1999).

NEGATIVES

Participants in virtual agencies do concede that drawbacks exist. Many of the perks associated with traditional agencies do not exist for clients of virtual agencies. In fact, one enthusiastic supporter of the virtual agency concedes that clients must be "ready to make the leap from Godiva truffles to a good old Hershey bar" (Papsadore, 1996).

One potential problem is the difficulty in obtaining personnel to "tweak" promotional materials at the last minute. Moreover, because of the virtual agency's relatively narrow margins, clients who request additional services must be willing to pay more. "When you ask for something extra… it goes right to the agency's bottom line, and they must charge you for it" (Papsadore, 1996). Therefore, prospective VA clients must weigh their desire to save money versus the types of services they desire.

Most virtual agencies have a cost advantage relative to traditional agencies; therefore, VA profit margins typically are lower than are profit margins at traditional ad agencies. Further, ad hoc combinations of promotions professionals may inadvertently combine personnel who do not work together well; indeed, some virtual agencies have even paired personnel who are professional rivals (Koranteng, 2000).

Scholars also note that the disconnected organizational structure of a virtual agency carries a number of potential drawbacks. Specifically, participants in virtual agencies must manage disparate coalitions of personnel while crafting effective promotions for clients:

> *At the same time, the virtual agency concept has major risks including inefficiencies due to organizational complexity, the danger of collective myopia, the problem of adopting standards too early, the difficulty of reaching objectives in a loose organizational structure, and the problem of properly balancing the tension between agency mission objectives and national policy agendas.* (Castro, Foster, Gunn, & Roberts, 2001)

Last, many traditional agencies enjoy long-standing relationships with their blue-chip clients. From the clients' perspective, it may be very risky to damage a good relationship and move to a new agency without a proven track record. Clients often base their selection of an agency on their relationship the agency's personnel (Crutchfield, Spake, D'Souza, & Morgan, 2003), it remains to be seen whether the virtual agency can foster these all-important relationships.

FUTURE TRENDS AND CONCLUSION

Observers predict that the virtual agency will not mean the death of the traditional agency. One J. Walter Thompson (JWT) executive said "that the Internet allows large firms to slash bureaucracy while still capitalizing on the immense global resources that virtual agencies will never have" (Koranteng, 2000). Nevertheless, the traditional agencies face a stiff challenge from their smaller, cheaper rivals.

Analysts predict that the virtual agency's business model will become a permanent part of the promotions industry's landscape. Indeed, the economic slowdown beginning around 2000 did nothing to decrease the virtual agency's appeal; instead, a number of traditional businesses (across a variety of industries) converted to the virtual business model. "One result of a slow economy has been to bring more companies to join… in the virtual niche as businesses, aiming to cut their overhead, have discovered that the virtual model is a viable way to do business" (Tanner, 2003).

In the future, virtual agencies must examine how they can make the virtual approach even more efficient. To date, the fact that relatively few businesses have adopted the model has given virtual agencies a cost advantage relative to traditional competitors. In the future, virtual agencies are likely to compete not only with traditional, bricks and mortar agencies, but with each other as well. Only the most efficient and effective virtual agencies will survive.

In order to retain their efficiency advantages, virtual agencies will have to consider—yet again—the manner in which they organize their personnel and technologies. After all, virtual agencies attempt to operate with personnel who are geographically dispersed; this situation can only add to the sharp differences often observed between the "creative" and "strategic" sides of a traditional ad agency (Koslow, Sasses, & Riordan, 2003). Personnel who are in different geographical locations may add to problems separated

A consultant from Bain and Co. argues:

Technology and telecommunications have driven the virtual phenomenon… But just having reliable and high-level performance in those systems isn't enough to make a business case for a company to operate as a virtual enterprise … A company has to be structured in a way that makes the virtual approach work, with incentives in place to support the system… employees must have the right capabilities, infrastructure and training and be empowered to take action. (Tanner, 2003)

The final hurdle to the virtual agency's acceptance lies in its ability to attract larger clients. To date, many blue-chip companies remain reluctant to hire virtual agencies. Whether a high percentage of the largest clients will become open to hiring virtual agencies is unknown at this writing. Many of these clients still aren't aware of the presence of virtual advertising agencies much less how their firms can benefit from hiring a virtual agency. Given that the client's buying center is often rather small when it comes to selecting an ad agency (Na, Marshall, & Son, 2003), virtual agencies seeking to obtain business from large clients may have to invest more in reaching the key decision makers among their potential clients.

It will be interesting indeed, to observe whether management at the top virtual agencies will be able to establish brand equity equivalent to that enjoyed by the top traditional agencies. Given that current research indicates that a firm or product's reputation is built over the long-term (Weilbacher, 2003), it is likely that virtual agencies will only establish such reputations after considerable amounts of time. Executives at some virtual agencies have become so frustrated by their inability to attract large clients that they have given in and established traditional offices; these former virtual agencies have had mixed results after adopting more traditional modes of operation (Slater, 2003).

For the foreseeable future, then, virtual agencies will quickly grow and continue to eliminate the distinction between full-service and boutique ad agencies. Because "no one tracks the total number of virtual agencies or how many make a go of it" it is difficult to predict precisely how much influence the virtual agency will have on the future shape of the promotions agency (Jarvis, 2002). One conclusion, however, is already apparent: "No longer can Advertising Agencies survive conducting business in the traditional manner" (PCF Virtual Advertising, 2005).

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KEY TERMS

Boutique Agency: Promotions firms providing some, but not all five, of the services provided by full-service agencies. (A synonym for boutique agency is *limited-service agency*; Burnett, 1993).

Buying Center: All of those who have influence over a business' purchase of a particular product.

Cherry Picking: Process by which virtual agencies may choose the best available talent for each job. Full-service agencies, meanwhile, are stuck using the staff that they have on hand (Bechard, 1999).

Cyber Agency: Promotions firm specializing in providing promotions services through the Internet medium. A cyber agency may or may not also be a virtual agency; LORE, 2005).

Full-Service Agencies: Promotions firms providing the following five services: (a) account management, (b) creative, (c) financial, (d) media, and (e) support services (Burnett, 1993)

Limited-Service Agencies: Promotions firms providing some, but not all five, of the services provided by full-service agencies. (A synonym for limited-services agency is *boutique agency*; Burnett, 1993).

Strategic Marketing Issues: Broad, far-reaching questions concerning the manner in which a firm serves its customers. Top management generally addresses strategic issues (Brandchannel.com, 2005).

Virtual Agency: "A type of marketing communications firm formed by a collaboration of experts—typically from a pool of big agency expatriates experienced in creative development, account service, even the billing process. Just as ensembles of actors are carefully chosen for a film project, advertising freelancers band together for different advertising projects, thus creating the virtual agency" (Bechard, 1999).

Virtual Communities and E-Business Management

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INTRODUCTION

As a result of the new possibilities offered by Internet managers are increasing options provided by the new technologies in strategic planning. The virtual community has become one of the more interesting options.

The general aim of this article is to explain the concept of virtual community, paying special attention to the most important strategies and management suggestions. Firstly, we will analyze the concept of community from a sociological viewpoint. We then define a virtual community and what causes an individual to belong to one. Secondly, we will show the main strategic implications of the development of virtual communities. Next we will detail a series of recommendations for the proper management of virtual communities. The two final sections present the future trends of research and the main conclusions of the article.

BACKGROUND

From a sociological perspective, Muñiz and O'Guinn (2001) consider that a community may be defined as having three principal elements:

- **Consciousness of Kind:** This refers to the feeling that binds every individual to the other community members and the community brand (e.g., admiration for Elvis Presley, or the passion for owning and driving a Volkswagen Beetle). It is determined by two factors: (1) legitimization, the process of establishing a difference between true and false members, that is, those who have opportunist behaviors and those who do not; and (2) opposition to other brands. In fact, identification with the rest of the group is mainly based on opposition; in other words, brand community is usually defined in comparison with another brand (e.g., the rivalry between fans of The Beatles and The Rolling Stones).
- **Rituals and Traditions:** These are processes carried out by community members which help to reproduce and transmit the community meaning in and out of the community. Members relate to each other with the memory of major events in the history of the brand and certain behaviors. All these processes help to reinforce brand consciousness and improve instruction on communal values.
- **Sense of Moral Responsibility:** This reflects the feelings which create moral commitment among community members. A sense of moral responsibility encourages conjoint behaviors and enables stronger group cohesion. As a result of moral responsibility, there are two types of fundamental actions: (1) integration and retention of members, which guarantees the community survival (e.g., by spreading bad experiences suffered by those individuals who chose a different brand); and (2) support in the correct use of the brand (e.g., by sharing resources and information about product properties).

Thanks to the Internet, social relationships can be developed in a new environment. Thus appears the idea of virtual community. The first virtual community was created in the seventies, specifically with the Talkomatic software, designed by Doug Brown of the University of Illinois in the autumn of 1973. However, it was not until the nineties that there was an exponential growth of this type of organization.

Several authors offer definitions of virtual community. Cothrel (1999) defines it as a group of individuals which uses computer networks as a form of primary interaction. Kardaras, Karakostas, and Papathanassiou (2003) consider it to be a group of individuals who communicate by electronic means such as the Internet, who share interests, without needing to be in the same place, or having physical contact, or belonging to a particular ethnic group. More specifically, the concept of virtual community is defined by Rheingold (1993) as a "social aggregation originated in the Internet when people discuss in this communication channel." Similarly, Yap (2002) explains that a virtual community is a social group originated in the Internet with certain beliefs, social forms (language, etc.), and traits that creates an emergent culture among its members. With a greater degree of complexity, Muñiz and Schau (2005) point out that a common aspect of virtual communities might be the potential for transcendent and magic-religious experiences. Finally, Preece (2000) states that a virtual community is formed by people:

- with a wish for interaction among them in order to satisfy their needs,
- that share a particular interest which is the reason for the community,
- with certain norms that guide the relationships, and
- with computer systems that favor interaction and cohesion among the members.

THE MANAGEMENT OF VIRTUAL COMMUNITIES

Strategic Issues Related to Virtual Communities

The exploitation of virtual communities may be implemented by means of two different marketing strategies: offering support or becoming a member of the group.

Strategy 1: Offering Support to the Community

This strategy supposes that a company manages the platform on which the community exchanges take place. This company is not a member of the community, but simply facilitates its existence by offering a Web site for communication purposes. For the development of this strategy, the main step should be an analysis of the real possibilities of creating a community via the Internet. These possibilities derive either from the particular characteristics of a product or brand, or else the pre-existence of the community offline. In the first case, the company should define the aspects which characterize the product or brand to ascertain to what extent these are likely to create an attendant community (e.g., the company Apple, http://www.apple.com/usergroups/, exploits the characteristics of Apple computers). In the second case, a new, better quality method of communication is offered to a group of individuals who are already linked outside the Internet (e.g., MarketingProfs.com, http://www.marketingprofs.com, facilitates communication between marketing consultants and educators).

Strategy 2: Become a Member of a Community

In this case, the company attempts to be perceived as a virtual community member. In this respect, obtaining the level of membership of a community will depend on the trustworthiness perceived in the company. According to established literature on trust (e.g., Roy, Dewit, & Aubert, 2001; Sako & Helper, 1997; Morgan & Hunt, 1994; Anderson & Narus, 1990; Dwyer, Schurr, & Oh, 1987; Anderson & Weitz, 1989; Bhattacherjee, 2002; Cheung & Lee, 2001; Gefen, 2000; Kolsaker & Payne, 2002; Luo, 2002; Walczuch, Seelen, & Lundgren, 2001; Geyskens, Steenkamp, & Kumar, 1998; Sabel, 1993), the organization needs to demonstrate its *honesty* (i.e., that it is sincere and delivers its promises); *benevolence* (being concerned for the welfare of the other members of the community, not acting in an opportunistic manner, and attempting to have compatible objectives); and *competence* (that is, it has sufficient capability for its contributions to the community to be significant and to generate value).

Hagel and Armstrong (1997) and Flavián and Guinalíu (2005a) show the virtual community as a tool that can increase the chances of success in the marketing and distribution of products over the Internet. The virtual community can boost a company's product differentiation by increasing commitment and emotional ties with the brand. Furthermore, brand awareness is increased, since the community acts as a catalyst in the transmission of word-of-mouth messages. Thirdly, the virtual community brings about a more effective market segmentation, increases consumer trust and security, acts as an information source, and can even become a major source of direct income. In a more detailed way, we can distinguish these managerial implications:

- **New Forms of Communication:** Hoffman and Novak (1996) notice the replacement of traditional communication models (one-to-many) with others in which the interactions between all the participants in the market are constant (many-to-many). The virtual community represents these changes. Thanks to social network and the use of the Internet, messages are transmitted to the community within a short period of time, obviating the need for costly investments in the mass media and thus reducing promotional costs (Barnatt, 2001; Guthrie, 2000; Kardaras et al., 2003; Wang, Yu, & Fesenmaier, 2002).
- **Information Source:** The virtual community becomes a relevant information source for the decision-making process (Hagel & Singer, 1999; Holmström, 2000; Barnatt, 2001; Kardaras et al., 2003).

- **The Creation of Barriers Preventing the Entry of New Competitors:** The virtual community creates barriers against new competitors (Barnatt, 2001; Hagel & Armstrong, 1997; Kardaras et al., 2003).
- **Increased Security and Trust:** The community creates a climate of security based on reputation and mutual trust. This phenomenon may be clearly seen in online auction communities (e.g., eBay), and in communities with risk-management systems based on reputation (Dellarocas, 2001; Kollock, 1999).
- **Facilitating the Development of Relationship Marketing Strategies:** According to certain authors (e.g., Guthrie, 2000; Wang et al., 2002), virtual communities are an ideal environment for implementing relationship marketing strategies.
- **Becoming a Source of Indirect Income (Wang et al., 2002):** In the case of virtual communities, it is customary to offer, through mailing lists, forums, or Web sites supported by the community, third-party products which might be of interest to the group. In this way, the business supporting the communication infrastructure of the community is financed (e.g., the company which supports the CRM professional community, http://crm.insightexec.com/). Likewise, some communities charge a fee in order to participate in debates (e.g., http://www.well.com).
- **A Source of New Clients (Kardaras et al., 2003):** Membership to a community creates a favorable predisposition towards the company supporting the platform for community interchange. For this reason, the community encourages members to recruit new members who ultimately will become new consumers.

E-Business Management Recommendations

Flavián and Guinalíu (2005a) identify the existence of some key aspects to guarantee the success of virtual communities. Specifically, these actions might be determined in light of the following issues:

- **Analyzing the Members' Needs:** The community should be created and managed according to the needs of its members, not the needs of the company which promotes it, the advertisers, or any other group not involved in the community.
- **Fostering Self-Management:** If self-management is technically impossible, they should try to create a situation in which the contents of the community are generated and published directly by its members.
- **Minimizing Control:** It is not advisable to establish control mechanisms on how the community members should mix with each other or the topics they should discuss in their conversations.[1]
- **Using the Most Suitable Technological Structure:** The type of technology used to manage a virtual community has a lot of implications. Flavián and Guinalíu (2005b) recommend using technological systems that are flexible, easy to manage, and visually attractive.
- **Specializing Roles:** Several sociological research studies have shown that inside a community it is common for individuals to adopt different roles which give the community a greater dynamism. Taking these findings as a reference, Flavián and Guinalíu (2005a) suggest the advisability of having this role assignment inside virtual communities.[2]

FUTURE TRENDS

For the immediate future, research into the concept of virtual communities is faced with some interesting challenges. Firstly, there is a need to analyze the influence of new methods of communication (e.g., Wi-Fi, Bluetooth, UMTS, or i-Mode), as well as the recent spread of other devices (e.g., Tablet PC, PDA, or Smartphones). Wireless technology will afford community members new means of interaction, while at the same time opening the way to alternative lines of business. Furthermore, there is a need to examine in more detail the application of virtual community marketing strategies aimed at specific sectors. Particularly interesting here is the use of virtual communities in political marketing strategies. Finally, it would be useful to analyze in more detail the role of virtual communities in corporate environments, such as CRM systems.

CONCLUSION

In this article we have proposed the virtual community as a useful ingredient of a successful e-business strategy. Virtual communities have a strong influence on strategic planning due to the fact that they offer a new form a communication, serve as a source of strategic information, generate barriers to prevent the entry of new competitors, increase consumer security and trust, facilitate the development of relationship marketing strategies, and may became a source of incomes and new clients. Nevertheless, the success of these strategies is dependent upon the monitoring of trends, such as helping self-management by minimizing control on the group dynamic, defining roles, or using suitable technologies.

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KEY TERMS

Bluetooth: Wireless telecommunications system which provides a way to connect and exchange information between devices like personal digital assistants (PDAs) or mobile phones.

Community: Social network whose members are characterized by a common interest, similar behaviors, and a sense of moral responsibility.

CRM (Customer Relationship Management): Systems with technological tools related to the implementation of relationship marketing strategies.

i-Mode: A wireless Internet service for i-mode mobile phones using http protocol.

Relationship Marketing: Marketing activities and strategies related to the creation, maintenance, and development of successful relationships.

UMTS (Universal Mobile Telecommunications System): One of the third-generation (3G) mobile phone technologies. This technology provides the mobile phone access to several services, such as videoconference.

Virtual Community: Community that uses the new communications technologies (e.g., the Internet) to maintain and develop social interactions.

Wi-Fi: Short for wireless fidelity"; a set of product compatibility standards for wireless local area networks (WLANs).

ENDNOTES

1 In this respect we may say that establishing control mechanisms on how members relate to each other is not very advisable. In fact, the use of a certain communication system cannot be imposed. Secondly, some freedom in the contents of conversations and messages should be granted. Obviously, any contents that may be offensive for the company or other members should be screened, but excessive control is not recommended. The community itself will create its own internal rules and will reject those participants who do not provide any value. In fact, it might be interesting to create a space where the members are free to talk about anything they want to, even though it has nothing to do with the community's primary aim. It is also advisable to publish on the Web site the community's conduct rules as soon as they are defined.

2 Some possible roles are: (a) social weavers: individuals who introduce new members to the community; (b) moderator: a respected member who channels the debates into a suitable direction and regulates conversations; (c) knowledge manager: a member who evaluates and searches for useful resources for the community; (d) opinion leader: a respected member who defines the community's ideological tendencies (establishing a system of scoring the members' comments is an interesting possibility for the group to define who is a leader and who is not); and (e) instigator: a member who, voluntarily and respectfully, proposes controversial discussion topics, thus encouraging participation.

Virtual Concept Use in the Construction Industry

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INTRODUCTION/BACKGROUND OF ORGANIZATION

Introduction

History is laden with many technological breakthroughs which have had enduring impacts on business affairs (e.g., automobile, mass power generation, etc.). It also appears that modern information and communication technology (ICT) tools, especially the Internet, have had some impact on the way in which business and other task deliveries are conducted. Aligned to this is the emergence of virtual model in business where people are able to operate independent of time and space via dependence on modern ICT tools to attain specific goals. During the previous decade (1990s) various virtual organizations (or "dot-coms") emerged and they were touted to be the future of business, and hence with the potential to completely overthrow traditional companies (see, e.g., Mandel, Ho, Himelstein, Foust, & Muller, 2001; Ousthuizen, Koster, & Rey, 1998). Although the end of the 20th century saw the demise of most of these companies, however, a few surviving ones like the search engine company Google have made significant impact in recent times by overtaking traditional companies like General Motors and Ford Motor Co. in terms of market capitalization (via an estimated value of about $27 billion in year 2004) (see, e.g., Shinal & Kopytoff, 2004).

Further to the above generic review of the impact of the virtual organizations, seminal accounts also exist on the significant use of the virtual concept to support engineering task delivery by traditional companies. In the aviation sector, for example, Boeing Co. pioneered the use of the virtual concept to support task value delivery processes via its first virtual collaborative design using 230 design/build teams which started in 1990 and resulted in the unveiling of Boeing 777 in 1995 (see, e.g., Rayport & Sviokla,1999; Russell & Flack, 1998). Boeing Co. thus avoided the use of traditional physical airframe prototypes of the proposed aircraft, and leveraged information-based virtual product prototypes (with the relevant laws of physics and material science) assembled on computer, and this aided the avoidance for physical means to solve conflicts of space (Rayport & Sviokla, 1999; Russell & Flack, 1998). This initiative led to massive gains in terms of 75% reduction in rework, testing of many designs at lower costs, better speed, and hence gains in efficiency (Rayport & Sviokla, 1999; Russell & Flack, 1998). On the other hand, Ford Co.'s first initiative via the Advanced Vehicle Technology project to use virtual model across geographic locations over traditional physical collocation resulted in efficiency levels which were a third less than physical collocation delivery (Russell & Flack, 1998). To sum, the accounts given above concern the potential success and "failure" in leverage of the virtual concept in business activities, from both generic and specific applications. One may extend this thinking to explore what lessons may also be learned from other industries like the construction industry on the leverage of the virtual concept to deliver value? With the virtual model depending to a great degree on the use of modern ICT, a track of diverse research on ICT in construction may be useful to enhance comprehension of the trends of research in this area.

There has been useful research on the use of ICT and its related applications in the construction industry for both academic and non-academic purposes. Research on pedagogic applications for architectural "studio" studies (see, e.g., Dave & Danahy, 2000), or construction and technology purposes (see, e.g., Clayton, Warden, & Parker, 2002) have provided understanding in the use of the concept in training students to experience the virtual concept. Studies focused on virtual structural designing/analysis, etc. (see, e.g., Deng & Nguyen-Minh, 2003); or software development and description oriented studies (see, e.g., Connell & Tullberg, 2002; Craig & Zimring, 2002); or virtual realty tools for the management and operation of construction activities (see, e.g., Caneparo, 2001) have assisted in moving the field forward, and also enhance actual construction operations. Survey-based studies which track the generic use of IT in construction (see, e.g., Howard, Kiviniemi, & Samuelson, 1998; Rivard, 2000; Samuelson, 2002) provide awareness on the trends in the extent of use of ICT in construction generally. The case-based research like that of Rivard et al. (2004) which gave an account of specific applications of IT use in the Canadian construction industry offer knowledge on emerging pioneering trends in the industry. However due to the relatively “youthful” age of this area of research there appears not to be much empirical studies which focus on the use of the virtual concept in construction value delivery. This article explores the leverage of the virtual model in delivering value in the construction industry by a construction company in Hong Kong. First, general issues (which includes an overview of the research activities) and the background of the company is given, before descriptions and the impact of the applications are presented.

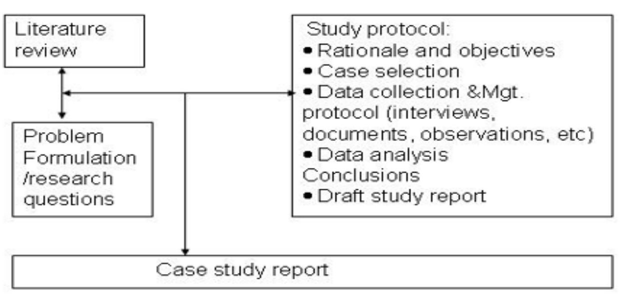
General Issues and Overview of Research Activities

The aim of the study was to explore the experience of the use of the virtual concept by a selected company in Hong Kong. Thus, to explore the question on how it uses the virtual concept in its task delivery processes to deliver value? This study (which is part of a broader study) is hence exploratory and descriptive in nature and has the unit of analysis at the organizational level. For the sake of confidentiality this company will be referred to as Case 1. This company is a construction contractor, and it was selected on purpose. A key reason for selecting this company was that it is perceived as one of the leaders in the local industry. The evidence provided herein is an analyzed data based on cross-verified in-depth interviews of senior company executives, archival data, observations, etc., and the use of a research study protocol (see, e.g., Rahim & Baksh, 2003) which set out (among others) the research rationale, objectives and methodology (which included procedures to guide the data collection process). A brief schematic diagram of the research activities is given in Figure 1.

A set of formulated questions was used to aid in the data collection process. This enabled gathering information on the following to achieve the aim of the research:

- The background information of the case company;
- The extent of leverage of the virtual concept in the firm; and

Figure 1. Brief overview of research activities



- Improvements attained (over previous traditional operational methods) through the use of the virtual concept in the case company; challenges and exploratory lessons learned.

The next sections give the details on the case company, descriptions of the application (with prior definition of key concepts), impact, before the conclusions are offered.

Background of Company

Case 1 is a construction company which is over 50 years old with headquarters in Hong Kong. Case 1 maintains other international branches (mainly in Asia) and it has an average annual turnover of about 1 billon dollars (U.S.). The activities of the firm cover a wide scope and include the construction of the following: residential houses (various types); railways, industrial buildings, varied commercial structures including shopping complexes, environmentally based projects and roads and bridges.

DESCRIPTIONS OF E-COMMERCE, E-GOVERNMENT, AND/OR MOBILE COMMERCE

General Issues

Before presenting descriptive applications of the concept, it may be useful to define the virtual concept and value delivery as applied in this article to aid comprehension.

Virtual Concept

Despite the varied inconsistent definitions which exist in literature for this term, this article will adopt this operational definition of the term virtual:

- When specifically applied to the organization or construction project to mean: the combination of skills by firms/groups/individuals (outsourced or otherwise) who depend on modern ICT to imitate the real world or operate independent of time and space, and collaborate to achieve common goals (see, e.g., Barima, 2003; Duarte & Snyder, 1999; Ousthuizen, Koster, & Rey, 1998).

To enhance understanding of the virtual model, a comparison with the traditional construction concepts may also be useful. In the traditional models there may be the reliance on traditional means like physical face-to-face, traditional postal delivery service, etc. for communication. Further in traditional construction processes the use of hardcopy versions of construction drawings, documents and designs, etc in addition to physical interactions between actors may be dominant. The extreme scenarios of the virtual and the traditional models may be perceived to be on the two ends of a continuum, with potential hybrids of them possible (Barima, 2003).

Value Delivery

While value delivery may have varied definitions to different people/stakeholders in a construction process, in this article this may be taken to mean the effectiveness and efficiency in delivering the tangible or intangible construction products from conception to asset disposal. The next section presents descriptions of the driving factors and leverage of the virtual concept in the company's operations before the impacts are offered and discussed.

Descriptions of Application of Virtual Concept

The Driving Factors, Management, and Creation of the Right Environment

Case 1 faced major problems and challenges with visibility and certainty in its task delivery and communication processes. Critical intra-company value delivery activities and processes, and also those with their key partners were deemed undesirable. For example, in a particular time span the company handled about 60 dispersed construction project sites, and not all activities including those at the headquarters were easily accessible and visible in real time to all the key staff. Aside the intra-company problems, the transactions and the activities of their key partners, like subcontractors, suppliers etc were also uncertain, invisible and involved a lot of paperwork and other bottlenecks. Such events obviously affected business efficacy, effective collaboration, and hence overall delivery efficiency and effectiveness. To overcome this problem, a vision was crafted to improve the construction value delivery processes via the use of ICT in a visible linked fashion across the company's value chain. This transformation process involved the primary adoption of enterprise resource planning (ERP) system to integrate functional activities both within the firm, and also with its key external partners (in the company's value chain). Apart from the ERP system other ICT tools like mobile phones, geographic positioning systems (GPS), video-conferencing tools, etc are also used to support virtual task delivery and collaboration to fit particular core needs. For instance GPS is particularly applied in tracking concrete delivery trucks, whilst the other tools are used to aid collaboration irrespective of time and location in value delivery efforts.

Top management created the right environment for the acceptance of the concept at the outset of the project, by emphasizing the important roles which every functional department had to play in this, as well as encouraging the active corporate involvement of both cross-functional staff and other key external partners. Top management also provided leadership via playing an active role in all key planning and implementation activities. For instance they demonstrated their proficiency in the use of the implemented ERP system to all relevant staff via accessing key information (in their domain) in real time which was previously not visible to others.

Observed Operational Changes

Observed changes from the previous traditional operational methods obtained through the use of the virtual model include the following:

- Real-time access to information and also improved collaboration between relevant staff and partners across its scattered construction project sites (which in particular periods may be about 60 in number).
- Innovative support for the production of concrete, a key product that is used in most construction activities. This is attained via the use of electronic communication across the various activities of concrete production (at the batching plant), transportation and delivery of the product to the final placing locations. The dispersed construction project sites daily communicate their demands electronically to the concrete production plant, then because of the integrated communication systems with the company's material suppliers (i.e. cement, aggregates and sand) these requests are then quickly fulfilled and paid for relative to consumption. Material storage is hence reduced, and this in turn provides associated cost savings. The company also uses GPS to coordinate and schedule the 'just-in-time' arrival of all trucks at the concrete batching plant, and also regularly track and evaluate the setting times of the concrete to optimally deliver the concrete at the destined locations for placing. It must be noted that the setting time of the concrete could affect the quality and hence the strength of the final constructed product.
- Electronic aggregation of clusters of material and other requisitions from all scattered construction projects sites, which provide the opportunity for lower costs via bulk purchases. Further, the electronic integration with all subcontractors and key

suppliers (e.g., fuel, etc.) across the value chain also enables easy generation of invoices and electronic payments which leads to savings in time, etc.
- Information capture to foster learning and hence the building of intangible capital for future potential construction projects.

Challenges

Problems faced within the case company in the leverage of the concept include occasional errors and computer bugs. Security issues are dealt with via use of firewalls and intrusion detection facilities. Further, there is the provision of 3 levels of security to aid detection and the tracking of any intrusions.

IMPACT OF E-COMMERCE, E-GOVERNMENT, AND/OR MOBILE COMMERCE ON THE ORGANIZATION

Observed Impacts in Value Delivery

The use of the ICT tools described above has enabled the company's staff and its partners to collaborate irrespective of time and location to improve on the efficiency and effectiveness in their task delivery. Thus improving on the company's value delivery processes relative to its previous traditional methods of operation. The impacts are particularly visible in the following:

- Improved visibility and certainty, as all relevant staff are able to see the company's activities in real time across the value chain.
- Reduction in the inventory of certain key materials (like cement, aggregates, etc.).
- Quicker fulfillment and payment for materials and other key inputs used on a daily basis (e.g., fuel, cement, etc.).
- Improved support for liquidity and other financial planning issues. Top management and all key staff are able to track in real time the status of invoices and any unpaid due amounts for certified work, and hence become aware in real time of any accountable units. This provides the opportunity to proactively avoid unnecessary delays in payments.
- Significant savings over previous traditional methods in terms of digital information storage, retrieval and dissemination via electronic value adding processes. This has for example saved the company the following in terms of storage space and associated costs:
    - Avoidance for the physical storage space for certain documents (drawings, pieces of paper, etc.). For small projects these documents are estimated to be about 8000; in large projects, this is between 35,000 to 50,000; whilst for particular very large projects this may be about 100,000.
- Relatively improved bidding rates and prices for competitive tendering for construction works, via leverage of key monetary savings and improved productivity in its operations. This in turn increases the chance of successful bids.

Discussion of Impacts

This case shows the potential benefits and positive impacts which could be obtained via the well orchestrated leverage of the virtual concept within the value delivery processes of a construction company. Whilst some of the benefits may be tangible like time savings, cost avoidance and savings, the intangible elements like visibility, certainty, convenience for all partners (could although be difficult to measure) have definite obvious benefits. One other important thing to note is the relative improvement in its competitive bidding capacity for works in the local construction industry where there is often fierce competition for works. On the other hand the problems faced like occasional errors and potential computer security issues prompt the important need to deal with potential risk management issues against complete systems breakdown via security breaches, etc. This could imply major negative impact for an activity like concrete production, transportation and placing with catastrophic related losses. Some of the identified benefits (improved efficiency, productivity, speed and better access to data) compare with certain research on IT use in construction in Canada (see, e.g., Rivard, 2000) and contrasts with Arif and Karam's (2001) survey study in South Africa which suggested the lack of conviction that the use of IT reduces costs.

CONCLUSION

This article presented an explorative descriptive case study on the leverage of virtual concept for value delivery in the operations of a construction company. The study demonstrates that the successful orchestrated leverage of this concept has definite potential benefits, since this has enabled the case company to attain tangible savings like time, cost, storage space and inventory reduction, and improved visibility across functional areas. One important issue is the potential ability of the company to leverage attained efficiency, savings, etc. to provide better competitive bid prices for the procurement of new works to increase the probability of successful bids in an industry where there is fierce competition for construction works.

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KEY TERMS

Concrete: Is an important construction product which is formed via the combination of aggregates (fine and coarse), binding material (like cement) and water.

Construction Project Sites: Refer to the physical geographic locations where construction works are done to produce the physical construction products.

Construction Tendering/Bidding: Involves the process of selecting suitable firms to execute any proposed construction project. Various criteria which includes the firm's bid price and its capabilities may be used for selection.

Enterprise Resource Planning (ERP) System: Is an information technology tool with capacity to integrate a firm's business functions or facets (like: planning, manufacturing, marketing, human resources, finance, procurement, etc).

Geographic Position System (GPS): Is a satellite based system with applications for determining locations, navigations, and monitoring the movement of people and objects including provision of accurate times and velocities.

Virtual Collaborative Design: Refers to two or more designers working together irrespective of time and place to deliver a common design product with the use of networked information and communication technology tools.

Virtual Realty Tools: Computer tools which aid the imitations of the real world's scenarios, places, etc which a person could experience or part-take.

Virtual Enterprise Organization

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INTRODUCTION

Competition among enterprises is changing. Initially competition was made between individual production systems. Now we are assisting to development of another kind of competition between production systems organized according to virtual enterprise (VE) concepts. This new focus is motivated by several aspects. The new global markets and the evolution of technologies and communications accomplished by the unpredictable consumer's attitude may be pointed out as the most relevant. Understanding social, economical, and technological changes, and taking advantage of them, is the path that will allow production systems to sustain their competitiveness. In this path, enterprises must make radical modifications, both inside their boundaries and also in their relations with partners and competitors. Coordination of participants in new forms of organization, such as virtual enterprises, global manufacturing, and logistics networks, and other company-to-company alliances, has become functionally and strategically important (Gunasekaran, Williams, McGaughey, 2005). The definition of each participant function in the organization and overall information exchange have become key components in their manufacturing strategies.

BACKGROUND

Opening countries' borders to external competitors, adding new international agreements between countries, and expanding industrialization processes to undeveloped countries are some of the aspects that have definitively contributed to the appearance of a worldwide economy concept (Alvi & Labib, 2001). New business opportunities are rising and become accessible as countries' internal economical protection borders are falling down. This economical globalization has increased competitiveness intensity and market uncertainty. It also has accelerated the decrease of product lifecycles (Kraemer, Gibbs, & Dedrick, 2002). In this new environment enterprises are allowed to access new technologies and new talents (Atkinson & Coduri, 2002).

Globalization will create new business opportunities, but also introduce worldwide competition. Information and communication technologies (ICTs) are considered one of the most relevant support factors to the latest world changes. In fact, they are an enabler of, and also enabled by, globalization (Kraemer et al., 2002). In a world that desperately claims for innovation, information and communication technologies are nowadays essential to catalyze and speed changes archived in managers' minds (Boyson, Corsi, Dresner, & Harrington, 1999). The ongoing evolutionary process of those technologies will affect enterprises in two different ways. First, considering a more proactive perspective, entrepreneur enterprises may take advantage of information and communication technologies to make an evolutionary jump in new collaborations, new partnership direction, and achieving new business and markets.

Another point of view reveals that enterprises must incorporate information and communication technologies as one of their strategic and operational components (Moodley, 2003).

This technological revolution also has a deep influence on the globalization process, supplying new tools that allow the capture of new global market opportunities. Using these new tools, enterprises became more agile and capable of dealing with changes in a more sensible way. The adoption of ICTs allows enterprises to stimulate a worldwide consumer appetite (Fraser & Oppenheim, 1997). In a global manufacturing environment, ICTs play a dominant role, as they allow the integration of production systems physically worldwide distributed (Gunasekaran, 1999).

One possible way to cope with these new organizational needs is the *virtual enterprise* paradigm (Wu & Su, 2004). A virtual enterprise is a temporary partnership of independent companies and/or individuals—suppliers of specific goods and services, customers—who are linked through modern telecommunications to exploit and profit from rapidly changing business opportunities. In a virtual enterprise, companies can share costs, skills, knowledge and access to specialized expertise, and access to regional and global markets, with each partner supplying what it can do best—whether a product or a service (VEA, 2002).

The virtual enterprise concept is in its youth and growing. In literature it is not possible to find yet a consensual and rigorous definition for all the concepts that surround it (Camarinha-Matos, Afsarmanesh, Garita, & Lima, 1998). More commonly found was the general term *virtual enterprise* and the concept of *extended enterprise*. At times it is possible to ease any confusion, to some degree, by looking at the utilization of each (Rolstadas, 1997). The virtual enterprise concept has a wider scope than extended enterprise and includes it in its meaning (Jagdev & Browne 1998; Camarinha-Matos & Afsarmanesh 1999). We may also be confronted with opinions that consider extended enterprise as the dominant expression. In a virtual enterprise the integration level is bigger and, comparatively to extended enterprise, the partnership agreements are shorter in time (Jagdev & Browne 1998).

In literature it is also possible to find a complete structure that allows developing virtual companies from virtual networks (Franke & Hickmann 1999). The virtual network concept is seen as the organizational part, with long-term duration and without time limit. This means that the set of enterprises that belong to that net are stable. Based on business opportunities, virtual companies are building up from that set of enterprises where the most adequate partners are selected. Virtual companies are dissolved when they have reached their purpose.

The idea behind the virtual organization concept looks to the virtual as being a dimensional organization and not as a distinguished factor (Steil, Barcia, & Pacheco, 1999). Virtual is used to describe an organizational logic especially relevant when geographical space, time limits, organizational units, and information access are relegated to a second level. This type of organization is based on the substitution of the traditional organizational structure by ICTs, seen as essential conditions of a non-institutionalized structure with time-limited cooperation (Sandhof, 1999). The cooperation time may be reduced to the fulfillment of a unique contract. In this sense, the subcontracting concept is being used to new limits (Golder & Brockie, 2001).

Virtual corporations (Davidow & Malone, 1993; Franke & Hickmann, 1999), variable production networks (Wiendahl & Helms, 1997), multi-site production facilities (Roux, Dauzere-Peres, & Lasserre, 1999; Zhou & Besant, 2001), virtual production networks (Tuma, 1998), logistic networks (Schonsleben, 2000), supply chain management, electronic commerce, cross-border enterprises, networks of enterprises (Camarinha-Matos et al., 1998), and virtual manufacturing systems (Davidrajuh & Deng, 2000) are other designations given to the same concept.

Concerning its lifecycle, a traditional enterprise may be seen as a stable organization that searches or creates business opportunities. A virtual enterprise formation is based on a business opportunity that may be seen as the virtual enterprise heart (Van-Schoubroeck, Cousy, Droshout, & Windey, 2001). By definition, a virtual enterprise will exist until the moment that the business opportunity will no longer be profitable. The time from the moment of virtual enterprise first steps formation until its dissolution is known as the virtual enterprise lifecycle (Goranson, 1999). Inside this lifecycle we find several concepts, including formation, reconfiguration or evolution, activity or operation, and dissolution or termination. Depending on the authors, the number of virtual enterprise lifecycle phases may change (Spinosa, Rabelo, & Klen, 1998; Strader, Lin, & Shaw, 1998; Goranson, 1999; Kanet, Faissat, & Mertens, 1999; Rocha & Oliveira, 1999; Biondi, Bonfatt, & Monari, 2000; Davidrajuh & Deng, 2000; Eschenbacher, Knuck, & Weiser, 2001; Katzy & Dissel, 2001; Van-Schoubroeck et al., 2001)

AUTONOMOUS PRODUCTION SYSTEM (APS) CONCEPT

Companies are traditionally organized in a hierarchical structure where the communication is established from top management to bottom levels and from bottom levels to top management through several levels of responsibility. In this type of organization, each department can only communicate with the outside world through the top management channel (Figure 1, top left).

In this work we assume that VEs based on the autonomous production system (APS) concept will increase their agility in coping with market needs (Carvalho, Moreira, & Pires, 2005). Thus, a company, instead of being organized as the traditional hierarchy of departments and sections, should become a network of APS, in a way that the relationships between its APS should be based on a partner-to-partner relationship (see Figure 1). In this way each APS could cooperate equally with an APS of another company for a particular business opportunity, as well as with an APS of the same company. An APS can be considered the smallest part of a company that, if divided, looses its autonomy. We will not concentrate on how APSs are generated. We will assume that they exist and virtual enterprises are APS based (Figure 1, top right). The big difference here is that VEs made from traditional enterprises use all the enterprise structure and APS-based VEs use only the needed APS (see Figure 2).

Figure 1. From enterprise traditional organization to APS-based virtual enterprise

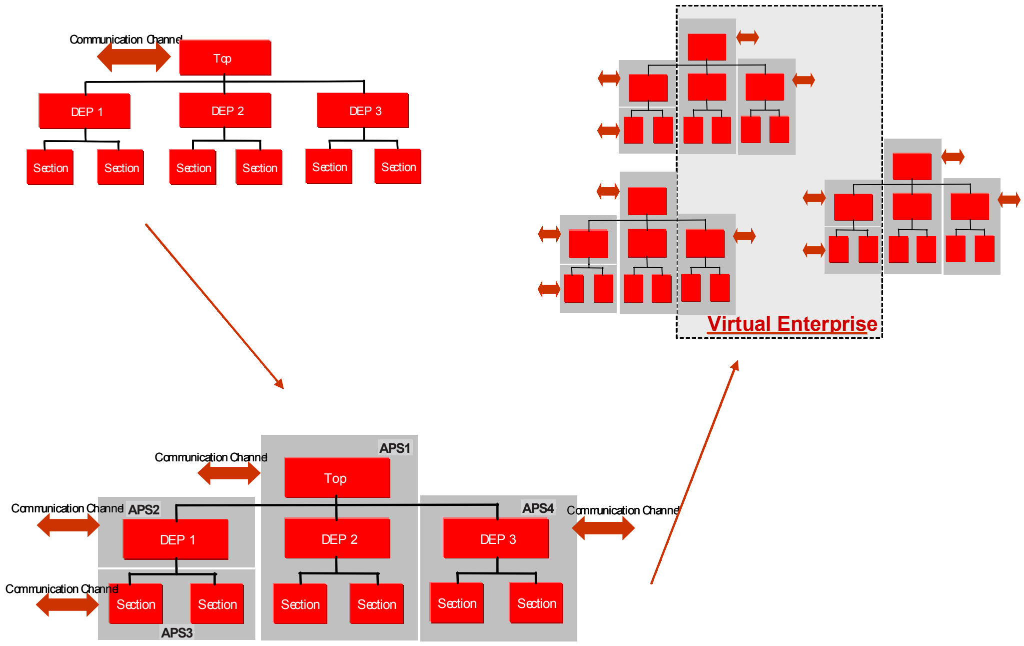
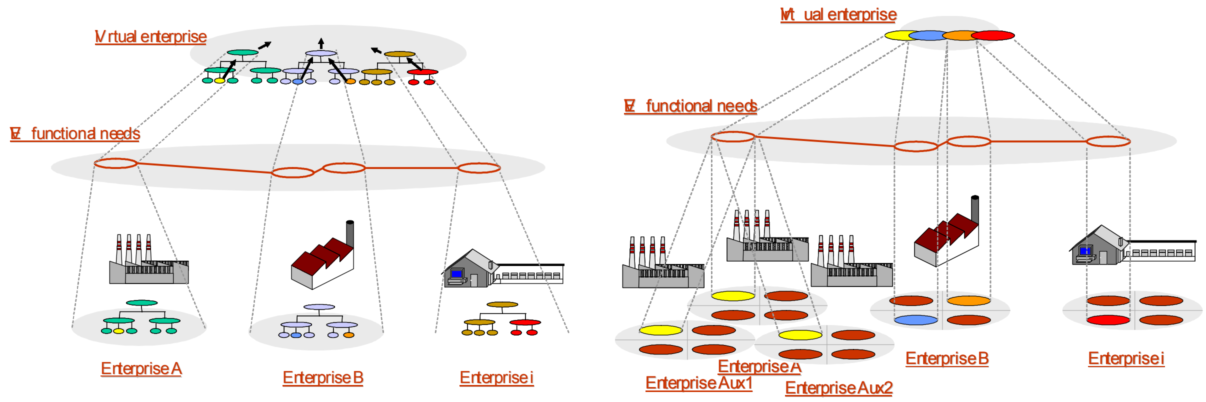


Figure 2. Virtual enterprise made from traditional enterprises and APS-based VEs



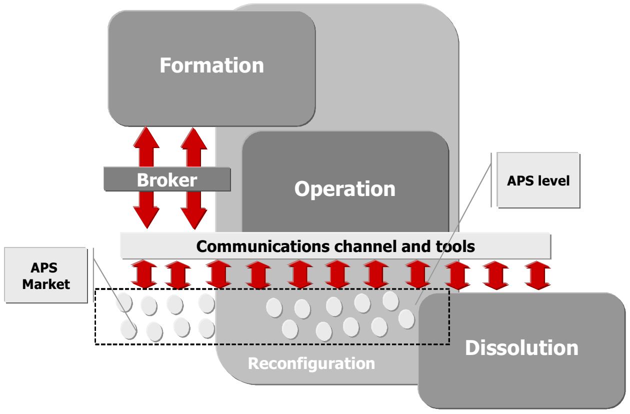
PROPOSED ARCHITECTURE AND FUNCTIONALITY

Some of the problems concerning virtual enterprises are directly connected with the knowledge of how to start up a virtual enterprise, how to find adequate partners to integrate it, how to proceed to manage them, if one can trust them, and who shares the risks, just to name a few.

Keeping in mind these new challenges that enterprises must pass through real integration, we propose a new reference architecture to allow an easier and faster integration, operation, and dissolution of virtual enterprise processes. This set of activities is shown in Figure 3, which represents the main activities of a virtual enterprise lifecycle.

Inside the scope of this work, the virtual enterprise formation is clearly initiated by the appearance of a specific set of conditions at a specific moment in time which we name business opportunity (BO). When a business opportunity is advised, it is necessary to start a rough strategic plan to transform the BO into a concrete business activity. This rough plan must answer ques-

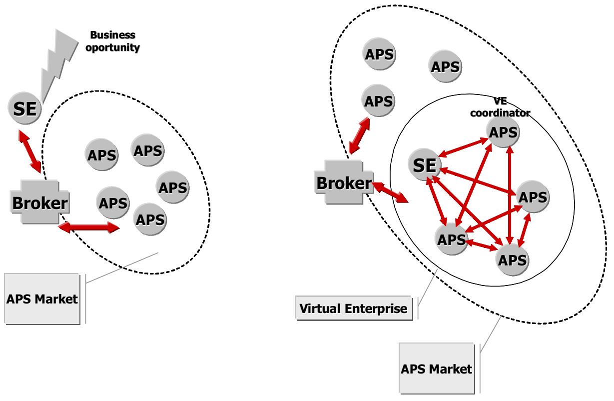
Figure 3. Virtual enterprise lifecycle activities



tions such as: Which tasks must be done to concretize the BO? Which resources and when will be necessary? Who may provide these resources, and how do we manage them? The proposed model intends to answer these questions, providing a set of entities and a functional structure that will aid in making the BO concrete.

The entity that detects the business opportunity, and that will be responsible for conducting the operations that will result in VE formation, is named *starter entity* (SE) (see Figure 4). In our opinion, this SE must have enough knowledge to make a rough process plan. Using this process plan, tasks to find partners to be assigned for necessary activities will be started. It is then necessary to know where to find resources that fulfill the activities specifications. These resources must obey a set of specific conditions, both technical and social. In this work, partners are APSs, and they exist in the APS market (APSM). This APSM is a functional structure where

Figure 4. Entities and structures that participate in VE formation



certified APSs are organized by their core competences. In APSM also exists accurate information concerning APS historic performance, VE experience, integrity, and so forth. Standard operational rules, standard procedures for APS integration in VEs, standard contracts to integrate VEs, and a set of tools to operate in the APSM are also available.

All the operations related to the APSM will be conducted by a certified entity that we call *broker* (see Figure 4). The broker is the APSM operator. Its main function is assisting the SE to find the APS to integrate the VE.

Partners' search activity is based on specifications collected from business opportunity analysis and specification. The search result may lead the broker to many different alternatives for the virtual enterprise configuration. This will be an iterative process until a set of APSs will be selected. All the information produced in these two activities will be worked in VE project activity (see Figure 5).

This activity is performed by: (1) partners' selection activity, (2) product and process specification re-analysis, (3) organizational definition and VE formalization, and (4) BOOM generation. Considering the global model, from the VE project will result a set of important entities and functional information (see Figure 6). The outputs of the VE project will be the base of all VE functionality. One important entity produced by the VE project is the *administration board* (AB). This entity is settled by delegates of each APS or APS set, and its function is administrating the VE. Some of its functions are formalizing standard contracts; defining VE strategy; dispensing, substituting, or incorporating the APS; maintaining legal responsibility; and providing other administrative needs. The VE manager or coordinator is another structural entity that results from the VE project. It is an APS partner whose function is to run the VE, based on the strategy defined in the AB.

Another important structure produced by the VE project activity is the Bill of Materials and Movements (BOMM). This is a nuclear structure of this VE lifecycle model functionality. It contains traditional bill of materials information, plus information about movement needs between each APSs; the assignment of each SPA to each production, purchase, movement, or manufacturing task; and information about the relative moment that a specific task must be executed. During the VE lifecycle, the BOMM may need changes according to product structure modifications, as well as changes occurring in the VE configuration. Reconfiguration tasks may originate from changes in demand. The ability of a VE being quickly redesigned as changes in demand occur is the main advantage of such organization. Consequently, the existence of a structure that immediately reproduces any VE structural modification is critical to deal with all dynamics that characterize the VE environment. It is necessary to have a structure or

Figure 5. VE formation activities in Idef0 format

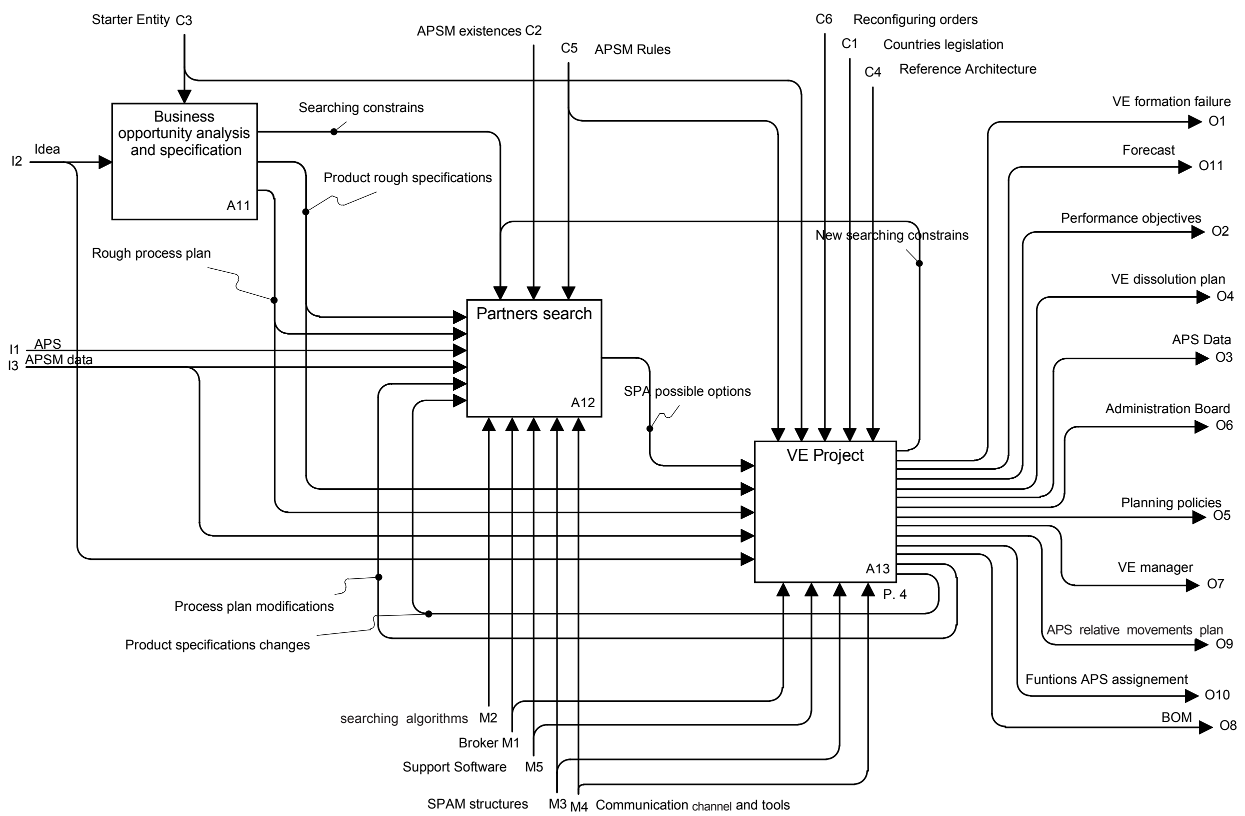


Figure 6. VE project in Idef0 format

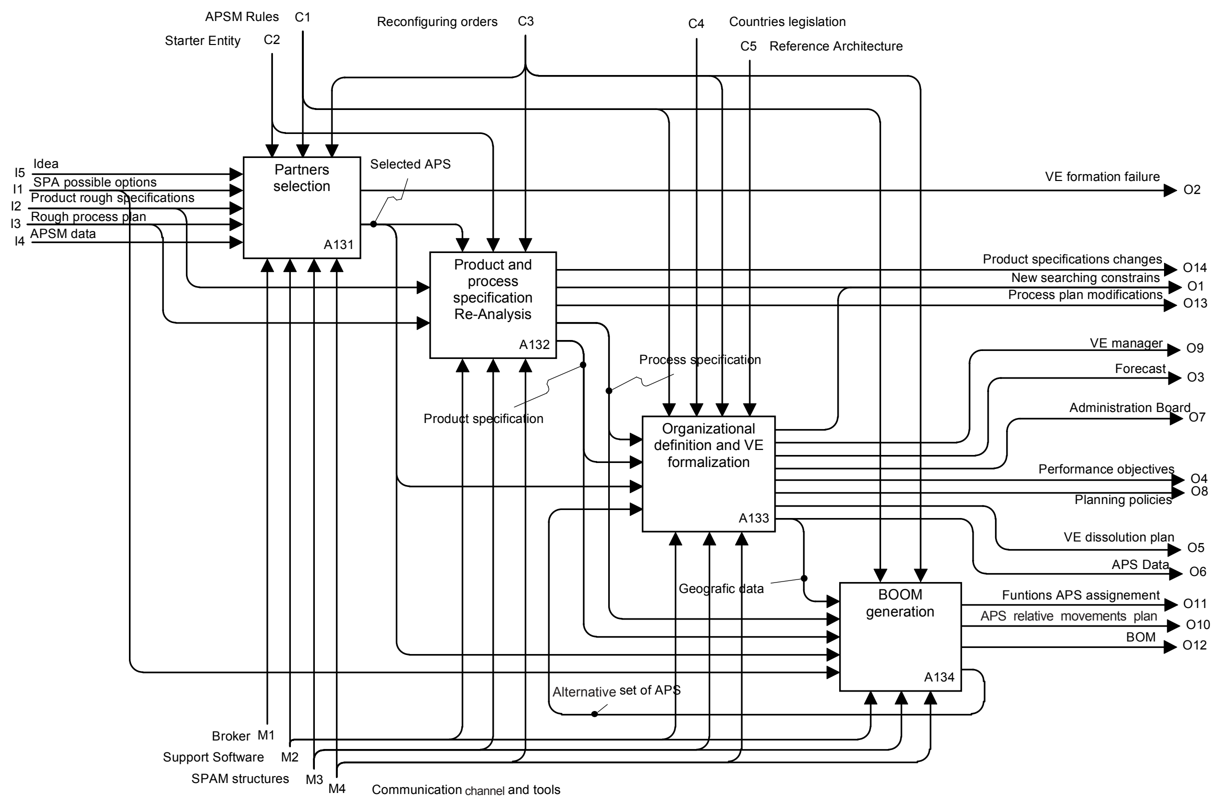
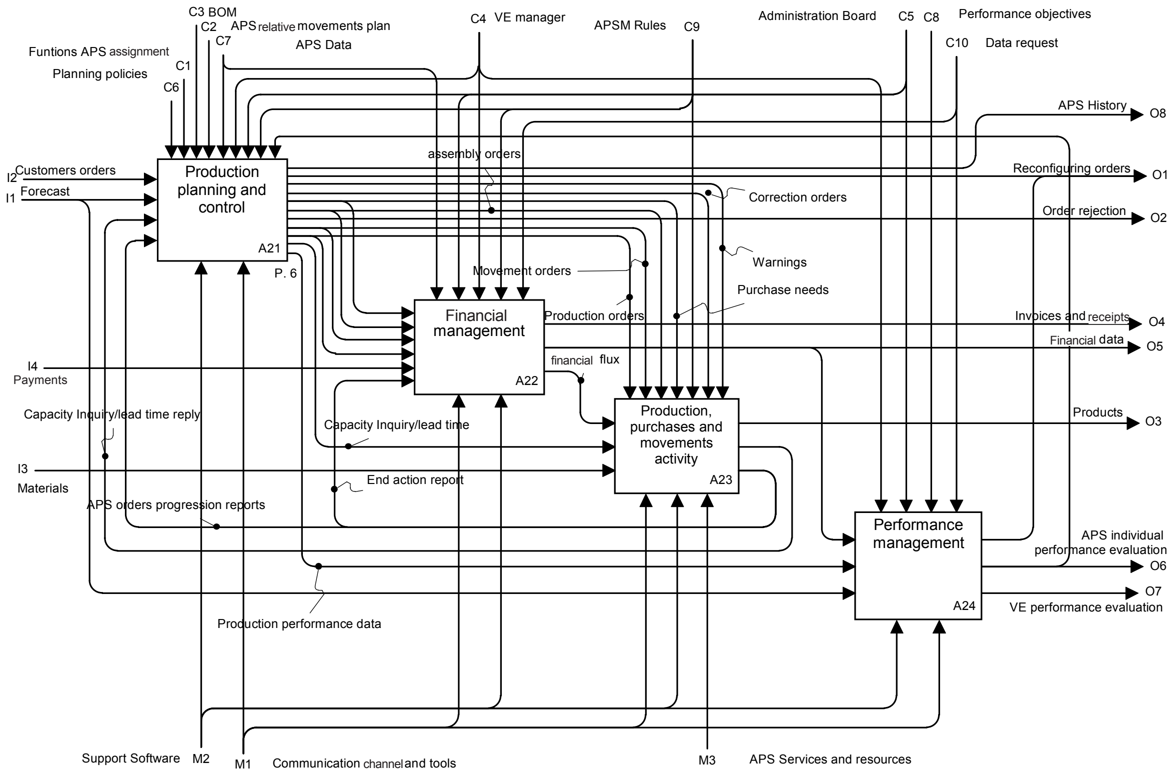


Figure 7. VE operation in Idef0 format



mechanism that relates the APS network production with the customer order or VE internal order at each moment. This aspect is often more important, considering the VE structure will change during VE operation. At the limit, it will change according to each customer order or VE internal order.

Virtual enterprise operation objectives are naturally similar to those of traditional enterprises. From the moment that the client order is placed, the VE has the responsibility to start internal procedures to satisfy the client order specifications. For us VE operation is performed in four main sub-activities (see Figure 7).

Production Planning and Control

This task will be responsible to perform high levels of coordination between all virtual enterprise partners. To do so it will use reengineered production and control tasks, adapted to this new environment.

Production planning and control activity in this model will be responsible to manage APS activity. Thus, production planning and control tasks will be implemented by the following activities: (1) master production scheduling will be performed similarly to those made in traditional enterprises, transforming customers' orders in a feasible master production schedule. These actions are supported in resources (APS) available capacity. If the orders are feasible for the available capacity, the system generates plans for production and movement orders through the (2) materials and movements detailed planning module. Between all those tasks are conditional plans that will check its feasibility until all tasks may be adequately done. PPC activity also includes the (3) production control and VE reconfiguration module and (4) production monitoring module (see Figure 8).

Other tasks that comprise VE operation are *financial management,* similar to those made in traditional enterprises; *production, purchasing, and movements;* and *performance management.*

Finally we have the dissolution phase of the VE lifecycle. Here we are not only concerned with VE dissolution. During the entire VE lifecycle, activities which will sustain the process of entrance and dispense of SPAs will be performed. VE dissolution will receive information from formation and operation phases. The dissolution phase will be sustained in four main sub-activities (see Figure 9):

1. **Continuous Viability Analysis:** Responsible for checking VE viability at all moments.
2. **Normal or Unfriendly Dissolution Process:** Used when VE is dissolved or when individual APS leave the VE. This process may be performed in two

Figure 8. VE operation activities in Idef0 format

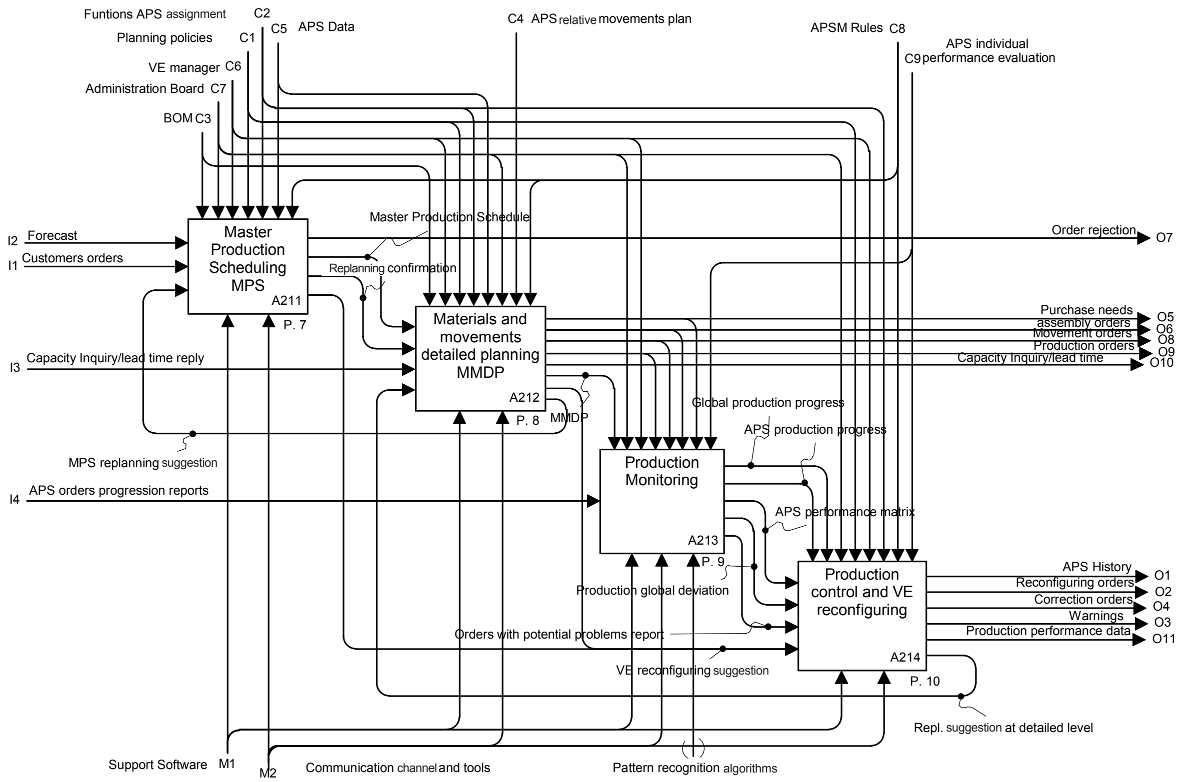
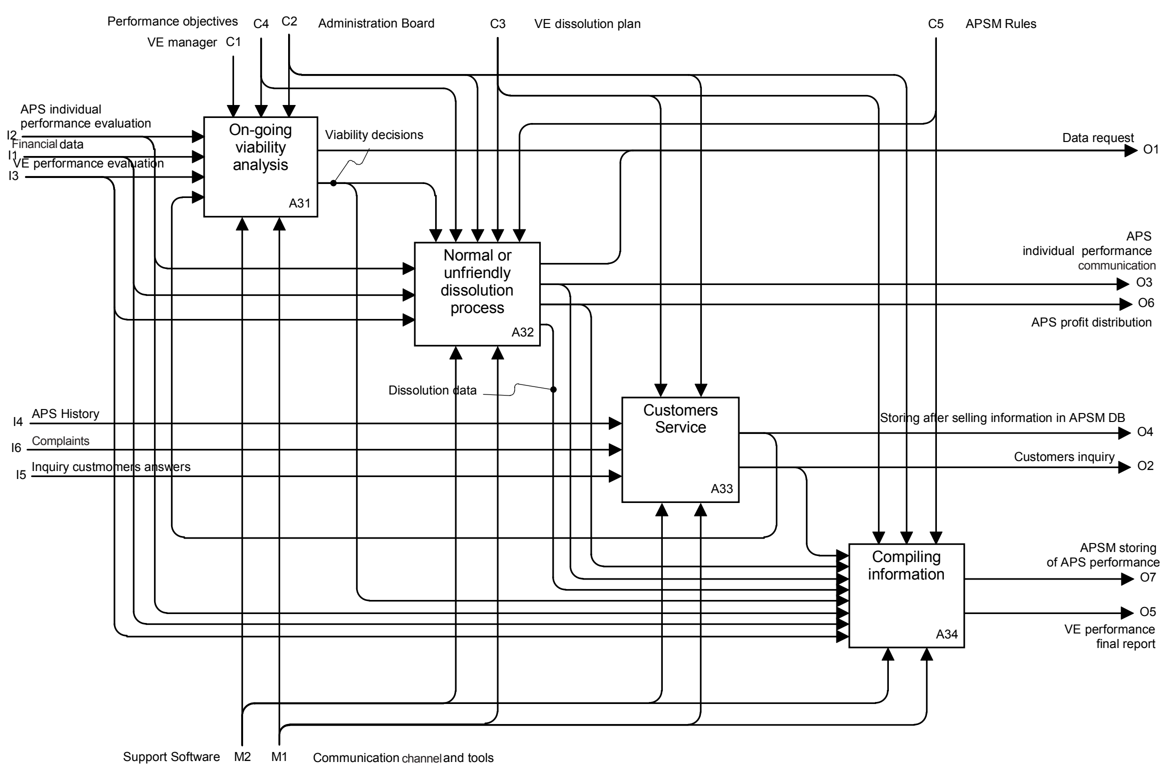


Figure 9. VE dissolution in Idef0 format



different ways: normal, according to the dissolution plan established in formation phase, or unfriendly.

3. **Customer Service:** Forms the bridge with costumers and is responsible for understanding the level of "product acceptance after sell" information. This will be important in questions concerning warranties and other after selling problems.
4. **Compiling Information Activity:** A functional activity that prepares all the information about this particular VE to store in databases of APSM.

FUTURE TRENDS

The rules are changing. A quick market evolution based on the introduction of new information technologies allows the appearance of new production systems characterized by a high level of automation and flexibility. It may also contribute to an increase in the competitive capacity of enterprises that decide to adopt it. Nevertheless, adopting this paradigm brings not only benefits or advantages; there are some limitations that enterprises must be aware of. The most relevant disadvantages relate to personal relationships, friendships, confidence, and legislation (Carvalho, Moreira, & Pires, 2003), as well the commercial level. Characteristics such as dynamics, great flexibility, agility, and responsiveness—near to the virtual enterprise concept—are potential problem sources (Martinez, Fouletier, Park, & Favrel, 2001). On the commercial level, the virtual enterprise must find the "commercial entry point" (Martinez et al., 2001). Virtual enterprises must work harder to convince the market of their product quality.

There are several subjects that virtual enterprises must cross to work properly, for instance questions concerning the guarantee and "after-selling assistance" problem. Virtual enterprises must have mechanisms that assure assistance even after their dissolution. In consulted literature we were not able to find a solution to this question. Virtual enterprises must also deal with the juridical problem. Countries (a large majority) have not yet adapted their laws to cope with the true meaning of virtual enterprise. Another important issue concerns the problem of confidence among virtual enterprise partners. This will be critical for the VE's success or failure (Chiles & McMackin, 1996; van der Meer-Kooistra, & Vosselman, 2000; Ishaya & Macaulay, 1999; Brutsch 1998).

CONCLUSION

We have presented the main guidelines to the formation of a VE under the APS concept, as well as a production planning and control model for the operation of a VE. Activities of VE dissolution are also depicted in the article. The proposed model does not intend to cover all VE types. It is designed only for VEs that produce low quantities of high-variety products during reasonable periods of time. We hope that the proposed model will also contribute to increase trust levels of potential VE partners.

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KEY TERMS

APS-Based Virtual Enterprise: A net of distributed APSs with those same objectives of *traditional* virtual enterprises, but with higher flexibility managing partners' core competences domain.

Autonomous Production System: Part of a company directly exposed to the market which is able to become part of a virtual enterprise when an adequate business opportunity arises.

Bill of Materials and Movements: Includes in a traditional bill of materials the necessary movement of materials between virtual enterprise members.

Broker: Generically, a certified entity authorized to link two different layers.

Business Opportunity: Perfect time interval to efficiently match a specific market need to a core competence and available capacity.

E-Commerce: Means selling items over the World Wide Web. Consequently, enterprises must incorporate new technology information and communication means.

Virtual Enterprise: A temporary network of independent enterprises or enterprise units, connected by new communication and information technology, to share technical competences, costs, and risks accessing thus to new markets, answering to a specific business opportunity.

Virtual Enterprises' Accounting Difficulties

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INTRODUCTION

The growth and expansion of enterprises into foreign markets presuppose the aggregation of financial information that includes non homogeneous elements. The purpose of this article is to present several accounting difficulties deriving from the establishment of virtual enterprises and consequently, to set some relevant management and cultural aspects. Emphasis is, also, given to the analysis of the accounting recognition and measurement difficulties deriving from recording accounting information in a virtual enterprise. In conclusion, although there are accounting, as well as, auditing problems of defined, measured and disclosed in a such a type of business, its importance will increase as the capital market grows.

BACKGROUND

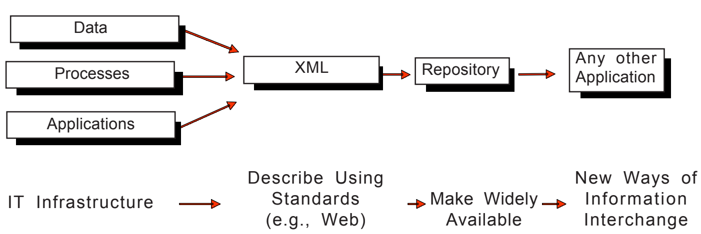
The development of technologies that can efficiently handle information, combined with the expansion of Internet for business process integration, will have a considerable impact on the worldwide market place. This information technology evolution will lead to the creation of a new economic paradigm, the virtual enterprise, where sets of economic actors are combined to provide a service by a single enterprise. Virtual enterprises have very limited resources of their own, but can achieve substantial outcomes using accessible resources of independent partners that become interdependent in achieving the virtual enterprise goals in their common interest. (Beckett, 2003).

One of the main research and development themes is the problem of the virtual enterprise integration, which means the task of improving the performance of the whole organization by managing the interactions among the participants. Its main objective is to improve teamwork and coordination across organizational boundaries (Zarli & Poyet, 1999) by increasing the effectiveness of the virtual enterprise as a whole (Figure 1).

Integration of an enterprise consists of putting components together to form a synergistic whole that transcends traditional external and internal corporate boundaries. Enterprise internetworking uses electronic network to form close ties with suppliers, distributors and customers (Ho, 1997). Problem solving and decision making are conducted by flexible teams cutting across the individual enterprises and distributed over time and space. It is a combination of horizontal integration for a better control of material and information flow and a vertical integration for efficient control of the decision flow.

An integrated virtual enterprise should, also, be able to overcome the changes in the internal or external envi-

Figure 1. Integration process



ronment and enable all the components to contribute to the overall objective in a coordinated way. The enterprise must react to the changes and accordingly adapt its operations.

In selecting the partners for a business opportunity in a virtual enterprise, there are many factors to be taken into consideration. These factors include cost, quality, trust, credit, delivery time, and reliability. (Wu & Su, 2005). The design and management of an efficient and flexible virtual enterprise is a very complex task. It involves different approaches regarding technology, management and cultural elements. High quality business process in an integrated business chain requires properly designed operations. Moreover, it is necessary to use methodologies, reference models, information infrastructures and computer enterprise engineering tools that help in the coordination of different objectives during the virtual enterprise design and management.

An important issue to consider is accounting services of the virtual enterprise specifically when the enterprise spans the boundaries of a country including partners from different continents with very dissimilar accounting standards.

ACCOUNTING ISSUES IN VARIOUS VIRTUAL ENTERPRISES ORGANIZATIONAL MODELS

Virtual enterprises refer to enterprises that consist of groups of people working together on an undertaking, regardless of their physical location, across enterprises and countries (Bobek, Potocan, Sternad, & Spicka, 2002), in real time (synchronously) or deferred time (un-synchronously). A virtual enterprise is a temporary organization of companies that come together to share common costs and skills to address business opportunities that they could not undertake individually. (Gou, Huang, Liu, & Li, 2003). Their existence will challenge large traditional corporations by being able to set up and offer a wider scale of innovative services with less capital in less time and with considerably less financial risk. Aside from competitive advantages, this new organizational model could, also, have other social side effects like, less office space, increased staff productivity and differently balanced work and employees' family life.

Although the idea of virtual enterprises is still in its infancy and every virtual enterprise works under its own agreements between the partners, the virtual enterprise organizational models can be categorized in three types: The supply chain, the hub and spoke (or more commonly referred to as the star), and the peer-to-peer models.

Concerning accounting, the valuation of expenses and revenues for reporting purposes depends upon the reporting objectives and concepts applied. In this case, if the objective is to measure and report the individual assets of the firm for each period, the only alternative is to measure the value of the firm as a whole and subtract from this value the valuation of other specific net assets (Tahinakis, Protogeros, & Ginoglou, 2004). However, if the objective is to measure and report specific assets, in order to provide the users of the financial statements with an indication of the resources available to the firm, an independent measurement of the intangibles might be desirable.

Peer-to-peer topologies and star topologies seem to be the most prevalent for virtual organizations, while supply chain topologies might not require special relationships between companies. The main virtual enterprises categories are:

Static Virtual Enterprises

In static virtual enterprises (SVE), a set of business partners are linked together in a static and fixed way, for example, the shared business processes are tightly integrated (Caraminha-Matos & Afsarmanesh, 1999). The business relationships and the process interfaces are predefined, tightly coupled, fixed, well integrated and customized among partners. The network is fixed and predetermined and thus the structure of the virtual enterprise is static and predetermined as well. Based on the distribution and management style of the network, two types of static virtual enterprises can be identified, namely centralized and decentralized.

The accounting difficulty is connected with the expenses that become a particularly important part for the enterprise. In this case, accounting for the costs requires careful analysis of the department activities. Usually, enterprises undertake costs in the hope of future gains, rather than only present benefits. The knowledge gained is either an asset of the firm or an increase in the value of the existing assets. The return on capital employed will only give a true measure of the company's profitability, if the deferred development expenditure is included in the capital employed (Garrison & Noreen, 2002).

Centralized Static Virtual Enterprises

In centralized static virtual enterprises (CSVE), a dominant business domain (also called business integrator) coordinates the business relationships among network members (Caraminha-Matos & Afsarmanesh, 1999). It enforces the technical interfaces for application integration among partners, integrates the process of the partners by creating shared processes and manages the underlying technical infrastructure and it creates shared business processes for partners in a static and centralized way. Partners and central organization form long-term relationships and focus on investment returns over the lifetime of that relationship. Also, the establishment of the virtual enterprises is performed manually in a customized way and under the full control of the dominant organization. The required integration, development and re-engineering costs are high for all members.

The accounting difficulty connected with the disclosure which should provide adequate information to users of financial statements. In this case the disclosure requirements are intended to improve the financial reporting of business combinations (Wechsler & Wandycz, 1990). This can be achieved by enabling users of financial statements to gain a better appreciation of the business acquired of the extent to which the results of the combined entity are attributable to trading performance.

Decentralized Static Virtual Enterprises

In decentralized static virtual enterprises (DSVE) different business partners are linked together in a rather autonomous and decentralized way (Vesterager, Larsen, & Gobbi, 1999). This type of network is similar to the previous one, except that there is no central, dominant, management organization and each member of the network may cooperate with many other domains. None of the partners has full control over the network and the underlying infrastructure, the integration of which among the business processes of the members is performed in a joint, coordinated and incremental way. Partners with long-term business relationships gain investment returns during the life cycle of those relationships. Moreover, the establishment of the virtual enterprise is performed manually and in a customized way addressing the specific technical requirements of the partners (Karcher, Knarr, & Jungkunz, 2002). The development and integration costs are rather high, while the evolution of the network is difficult.

Every partner plays a role in the virtual enterprise and contributes primarily with their own core competencies, like business processes and resources. In a high tech manufacturing company a member of a virtual enterprise can work on the production of new products, as well as on the distribution of products to different re-sellers.

The accounting difficulty connected with an obligation arises from a contract where the amount and time of payment of the obligation are specified or determinable from the conditions of the contract. Thus, an obligation should be classified as a liability if it can be reasonably measured or if a meaningful range of values or probabilities can be assigned to it. Liabilities can not be included in the balance sheet as separate items unless they can be quantified (Anthony, Reece, & Hertenstein, 1995). However, an inability to quantify an obligation does not imply that it is not a liability in this can it must be disclosed by footnote rather than by listing among the liabilities in the balance sheet.

Dynamic Virtual Enterprises

In dynamic virtual enterprises (CSVE) a set of business partners are linked dynamically on demand and according to customer requirements through the development of a virtual marketplace. The business domains do not have fixed business relationships and thus the virtual enterprise is not static and might continuously change based on market-driven criteria. The virtual marketplace provides services for the registration of partner processes based on certain generic and globally specified process templates. Business domains wishing to form virtual enterprise relationships can register in the marketplace related to certain process templates. Whenever a business domain wants to use a particular process, it searches the marketplace and locates all the potential partners that can provide the service (Katzy & Schuh, 1998). As soon as the list of virtual enterprise candidate partners for one particular process has been found, the selection process begins. The selection process between the domains is usually performed through negotiation. This process might be either manual or automated, while the result is usually a short-term contract that regulates the business relationship among the involved domains. In the development of virtual marketplaces there are no explicit static business relationships among partners and thus no integration is required among the processes of the partners.

The accounting difficulty derives from the treatment of interdivisional transfer pricing. In this case, the final service (product) of one department can be the raw material of another within the same enterprise, so that if transfers are made in excess of cost income will appear at the time of the transfer rather when the final service (product) is sold to the customers. The internal prices affect the reported revenues of the selling segments and reported costs of the purchasing segments. Two broad categories of transfer prices exist, the market and cost based. In general, it is considered that the market based transfer price system is more appropriate because the divisions do business with each other, as well as, in the open market and divisional managers are supposed to react to internal prices as they would react to external market prices (Hendriksen & Van Breda, 1992).

Marketplaces

Marketplaces are usually globally organized specifying services or product templates that can be offered by different vendors (Tarabanis, Protogeros, Walsh, & Koumpis, 2001). The marketplace is a matchmaking mechanism that brings potential process providers together with potential users of these processes. Although marketplaces and matchmaking mechanisms, they have been used for some time for business-to-consumer (B2C) electronic commerce purposes and have not been actually deployed for dynamic virtual enterprise purposes. (Perrin & Godart, 2004). The main reason was the lack of technologies that enable the easy and flexible definitions of process templates, mechanisms for automated negotiation and autonomous interaction among different domains. Due to the advent of eXtensible Markup Language (XML) (W3C) and its ultimate acceptance as Internet, meta-language concepts like virtual marketplaces have started to appear. Furthermore, Web services based on XML is a promising technology that permits the description of business processes in a standard way.

The accounting difficulty connected with the reporting on segments of a business and the decision regarding how logical breakdown should be made for reporting purposes. The main function of segmental reporting is to provide financial information, among others, to investors or potential investors about segments of a business connected with its profitability, risk and growth mainly in order to give them a better understanding of an enterprise's past performance and thus a better idea of its future prospects (Boyle, 1990).

ACCOUNTING RECOGNITION AND MEASUREMENT DIFFICULTIES

Most of the technologies developed today are in their infancy and still under development, requiring considerable effort for the implementation and configuration of comprehensive virtual enterprises support infrastructures. In fact, even the most advanced infrastructures deriving from leading research and development projects still require complex configuration and customisation processes, which are hardly manageable by small and medium enterprises (SMEs).

From the existing literature on the accounting treatment of expenses, it is clear that there are three opposing views as to how expenses should be treated in the balance sheet, as well as, in the profit and loss accounts. However, once a company has selected the appropriate method, it should apply it consistently.

The inherent difficulty in the capitalising and amortising method lies in the high degree of uncertainty associated with the expenses. At the beginning, the management would be required to identify the expected revenue-benefit to be generated and the expected duration. Thus, only when the product is successful should its associated costs be capitalized and amortized through the income statement, by matching the expense with the revenue (Welsch, Zlatkovich, & White, 1972).

An alternative to full capitalization and amortisation is the case of capitalising only costs that relate to specific projects with expected net revenue contribution streams. Under this method all direct and indirect costs are charged and allocated among the specific projects according to the absorption basis. The costs of projects not producing useful results should be charged, according to *accrual concept*, against revenues of the accounting period, in which the uselessness is determined (Lewis & Pendrill, 1995). Costs of successful projects should be capitalised and amortised over the future periods benefited. Thus, these special projects are treated like investments in plant and equipment and the amortisation is similar to the depreciation concepts.

Another treatment is that, all costs should be charged to expense when incurred due to the uncertainty of future benefits, lack of causal relationship between expenditures and benefits. It is, also, based on the lack of interpretation of the assets, on grounds that it does not reflect the value of specific future benefits. If those benefits do exist, their value is not measurable. An immediate write-off may result in lower net earnings, return on capital employed and share price and thus, it renders a company weaker to the threat of a hostile takeover bid. In addition, managers are very concerned with earnings per share and they assume that these numbers are used in the investment decision process (Warren, Reeve, & Fess, 2003).

The choice of an appropriate accounting treatment for expenditure focuses on the application of fundamental accounting concepts. More specifically, the *accrual concept* means all revenues and costs that are accrued and matched within the same economic year. The *prudence concept* by which revenue and profits are not anticipated but recognized only when realized in the form either of cash or of other assets, the ultimate cash realization of which can be established with reasonable certainty. It is an inference of the *prudence concept* that expenditure should be written off in the period in which it arises, unless its relationship to the revenue of the future period can be assessed with reasonable certainty (Schiff, 1974).

Finally, one indirect difficulty is connected with the auditors' responsibility which is to obtain sufficient materials in order to assess the credibility of the financial statements presented by the management. In this regard, there are audit problems including the problem of materiality and the application of materiality criterion in the audit of the financial information disclosed for each asset, especially, the use of market base and the allocation of common cost. The auditors' task is, therefore, difficult because there is no clear guideline by which they are able to evaluate the management decisions.

FUTURE TRENDS

The present article is subjected to a large number of limitations deriving from the fact that realism in experimental research is difficult to be achieved, since the idea of virtual enterprise is still in its infancy. The inclusion, exclusion or replacement of factors could easily lead to significantly different conclusions and results. However, further research studies should be useful to this area. It would be interesting, and also useful, to examine the quality controls and interpersonal factors. More research is, also, needed into the area of impartial and adequate distribution of tasks and protection of proprietary know-how of each industrial partner, as well as, company independence.

CONCLUSION

Virtual enterprises can be considered as a new alternative of organizational form supported by information technologies using and adding to the variety of organizational instruments. The general trade-off flexibility and production efficiency becomes stronger through the use of information technologies and the emergence of new organizational forms. The main goal lies in the description of the modern technologies that enable the integration of virtual enterprises.

An outcome of this study is that there are accounting problems of defined, measured and disclosed accounting information, deriving from a virtual enterprise to users of financial statements. However, the expansion of virtual enterprises together with the extensive use of new information technology will not only enhance the quality of the services offered to customers but will, also, lead to higher benefits and greater economic resources for the government. Despite any difficulties, the importance of such types of business will increase, as the capital market grows and there is a constant need to supply reliable accounting information.

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KEY TERMS

Accrual: Concept means all revenues and costs that are accrued and matched within the same economic year.

Assets: Can be characterized as these having physical or non physical existence and their value being dependent on the rights that possession confers upon the owner.

Centralized Static Virtual Enterprises: Refers to a dominant business domain (also called business integrator) coordinates the business relationships among network members.

Dynamic Virtual Enterprises: A set of business partners are linked dynamically on demand and according to customer requirements through the development of a virtual marketplace.

Liabilities: Can be defined as probable future sacrifices of economic benefits arising from present obligations of a particular business to transfer assets or provide services to other entities in the future as a result of past transactions or events.

Marketplaces: Are usually globally organized specifying services or product templates that can be offered by different vendors. The marketplace is a matchmaking mechanism that brings potential process providers together with potential users of these processes.

Prudence: Concept that expenditure should be written off in the period in which it arises, unless its relationship to the revenue of the future period can be assessed with reasonable certainty.

Static Virtual Enterprises: A set of business partners are linked together in a static and fixed way, for example, the shared business processes are tightly integrated. The business relationships and the process interfaces are predefined, tightly coupled, fixed, well integrated and customized among partners.

Virtual Enterprises: Refer to enterprises that consist of groups of people working together on an undertaking, regardless of their physical location, across enterprises and countries, in real time (synchronously) or deferred time (un-synchronously).

Virtual Government in Singapore

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INTRODUCTION

Governments are a strategic necessity, as they provide the overarching administrative machinery to ensure that national (and citizens') needs are taken care of. The need for the civil service to be more cognizant of citizens' concerns has been reiterated in several recent studies (e.g., Tarabanis, Peristeras, & Koumpic, 2000; Janssen, Wagener, & Beerens, 2003). People interact with the government for a variety of needs, for example, payment of bills for utilities, seeking approvals for licenses, and so on. While this has served citizens well, there is a general perception that governments are generally lackadaisical in terms of response times. Citizens and businesses in today's society have high expectations and demand that their governments be more responsive to their needs. Though upping of civil service head count and decentralizing of official machinery have met with a good degree of success, it has been at the expense of a cost factor which may not be that easy to justify or sustain in the future, especially when there are so many pressing sectors of the economy needing fiscal injections. Any productivity increments achieved in maximizing use of government manpower and resources through various enabling tools means that the savings realized can be deployed back into the economy. The emergence of the Internet has given governments an opportunity to act in this regard. This has given rise to what is known as e-government.

BACKGROUND

The term e-government refers to the use of the Internet to improve work processes in the public sector. It started in the United States in 1995 (Heeks, 2000; Prins, 2001; Ronagan, 2002; Jakob, 2003; Holden, Norris, & Fletcher, 2003).

An e-government allows people to be connected to the bureaucracy at all times. Owing to various factors—basic telecommunications infrastructure is not yet pervasive, presence of vested interests, best practices in e-government are still evolving, and so on—the "off-line" public sector is still firmly entrenched, especially in many developing countries.

In Singapore, a developing country, the e-government has matured tremendously over the past few years (Tan & Subramaniam, 2005). This article describes the infrastructure and standards supporting the e-government in Singapore, provides information on some of the key services that have been "virtualized", and offers a commentary on the efforts of putting in place an e-government. As Singapore was among the pioneers of the e-government movement, its experience would be of relevance to other countries. The Singapore e-government Web site is located at http://www.egov.gov.sg.

INFRASTRUCTURE FOR E-GOVERNMENT

Modern Telecommunications Network

A modern telecommunications network is a must for the smooth transition to e-government. An e-government by itself has little effectiveness if efforts are not translated into promoting connectivity for the citizenry. A technology-neutral approach was taken to deploy a modern telecommunications network in the 1990s. Major telcos were encouraged to roll out different platforms for access. To ensure a level playing field for all operators and to promote the spirit of competition, an independent regulator was appointed.

Five principal telecommunication platforms are now in place:

- Public Switched Telecommunications Network (PSTN)
- Asymmetric Digital Subscriber Line (ADSL): For broadband access
- Hybrid Fiber Coaxial (HFC) Cable Modem service: For broadband access
- Asynchronous Transfer Mode (ATM): For broadband access as well as for linking ADSL and HFC

cable modem service to the ordinary telecommunications network
- Wireless access

These have been addressed in detail by Tan and Subramaniam (2000, 2001, 2003).

With the telecommunications network operating on a plurality of platforms which are interoperable, a competitive landscape has emerged for the cost-effective delivery of services. Table 1 shows the maturation of the telecommunications market in Singapore over the years.

Public Services Infrastructure

The Public Services Infrastructure (PSI) constitutes a core feature of the e-government architecture in Singapore, and comprises a three-tier framework (http://www.sun.com/br/government/feature_psi.html):

- an infrastructural ICT framework;
- a middle layer, which inter-links all government agencies and allows them to host their data in a central data storage facility, as well as integrates all the database software of these agencies; and
- an applications layer, which has security features for safe financial transactions.

Before the installation of the PSI, there was recognition that if the existing ICT systems of the various agencies are to be integrated, the complexity of the various systems and the plurality of the user interfaces would present technical difficulties in migrating these services onto a central portal. The legacies of these systems would also come in the way of restructuring work processes with those of other agencies in an effective manner. All this would come in the way of promoting effective delivery of a citizen-centric range of services.

The PSI enables the various agencies to realize operational synergies and cost savings by riding on the same platform (http://www.sun.com/br/government/feature_psi.html).

For example, e-payment channels, electronic data exchange, and security features of the framework can be used by all government agencies. The cost of introducing new services to the public is also dramatically decreased. This means that economies of scale in the operations allow for significant overall cost savings to be realized by the government.

A tool called the eService Generator allows government agencies or their appointed vendors to introduce new services and applications rapidly and securely on the PSI without the need to worry about source codes. When the New Singapore Shares scheme was introduced in 2001 by the government to reward citizens for their contributions to the economy, the amount of shares allotted to each citizen was determined by factors such as age, income level, and type of housing. An e-portal which allowed Singaporeans to check on their share allotment was conceptualized and rolled out in three weeks on the PSI—compared to six months if it were to be launched on any other platform.

ISSUES IN RELATION TO IMPLEMENTATION

The transition to e-government must proceed in a phased manner. There was little guidance on best practices that Singapore could follow when it started to e-enable its civil service—after all, it was among the forerunners of the e-government movement when it started in 1995 with a Web site offering the public a range of information for their needs. A phased evolution allowed adequate time to sort out bottlenecks and bugs in the system, set the standards, fine-tune the workflow processes of the various government agencies for riding on the Internet, learn from other e-governments, and allow for policy issues to be better understood for proper implementation.

As the civil service started its computerization in the 1980s, it was well positioned to ride on the Internet platform. Workflow processes in the various agencies were streamlined internally before up-linking these to the Internet platform.

As part of the ongoing support for the e-government, an investment of S$1.5 billion was made in June 2000 with the specific aim of reaching out to three segments of the

Table 1. Timeline showing growth of fixed-line telephony, mobile phone, and Internet market in Singapore (Source: http://www.ida.gov.sg)

Sector	1997	1998	1999	2000	2001	2002
Fixed Line	-	1,751,500	1,850,700	1,935,900	1,948,900	1,993,700
Mobile Phone	743,000	1,020,000	1,471,300	2,442,100	2,858,800	3,244,800
Internet Dial-Up	267,400	393,600	582,600	1,940,300	1,917,900	2,000,700

Table 2. Comparison of selected services on civil service and e-government platforms (Source: http://www.egov.gov.sg)

Item	Civil Service	E-Government
Opening new entertainment outlet	2 months for approval	2 weeks for approval
Incorporating new company	S$1,200 to S$35,000, depending on size of company Approval time of 2 days	Online incorporation at a cost of S$300 Approval time of 2 hours
Submitting business plans	Entails separate submission of documents to 12 departments	One-stop submission at G2B portal Savings of S$450

citizenry through the migration of those government services which can be put online. These are now addressed.

Government-to-Citizen (G2C) Portal

This facilitates online access for people with the government any time of the day, unlike the traditional public sector routine of 8:30 a.m. to 5:30 p.m. on weekdays, and 8:30 a.m. to 1:00 p.m. on Saturdays.

The G2C portal hosts a range of information and services which citizens need. That it is well used can be seen from the fact that the number of hit counts registered increased from 240,000 in October 2001 to 8.7 million in May 2003 (http://www.egov.gov.sg/g2c.htm).

In March 2003, SingPass was introduced for citizens aged 15 and above. This offers them a single password to transact safely with any government agency where authentication is required. Previously, government agencies had their own authentication systems for such access.

Government-to-Business (G2B) Portal

This portal sought to show the pro-business face of the government to local and multinational businesses (http://www.egov.gov.sg/g2b.htm). It is common for businesses to interact with governments for various matters, either through mail or visits to the respective agencies. The availability of the necessary information and services on this portal means that businesses can realize cost and time savings by transacting online.

An indication of the effectiveness of the G2B portal for businesses can be seen from data displayed in Table 2.

As many businesses depend on government contracts, competitive bidding for these contracts not only allows the government to get the best value for its money, but also ensures that all businesses stand a chance to get these contracts. Such procedures promote transparency and help to check on any lapses on the part of the government. The Government Electronic Business (GeBIZ) portal was thus set up as an online procurement system for the public sector. This allowed businesses to access a one-stop portal for government contracts. In the year 2002, over S$262 million worth of transactions were done on this portal.

Government-to-Employees Portal (G2E)

This is a portal for civil servants (http://www.egov.gov.sg/gt2.htm). As service levels of the e-government hinge on the quality of the human resources in the public sector, the need for officers to be ICT savvy and be abreast of new developments in technologies and work processes is important. The G2E publicizes the numerous ICT training programs available for staff development.

E-Citizen Center

This portal marks a drastic shift in the manner in which the public interacts with the bureaucracy. Launched in April 1999, all kinds of services that citizens need are listed here (http://www.ecitizen.gov.sg). Annual savings of over S$40 million are realized through this portal (Poon, 2000).

Currently, over 1,600 online services in 16 categories, based on the common needs of citizens, are featured in this portal. Some of the more important ones are indicated below:

- **Education:** Searching for information on schools; registering for GCE N-, O-, and A- level examinations; applying for government scholarships; etc.
- **Housing:** Checking availability of public flats for sale, balloting for allocation of flats, etc.
- **Business:** Registering a business, getting a license or permit, etc.
- **Employment:** Searching for jobs in the public sector, filing income tax returns, checking balances in the employee's Central Provident Fund account, etc.

- **Defense:** Registering for national service, seeking permission for traveling overseas, allowing reservists to book a date for their annual Individual Physical Proficiency Test, etc.
- **Family:** Registering birth and marriage, applying for work permit for foreign maid, etc.
- **Travel:** Applying/renewing of international passport, etc.
- **Parking:** Paying of fines for traffic offenses, etc.

Three world firsts are also in place:

1. **E-Judiciary System:** Set up in 2001, it is the world's first paperless civil court system (Wee, 2000). Established at a cost of S$29 million, it has almost eliminated paper transactions in civil litigation cases since lawyers are now required to file their legal papers online. This allows workflow processes in the judiciary to be streamlined, thus contributing to more effective dispensation of justice. The waiting time for litigation cases has been reduced from two years to a few months. This system alone contributes to a savings of about S$4 million a year.
   A survey of law firms in 2003, however, indicated that e-filing has not only resulted in higher costs for them, since their clients have to bear the expenses related to scanning of the large numbers of documents before uploading these online, but has also added to their workload because of the labor-intensive nature of such tasks. Also, court officials did not particularly warm towards the system, preferring instead hard copies of documents. This led to a review of the e-filing system in early 2003 and has resulted in online fees being decreased by 20% and the requirement for e-filing of the voluminous amounts of trial documents to be waived (Lum & Ho, 2003).
2. **TradeNet:** This is an electronic trade clearance system (http://www.tradenet.gov.sg). In effect, the process of obtaining clearances from multiple agencies such as port authorities and customs departments has been migrated to one site. What formerly required the completion of 35 forms has been reduced to just a single form. Processing time has been dramatically reduced from 2-7 days to less than a minute. As a result of these initiatives, it has been estimated that businesses save about 50% on processing fees and 30% on their own administrative costs—this is equivalent to about US$1 billion in savings a year. Currently, over 25,000 companies use TradeNet.
3. **E-Stamping System:** This service allows lawyers and realty agents to get all the documentation for leasing, renting, mortgaging, and other processes to be annotated with an online electronic stamp (Wee, 2000). The repository of documents uploaded onto the agency's Web site also helps to build up an electronic archive, which facilitates easy retrieval of documents. Over S$7 million in transaction costs are saved annually through this service. About 100,000 documents are e-stamped annually.

COMMENTARY

The e-government in Singapore has matured significantly over the years and has cornered several accolades (see Table 3).

It has to be recognized that investments in e-governments cannot be made on a one-off basis. Governments have to be committed to periodic investments to sustain operations at efficient levels. Accumulated experiences and cognizance of evolving practices elsewhere necessitate the need for changing or fine-tuning the format of

Table 3. Ranking of Singapore e-government by international agencies (Source: http://www.egov.gov.sg)

Year	**Agency and/or Award**	**Rank**
2000	Commonwealth Association for Public Administration and Management International Award	Bronze medal for eCitizen Portal
2001	Accenture's 2nd Annual Survey on E-Government	2
2002	Stockholm Challenge Award for Portal Information	1 for eCitizen Portal
2002	Accenture's 3rd Annual Survey on E-Government	2
2002	Economist Intelligence Unit's E-Readiness Rankings	11 out of 60
2003	World Economic Forum's Global Information Technology Report for E-Government Category	1
2003	Accenture's E-Government Leadership in Engaging the Customer Report	2

services delivered online and improving service delivery. Ultimately, these investments will be more than recovered from the savings in manpower and the greater generation of economic activity by businesses. For example, in Singapore following the S$1.5 billion invested by the government over the years 2000-2003, another S$1.3 billion has been made available for the years 2003-2006 in order to further improve services to the public through the integration of the functions of the various agencies (Soh, 2003).

Citizens will not warm towards e-government initiatives if the services are not accompanied by decreased fees and increased conveniences. The payment protocols for services must thus be simplified for the public to make use of these. In putting counter services online in Singapore, the fees payable have been decreased to ensure that more people can transact online.

On the productivity enhancements afforded by the e-platform, a good example is the e-filing of income tax returns. Established at a cost of S$2.2 million in 1998, this system contributes to savings of S$2.70 per e-filing—chiefly through less paperwork, absence of mailing expenses, and e- storage of documents (Poon, 2000). Taxpayers' penchant for warming towards this initiative can be seen from the fact that the number of people e-filing their tax returns has been increasing over the years: 113,000 in 1998, 484,000 in 2000, 690,000 in 2001, and 700,000 in 2003.

In moving onto the e-platform, dismantling and simplifying of various work processes and protocols are necessary. Though these are necessary for the civil service to function, too many bureaucratic procedures can affect the effectiveness of public administration—in Singapore, an e-government has been a welcome development to do away with unnecessary procedures and legacy protocols of yesteryears!

The hierarchical matrix of the bureaucracy in Singapore has been flattened significantly with the establishment of an e-government. E-mail addresses of public officers, including ministers and other elected representatives, are available in the public domain, and people can contact or follow up with them for their requisite needs. The fact that the top administration officers are within e-mail reach by citizens poses additional responsibility on the civil service to remain effective and answerable—a challenge which has to be met by improved service levels and commitment.

Though the effectiveness of e-governments is not an issue, there are some perceived drawbacks. It is heavily skewed in favor of people who are ICT savvy and who have network access. Those on the wrong side of the digital divide can be marginalized from participation. The human face of the government, which is reassuring in normal public sector participation, can be increasingly missing. With more services going online, rationalization of civil service headcounts in some agencies is an issue which needs to be grappled with. The foregoing concerns apply to all e-governments, and Singapore is not an exception.

Singapore's compact city state structure and well-developed ICT infrastructure are factors which have helped in the maturation of its e-government. Such conditions may not exist elsewhere and, accordingly, some of the practices may not be easily replicable in other countries. However, as one of the top three e-governments in the world, Singapore—through experience—does offer useful ideas on best practices and what works.

FUTURE TRENDS

In Singapore, the e-government initiative is well entrenched and attracts good support from the public and businesses. As it is, the world is now running on Internet time, with the expectations of citizens and businesses at a level that are not that easy to be realized by traditional public sector work processes. The e-government movement in Singapore will thus become more pervasive in the years to come—support for this viewpoint emerges from the observation that there is a growing trend among people to transact online rather than offline for many kinds of government services. This is likely to put additional pressures on those who are interacting face to face with the bureaucracy to learn to move online in order to realize conveniences and cost savings.

More government services will move online in the near future. Further integration among the various government agencies is currently underway, and this will help to streamline work processes for people and businesses through the emergence of one-stop solutions for their needs which are previously catered for by multiple agencies.

There will also be greater participation by the citizenry in the process of decision making by the government as it grapples with various policy issues that affect the country. All this will help to usher the country into "new age" governance with even more transparency. Of course, the traditional public sector will still be there, but it will be leaner due to productivity increments achieved through the migration of many government services online.

CONCLUSION

An e-government is accompanied by increased levels of responsibility for the civil service. This recognition is crucial for positioning the bureaucracy for "new age" governance. More importantly, political vision is the key prerequisite to morph public administration onto an e-government platform, and this has been a key factor in the success of the e-government in Singapore. This has been indispensable in providing the necessary momentum for government agencies to reinvent themselves. It is suggested that aspects of the Singapore experience would be useful for other countries.

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KEY TERMS

Broadband Network: Telecommunications network that allows for rapid transmission of voluminous amounts of information.

E-Commerce: Transaction of goods on the Internet using electronic payment protocols.

E-Government: The Web-based equivalent of the public sector.

G2B: An abbreviation for government-to-business, it refers to government contracts and other services available online for businesses to bid for.

G2C: An abbreviation for government-to-citizen, it refers to the various government services that citizens need access to.

Portal: A one-stop site on the Web that provides a range of information and services for people.

Public Services Infrastructure (PSI): An integrated Web services framework that allows for rapid development, deployment, and ease of management of online services.

Category: Applications of E-Technologies

Virtual Marketplace for Agent-Based Electronic Commerce

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INTRODUCTION

Information overload has become a real problem with the ever-increasing amount of available online resources. One possible solution is the application of software agents in e-commerce. Intelligent agents are already on the Web, freeing people from some of the drudgework of searching and automatically keeping them up to date. There are now many examples of software agents currently available on the Web. Shopping agents like BargainBot, Excite's Jango and Andersen Consulting's BargainFinder are but a few. They have their shortcomings, however, such as a lack of purchasing capability and a limited range of product selection. Furthermore, the current Web front-end to an online storefront is not conducive to autonomous browsing by search agents.

A more comprehensive solution would therefore be to build a virtual marketplace whereby producers and consumers can come together, and with the help of software agents, actively participate in and conduct e-commerce. There are currently several agent-based marketplace systems that have been developed for the purpose of e-commerce, and these include Kasbah (Chavez & Maes, 1996), MAGMA (Tsvetovatyy & Gini, 1996) and MAGNET (Collins, Youngdahl, Jamison, Mobasher, & Gini, 1998). These systems have certain limitations, however, and shortcomings that make them questionable for e-commerce applications. An example is the Kasbah system architecture that did not include any form of payment mechanisms. Another is MAGMA, which is felt to be rather expensive on network bandwidth and the system performance is heavily reliant on network latencies as it communicates through socket connections. The objective of my research is to build a new virtual marketplace prototype whereby producers and consumers can meet and conduct e-commerce in the cyberspace with the help of software agents.

DESCRIPTION OF MARKETPLACE ARCHITECTURE

A marketplace is where buying and selling agents meet to negotiate transactions. It is important, therefore, that the architecture of the virtual marketplace is designed to facilitate interactions between agents by providing a secure and reliable environment for the conduct of electronic commerce. A business-to-consumer model has been adopted for implementation in the virtual marketplace.

The architecture of the virtual marketplace can be divided into three separate elements: the Control Center, Business Center, and Financial Center (see Figure 1). Specialist agents reside in each module and work independently as well as collaboratively with the other agents in the virtual marketplace to achieve their goals and objectives.

Financial Center

If a marketplace is to become anything more than a toy, it needs to provide the necessary banking and financial services that are required by the transacting agents (Tsvetovatyy & Gini, 1996). The financial center (see Figure 2) is aimed at achieving these objectives by housing within it various authorized banks, which are able to provide these services. It is a virtual financial hub that

Figure 1. Virtual market architecture overview

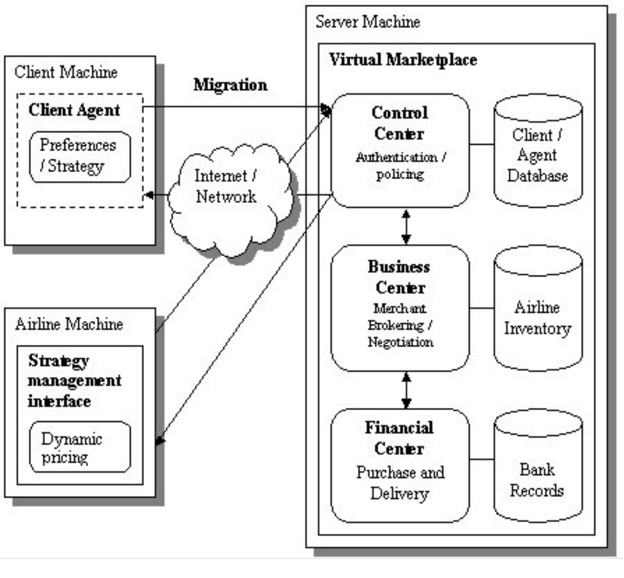


Figure 2. Architecture of financial center

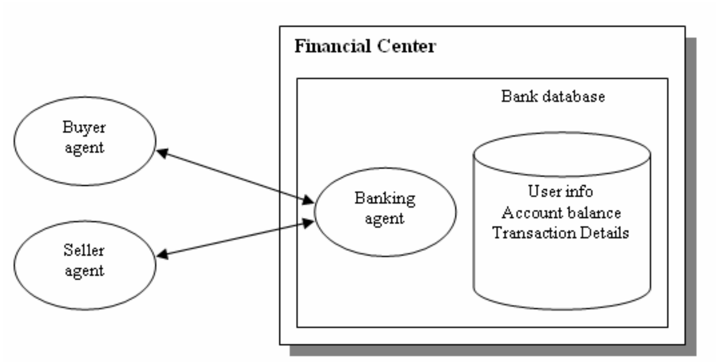
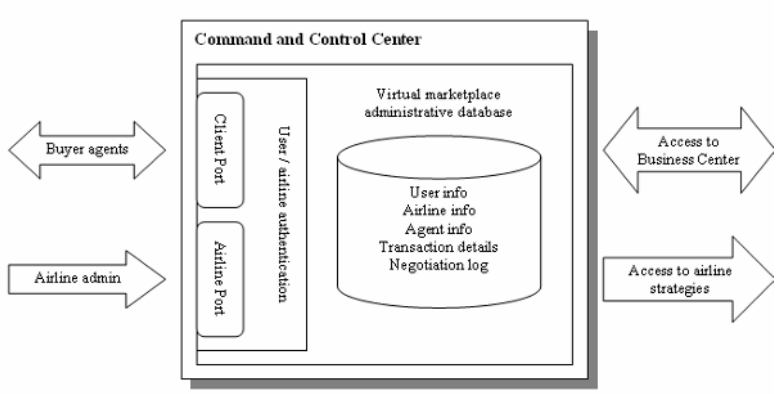


Figure 3. Control center architecture



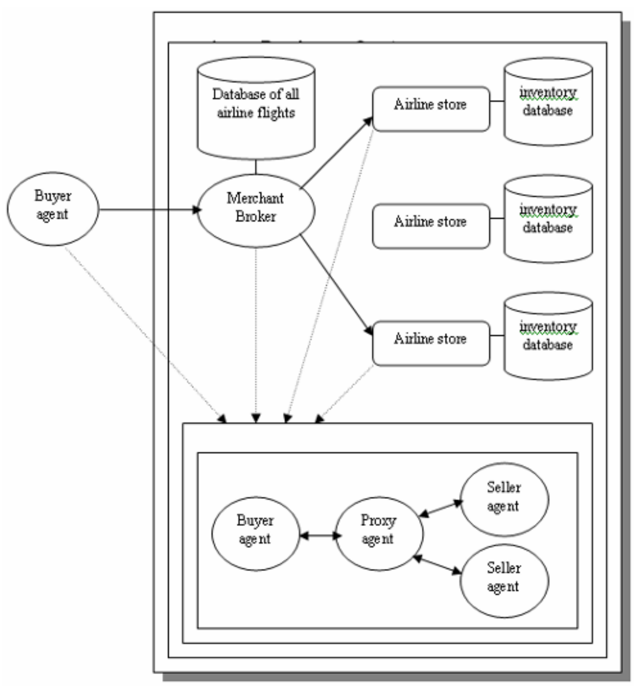
handles all necessary payment activities within the virtual marketplace. The individual banks themselves are represented by their own agents. These agent representatives handle such tasks as verification of legal transactions and assisting in fund transfers from the parties involved in the transaction. They also manage their clients' bank accounts and help carry out the necessary paperwork involved in marketplace transactions. Communication within the financial center, especially those between agent-to-bank or bank-to-bank, needs to be encrypted and secure.

Control Center

The control center (see Figure 3) acts as the administrative center of the virtual marketplace and is the main gateway used by all agents roaming to and from the marketplace. For reasons of security, all potential users of the virtual marketplace will first have to register an account with the control center before its agents are allowed to participate in marketplace activities. Once registered, important user information will then be stored in the market database, to be retrieved for various purposes such as user authentication and user alert notifications. Besides clients, the airlines themselves can also log into the marketplace for purposes of viewing and updating their own customized negotiation strategies. The control center accepts airline connections on a different port to distinguish between client and airline access. To gain access to the server, the airlines will still have to be authenticated.

The control center keeps a list of all active buyer agents currently residing within the virtual marketplace, and it also acts as the policing authority within the virtual marketplace. The agent and transaction monitoring capability is the most important function of the control center. From the time a buyer agent enters the marketplace until it returns home to the client machine, the control center keeps a record of all its activities. Details such as the time the agent entered and left the marketplace, the duration of

Figure 4. Business center architecture



stay, and the owner of the agent are all noted and recorded in the database. If a successful transaction was completed by the buyer agent, the control center will also keep a record of the exact details of the item in question, in this case, details such as flight times, number and cost of each ticket bought, the time the transaction was completed, and so forth. The control center goes a step further by keeping a log of the entire negotiation process that took place between the negotiating parties, regardless of whether a sale was concluded.

With such a monitoring mechanism in place, it is hoped that fraud and misrepresentation by buyers and sellers can be more effectively controlled within the virtual marketplace. This in turn will help increase the level of trust and confidence that users will have in the system.

Business Center

The business center is the heart of the virtual marketplace and is where buyer and seller agents meet to negotiate deals. This research has been modeled after the business-to-consumer model of electronic commerce, and clients are therefore capable of only sending buyer agents into the marketplace to negotiate for items that they would like to purchase. The business center (see Figure 4) consists of several virtual storefronts belonging to various airlines. These storefronts are controlled by seller agents representing the various airlines. Virtual stores are tied into their own individual inventory databases, and they maintain a permanent presence in the marketplace. The agents controlling the stores are akin to sales personnel, and may adopt different marketing strategies based on preferences set by individual airlines.

After a buyer agent has been authenticated by the control center, it arrives at the business center, where it is matched to relevant seller agents by marketplace merchant brokers. The service that merchant brokers provide frees the agents from having to do this additional work. This is important, as incorporating too many functions will inevitably increase the size of the buyer agent, and this will make them more costly to transport through the network. More importantly, it reduces the security risks by not allowing the buyer agent to gain access to the virtual marketplace's database and other system resources. This step can be classified under the merchant brokering stage of the consumer buying behaviour (CBB) model that has been proposed by the Software Agents Group at MIT Media Lab (Maes, Guttman, & Moukas, 1999).

Once potential merchants have been identified, buyer and seller agents can then commence the negotiation stage of the CBB. All negotiations take place in their own particular negotiation session container. This session serves as an encapsulation for a transaction in the marketplace. Furthermore, in the virtual marketplace, negotiations between buyer and seller agents take place through an intermediary, appointed by the marketplace, for reasons of trust, security, and transaction monitoring. This intermediary, which resides within the session, is the marketplace's proxy agent.

After negotiations have been concluded, the finalized deal, together with the respective seller and buyer, are then passed to the banking agent for payment in the financial center. This forms the final, purchase and delivery stage of the CBB. Once the final stage in the buying process has been completed, the buyer agent will then be returned to the client.

Client Application and Airline Management

The design of the client application for the virtual marketplace architecture is crucial. A well-designed client application will facilitate the acceptance and adoption of the application. To facilitate ease of use, it is designed with a user-friendly GUI (see Figure 5) that allows easy configuration of the agent parameters and monitoring of agent activities in the virtual marketplace. It consists of various functions, such as agent retrieval and termina-

Figure 5. Client application interface

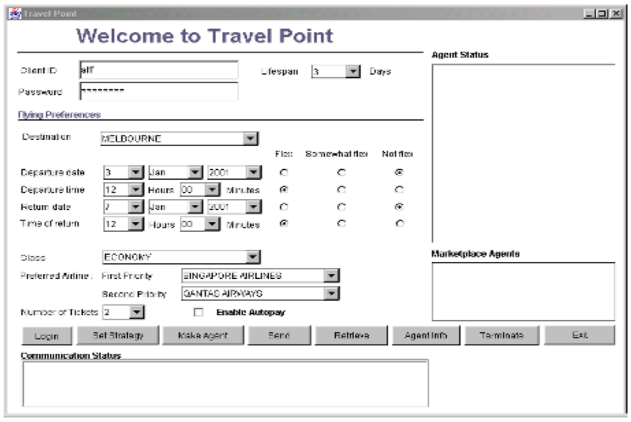
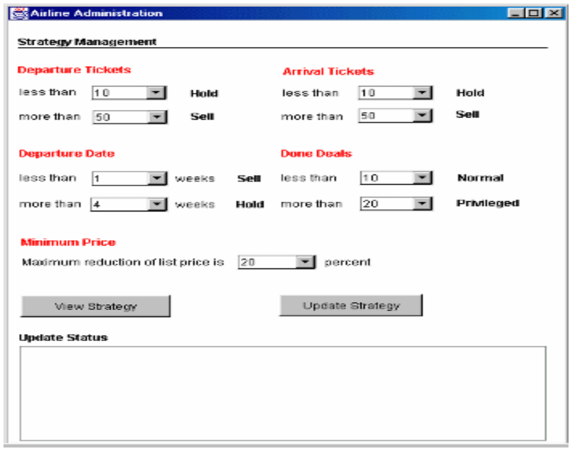


Figure 6. Screenshot of airline pricing strategy management



tion. As a business-to-consumer model has been adopted for this research work, the user's role is solely as a buyer looking to purchase airlines tickets in the virtual marketplace that match his or her preferences. Besides flight preferences, the user is also able to configure a custom negotiation strategy.

Airlines are also able to manage their stores within the virtual marketplace via a strategy management interface (see Figure 6). To be granted access to the airline's strategy settings, the airline administrator must first log in and be authenticated by the control center. This strategy management tool allows the individual airlines to customize and personalize its pricing strategy using real-time, individualized analysis. This dynamic pricing capability is an important feature of the virtual marketplace architecture.

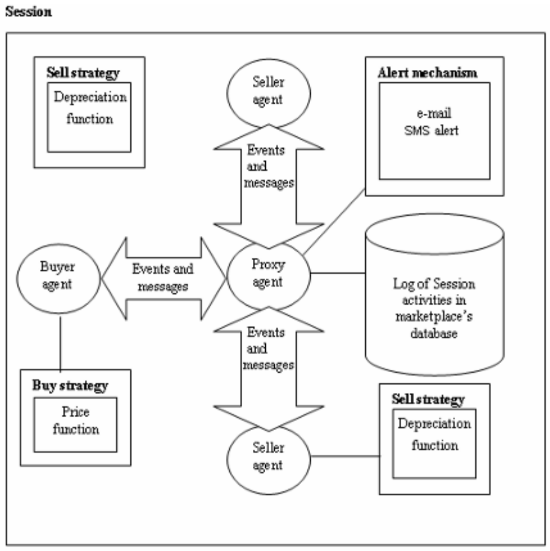
IMPACT OF MARKETPLACE ARCHITECTURE

There are three features of the marketplace architecture that deserve special attention: the negotiation session, the dynamic pricing mechanism, and issues on security, trust, and privacy.

Negotiation Session

A session is created with the creation and implementation of the proxy agent (see Figure 7). To join the session, the buyer or seller agent must first register with the proxy agent. This is done by providing the proxy with an individual, unique agent identification and a reference to itself. The proxy agent thus maintains a list of all agents participating in the session. Initially, the buyer agent is the only party in the session, and it waits patiently for the respective airlines to send forth their representative sellers into the session. Negotiations commence as soon as the first seller agent enters the session and initiates with an offer to sell. It is always the seller agent that initiates the negotiation process. Thereafter, all arriving seller agents will also initiate their own negotiation process. The buyer agent thus has to simultaneously keep track of each individual negotiation with each individual seller agent. Each negotiation process between the buyer and a particular seller is independent of other concurrent negotiations within the session.

Figure 7. Session negotiation mechanism



The session thus serves as an encapsulation for a transaction in the marketplace. This is where all the negotiations between buyer and sellers take place. The session always contains only one buyer agent but may house several different sellers. Due to security issues, these negotiations take place through an intermediary, a proxy agent, designated by the virtual marketplace. There are two benefits to using a proxy agent. First, the agents never have a direct reference to one another, and as such, the security risks posed by malicious agents are reduced considerably. Second, the marketplace is able to closely monitor and log all agent negotiations, which instills an element of trust and confidence in the system by guarding against cases of misrepresentation and repudiation.

Another unique feature of the session is that negotiation is a nonbinding agreement, thus allowing the buyer agent to negotiate concurrently on several items and thereby increasing the chances of obtaining a successful match and a better deal (Morris & Maes, 2000a). The motivation for adopting this design approach stems from a limitation in the Kasbah system, wherein agents always accepted the first offer that met their asking price. In the Kasbah architecture, once an agent makes a deal, it ceases to negotiate with other agents and is removed from the active list (Chavez, Dreilinger, Guttman, & Maes, 1997). In this research, the buyer agent has the capability to wait until all negotiations have concluded before making a comparison. The agent is therefore able to make an informed decision on which is really the best deal on offer, as it is able to compare the various finalized offers instead of just picking the first acceptable offer.

The session is concluded when the buyer agent finally pays for a ticket or rejects all the offers and decides not to purchase anything. Subsequently, all agents associated with the session are stopped and terminated, and the buyer agent is returned to the client machine.

Dynamic Pricing Mechanism

Although the negotiation process currently tends to favour the buyer, the virtual marketplace architecture adds benefits to airlines by providing them with a strategy management tool that allows them to formulate a negotiation strategy based on complex criteria and real-time data, not just price alone (see Figure 6). There are currently four nonprice criteria by which the airline uses to configure its pricing strategy. These are the number of departure flight tickets remaining, the number of arrival flight tickets remaining, the time left to the departure date of the flight, and the number of previous deals that the user has completed with the airline.

Each time a seller agent is dispatched into the session to negotiate with the buyer, the airline store will have to first set the selling strategy of that seller agent. With the dynamic pricing mechanism in place, the airline can customize the pricing strategy of each flight ticket it sells, based on a set of criteria and real-time data from its inventory database. Such criteria will include real-time factors such as the number of tickets left for the flight in question or the length of time left until the departure date. For example, if a flight that is less than 1 week away has more than 50 tickets remaining for that flight, the airline could indicate to its sales representative (seller agent) to adopt a more eager approach to selling those tickets and, as a consequence, would be able to offer the ticket for a cheaper price and eventually made the sale. Therefore, by allowing airlines to formulate their strategies based on a just-in-time, individualized analysis of the immediate situation, it gives the airlines a greater ability to maximize revenue over each flight with better precision (Morris & Maes, 2000b).

Security, Trust, and Privacy

Security, trust, and privacy are important considerations given any electronic commerce application (Corradi, 1999; Greenberg, 1998; Marques, 1999). Furthermore, with the introduction of agent autonomy, these issues become even more crucial. If the trading mechanism cannot be trusted, or is perceived to be insecure to protect privacy, then acceptance of the application will be severely limited. To address these, the following design issues have been adopted.

Secure Transport and Agent Integrity

Because this application is based on a mobile agent concept, the agent and its data will be susceptible to "attack" whilst it transverses the network, especially if this application is deployed over the Internet. Therefore, a secure transport mechanism is required (Guan & Yang, 1999); for example, encryption of the agent before transportation. Agent integrity can also be achieved using a similar mechanism, as in Wang (2001).

Trusted Client Applications

Fellow agents and the virtual marketplace have to be protected from malignant agents. To ensure that only trusted agents are allowed into the marketplace, only agents manufactured from trusted agent factories (Guan, 2001; Guan et al., 2000; Zhu, Guan, & Yang, 2000) are allowed into the server. In this particular implementation, only agents constructed and verified by the provided client applications are granted access to the marketplace. The disadvantage of doing so is that this does not allow clients to custom build their own agents that might have greater intelligence and negotiation capabilities, but this downside is seen as minimal since most users would not bother to go through the complexities to do so anyway.

CONCLUSION

In this research, an agent-based virtual marketplace architecture based on a business-to-consumer e-commerce model has been designed and implemented. Its purpose is to provide a conducive environment for self-interested agents from businesses and clients to interact safely and autonomously with one another for the purposes of negotiating agreements on the behalf of their owners.

The three fundamental elements of the marketplace architecture are the control center, the business center and the financial center. This implementation has been concentrated on development of the control and business centers. Of particular interest are two of the design elements that warrant greater attention: the negotiation session mechanism and the dynamic pricing strategy management scheme that was implemented.

At present, the pricing strategy of the buyer agents are still limited and based on some simple time-based functions. Future work should therefore try to address this issue and work on enhancing the buyer agent's pricing strategy with greater room for customizability by the owner.

Other than the priority airline settings, users are able to evaluate an item based only on its price. This price-based paradigm is a disservice to both buyers and sellers because it does not allow other value-added services to be brought into the equation. Further work needs to be done in this area to address this limitation. A possible solution would be to set up a rating system similar to the Better Business Bureau, which is currently in use in the Kasbah system (Chavez & Maes, 1996). This new system should allow buyers to rate the airlines on factors such as punctuality, flight service, food, and so forth. Users will then be able to evaluate air tickets based on more than just the price and can include the aforementioned criteria listed within the rating system.

Finally, in the current implementation, all sellers (and buyers) are assumed to reside within a single marketplace. This does not fully illustrate the migration capability of buyer and seller agents. Future work should accommodate this aspect.

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Web Accessibility

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WEB ACCESSIBILITY

The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect. (Tim Berners-Lee, W3C Director and inventor of the World Wide Web)

INTRODUCTION

Accessibility means making resources usable by the largest number of people possible, or alternatively, allowing people with some kind of disability to effectively participate in day-to-day activities, including the use of services, goods, and information. The evolution of civil rights enhanced the physical world with several accessibility aids, such as ramps to remove architectural barriers for wheelchair users or bells near elevators for blind users. To address the size of the "disable world", let us consider that only in the European Union there are about 37 million people with disabilities. Disabled people find in the Internet a major reference for their daily necessities to overcome their difficulties in moving and communicating. As institutional, economical, and social services provided through the Web become increasingly central to our lives, to avoid the risk for severe social exclusion, there is the need for "accessibility aids" for the Web. Informally, it means that Web-based content should be presented in a way that allows disabled users to maximally and equally benefit from the information, as well as have the faculty to fully interact with the site. People with physical, cognitive or even technological disabilities should be enabled to effectively read information, browse sites, compile forms, navigate links, download documents, and so on. This goal can be achieved by using a mix of hardware/software solutions, suited to provide specialized input and output capabilities. For example, text-to-speech systems read text on the screen, allowing blind users to navigate Web sites. However, to work effectively, such solutions require Web designers to use Internet technologies accordingly to some recommendations. Incidentally, the recommendations and principles that form the accessibility foundation are very similar to the factors affecting Web quality (Fitzpatrick, 2000; Top of the Web, 2003), and thus can provide benefits to every user of the Internet, whether disabled or not. As a result, accessibility should represent one of the most important references for Web developers.

In this article, we provide an insight into the development of accessible Web sites. In particular, we will start by outlining the historical background about the accessibility issues. Then, we will focus on the design of Accessible Web sites inspired to the *universal design* principles (Follette, Mueller, & Mace, 1998) and *World Wide Web Consortium*'s (W3C) directives, and on the solutions to verify and validate accessibility. Finally, we will give an insight on future trends and challenges due to novel Internet technologies.

BACKGROUND

In order to avoid a growing digital divide in access for people with disabilities, many efforts have been devoted on developing accessibility solutions for the Web. As a result, most of the digital barriers for disabled people can now be easily avoided if site designers follow a set of simple rules, which were mainly defined by the *World Wide Web Consortium's* (W3C) *Web Accessibility Initiative* (WAI) (W3C WAI, 2005). Funded by government, industries and W3C members, the WAI is responsible to create technical guidelines regarding accessible content, browsers and authoring tools. The *Web Content Accessibility Guidelines* version 1.0 (WCAG 1.0, 1999), recognised as a *de facto* standard for the design of accessible Web sites, has three conformance levels (*A*, *Double-A*, and *Triple-A*), depending on the accessibility rank. To ensure an effective level of accessibility, Double-A is recommended.

In many countries, the evolution of disability rights laws have resulted in the understanding that access to information and communication is a civil right for people with disabilities (Waddell, 1999). Then, many governments around the globe, such as European Union, United States, Canada, and Australia, issued laws and regulations demanding accessibility for public organization sites, usually starting from W3C WAI technical recommendations.

European Union resulted very sensitive on this issue, since Web accessibility results to be a strategic objective of the European Commission's Information Society. In particular EU is promoting the concept of *e-inclusion*, aimed to prevent "risks of digital exclusion", that is to ensure that disadvantaged people are not left behind and to avoid new forms of exclusion due to lack of digital literacy or of Internet access (EU 6th FP, 2004).

United States legislation widely covers Web accessibility aspects. The Section 508 of the Rehabilitation Act of 1973, revised in 1998 (Section 508, 1998), imposes strict accessibility requirements for electronic and information systems developed, maintained, procured, or used by federal agencies. Title II of the Americans with Disabilities Act requires institutions to take appropriate steps to ensure that communications with persons with disabilities "are as effective as communications with others" (Section 504). Office for Civil Rights has repeatedly held that the term "communication" in this context means the transfer of information, including the resources of the Internet. This means that U.S. institutions must provide documents in an alternate format in order to remove communication barriers regardless of its original format.

About solutions for making computers more accessible, there are on the market many hardware and/or software products suited to this aim, and collectively named *assistive technologies*, or accessibility aids. Among these there are:

- **Screen Readers:** Making the information presented on the screen available as synthesized speech or through a refreshable Braille display.
- **Screen Magnifiers:** Supporting people with low vision by enlarging a section of information on the screen.
- **Speech Recognition Engines:** Useful to mobility impaired, by allowing people to control the computer via vocal commands.
- **Alternative Input Devices:** Such as larger keyboards or mice, eye-gaze pointing devices, and sip-and-puff systems controlled by breathing.

DEVELOPMENT OF ACCESSIBLE WEB SITES

Integration of the basic accessibility pre-requisite requires careful design and testing phases. In particular, during the design phase, the designers planned the tasks to be performed in order to build accessible Web pages, so that both graphic and textual Web contents could be navigated by disables and could be understood by all categories of users. During the testing phase, testers should carry out a complete and exhaustive verification which combines semi-automatic, manual, and user testing of accessibility features.

Designing Accessible Web Sites

The greater level of accessibility can be achieved by applying the principle of the *universal design*, which states that every design activity has to consider the different requirements from all potential users (Follette, Mueller, & Mace, 1998). When dealing with Web sites, this principle can be applied by designing applications that are easy to use, (i.e., directly accessible from every category of users), possibly in combination with assistive technologies.

The application of the *universal design* principle does not necessarily introduce restrictions in the development of software systems and does not limit the expressiveness of Web developers. Indeed, it should be seen as a creative challenge for everyone involved in Web development and not as a limitation. Currently, many Web sites effectively combine accessibility issue with visual appealing. An example is the Web site of the international project VISUAL (*Voice for Information Society Universal Access Learning*) (VISUAL, 2004), a portal aimed to create an e-community for visually impaired people, and supported by the Information Society Technologies Programme of the EU. Another interesting example is the Web site created for the Exhibition "Edvard Munch. The graphics at Kupferstichkabinett Berlin" (EMKB, 2003).

For Web sites characterized by a significant amount of interactions with users and data sources/sinks, the accessibility requirement is more suitably gained if the design is based on the separation of the contents from the presentation modality. Nowadays, this separation is facilitated by the diffusion of the *markup* languages and the use of *style sheets*.

In the following we provide some recommendations that should be taken into account to design and develop accessible Web sites. They are based on WCAG 1.0 guidelines (WCAG 1.0, 1999) and focus on the design and development activities concerning the accessibility design goal.

Web Site Structure

- A basic task during the design phase is the definition of an overall editorial plan meant to describe the Web site structure and the navigability criteria to adopt. The document usually includes a navigation structure whose thoroughness and formal correctness is ensured by the designer. Moreover, usability criteria should also be followed to avoid the overcrowding of links, and the generation of too length textual sections and complex navigation structure.
- The Web site should include an interactive navigation map to improve the structure comprehension and a search engine characterized by an integrated orthographic checker.
- Moreover, a uniform structure should be preserved.

Web Content Accessibility

- In general the development of an alternative accessible Web site to meet both a high level engagibility and the accessibility is not recommended. Indeed, multiple/parallel versions of the same Web site induce greater difficulties during the modification and/or the updating of the system. However, if the construction of an alternative Web site is the only solutions assuring an acceptable accessibility level, Web engineers should guarantee the consistency between the content of the main Web site and the content of the accessible version. When repairing an existing Web site in order to obtain an accessible version suitable transformations following the (WAI) accessibility guidelines should be performed.
- The design and the development of the documents should be carried out trying to satisfy the necessities of all categories of users. As an example, the options *noframes* and *noscripts* can be used in the case of browser not supporting these type of documents.
- Web developers should avoid to insert too many multimedia objects into the graphical user interface and should identify the right compromise between an attractive graphics and ease of use. Indeed, the use of such components should be limited to the case of true usefulness. However, for each graphic or auditory presentations the corresponding textual descriptions or an equivalent visual alternative should be produced in order to provide the same information to users that cannot access these multimedia components. The equivalent textual description can be simple labels associated to the components or detailed descriptions inserted into other pages connected to the graphical elements through links.
- The use of images as background is advised against. Indeed, figures as background can disturb the perception of the overlapped text by users with cognitive or visual disabilities.
- The use of interactive components is limited to the case of true usefulness, and alternative visualizations are provided when they cannot be managed with assistive technologies for disable people.

Information Formats

- A compressed version should be provided for each high dimension document, together with the necessary files required to navigate it off-line by using a relative link. The formats should be accessible and not property owner (e.g., HTML and text).
- The Web content, its structure, and the presentation should be separately modeled by using style sheets (CSS) in order to ensure consistent transformations of the Web pages when different visualizations can be chosen by the users.
- Tables should be built so that they make sense when they are read cell by cell or row by row, and an equivalent alternative is provided when the mean is not clear. In particular, for tables that have two or more logical levels of row or column headers markup should be used to associate data cells and header cells. Moreover, in some cases a description of the data organization can be useful for a better comprehension of the provided information (e.g., by a legend).

Accessibility Verification

Several tools are currently available for validating Web site accessibility, HTML syntax and style sheets in semi-automatic fashion such as *Bobby* (Bobby, 2005), *HTML Validation Service* (W3C Validator, 2004) and *CSS Validation Service* (W3C CSS Validator, 2004). However, since accessibility involves not only the syntax of the HTML code but also the semantic of the Web content, the above listed tools are not sufficient to guarantee accessibility, but also the human control is needed. Thus, a procedure able to simulate the use of the Web site by disables should be used to assess accessibility. To this aim, some checks can be carried out in order to identify accessibility problems. Several graphical user interface browsers, such as Internet Explorer, Netscape and FireFox, by considering also different versions and different screen resolutions, can be used to verify page selection. Images and sound can be turned off to verify the presence of alternative and appropriate text, and the usability of Web pages can be verified by varying the font-size. Furthermore, the adequacy of color contrast can be evaluated by changing the display color to grey scale, and the accessibility through keyboard commands for all HTML links can be verified. By executing these checks Web developers can perform an initial accessibility verification which is not strictly related to the assistive technologies employed by users with disabilities. In particular, these verifications cover all the necessities of people not affected by sensorial limitation but that cannot take advantages of multimedia components due to the environment conditions or the use of not advanced technologies. Indeed, these checks are based on the deactivation of one or more functionality and simulate disability conditions (e.g., deactivation of graphics to simulate blindness, deactivation of sound to simulate deafness, etc.).

Moreover, when assistive technologies are adopted, like screen readers, alternative keyboard and mouse, we have to verify that the information is equivalent to that provided by a graphical user interface browser, and is understandable when serially read. In particular, such type of verification allows to suitably simulate the operating conditions of users with disabilities.

Now, let us observe that in order to ensure accessibility a testing phase involving also people with different disability is necessary. Indeed, a Web site can still be hard to use by disables even if the system follows the technical accessibility standards. On the other hand, it is widely recognized that the only technical accessibility does not ensure usability. Indeed, when dealing with Web sites several usability features should be taken into account in order to meet the usability requirements (Nielsen, 2000). In particular, ease of learn, orientation, navigability, and content comprehension are all factors that contribute to gain user satisfaction.

FUTURE TRENDS

We are at a technology crossroad. Internet technologies are continually evolving, moving toward multi-modal, ubiquitous, and context-aware computing. We are also experiencing a shift from Web content publishing to Web applications. Such profound changes can be an interesting challenge from the accessibility point-of-view. Some of these novel technologies have requisites very similar to the accessibility, such as Internet-enabled smart phones, automotive information systems, Web TV, etc. This can be a very strong motivation for the development of accessible contents, since Web accessibility is one of the best foundations for device-independent access to the Web (NCDDR, 2001).

Another branch with potential huge benefits for Web accessibility is the Semantic Web Activity, which focuses on the development of machine-understandable data on the Web. It deals also with the possibility to link resources on the Web that can support accessible description and/or rendering of Web content.

On the other side, new emerging technologies allowed by large bandwidth (audio/video streaming, Webcast, etc.), as well as solutions available for digital rights management (DRM), can pose heavy accessibility challenges, while some other areas of evolving Web technology can be a two-edged sword. For example, vocal interfaces can be a concrete benefit for people with visual impairments, but also a barrier for people with auditory disabilities.

However, to address these new issues, many efforts are devoted by international Web community. Now, technologies developed by W3C are reviewed for potential accessibility barriers prior to be released. For example, WAI worked internally in W3C to address potential accessibility concerns in the development of scalable vector graphics (SVG). In the mean time, W3C WAI is currently working on a new version of accessibility recommendations, currently available as a draft and named WCAG version 2.0 (WCAG 2.0, 2004).

CONCLUSION

Since few years ago, many organizations deemed the creation of a text-only alternative to be enough for disabled users. However it is now clear that accessibility does not necessarily limit the expressiveness and creativity of Web developers, but instead it is a kind of usability, and then accessible Web sites are usable Web sites.

Moreover, providing accessibility brings both ethical and business benefits. Putting accessibility at the forefront of the development process will reduce in the long-term costs of the site (Arch & Letourneau, 2002), as maintenance and server overheads are reduced. Moreover, Web sites that are simple to navigate will bring repeat visitors to the site, creating an environment that will bring more users in contact with services and products. Thus, developing accessible Web sites is an important social requirement, but it is also a way for increasing market share and audience reach, and improving Web sites efficiency (Arch & Letourneau, 2002).

A fundamental goal of the international community should be the removal of technological barriers, for giving the users the possibility to navigate through Web sites in order to efficiently accomplish their needs. Several technologies are now available to effectively eliminate those barriers and make the Web accessible to all people to ensure e-democracy.

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KEY TERMS

Accessibility Legal Issues: Many governments around the globe issued laws and regulations demanding accessibility for public organizations sites, usually starting from W3C WAI technical recommendations.

Assistive Technologies: A set of solutions, both hardware and software, aimed at supporting disables in interacting with digital contents.

Digital Divide: Gap existing between communities regarding their ability or possibility to effectively access information and communications technologies.

Universal Design: A principle stating that every design activity has to consider the different requirements from all potential users (Follette, Mueller, & Mace, 1998).

Validation Tools: Tools available for semi-automatic validation of Web site accessibility. Such tools test only the code syntax and style sheets, without considering semantic aspects, where the human control is needed.

W3C WAI Guidelines: A set of guidelines defined by W3C for designing accessible Web sites. It has three conformance levels (A, Double-A, and Triple-A), leading to different accessibility rank.

Web Accessibility: Presentation of Web-based contents in a way that allows disabled users to maximally and equally benefit from the site content. It can be achieved by using some assistive technologies (cfr.).

Web Design Dimensions and Adaptation

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INTRODUCTION

Recent developments in the World Wide Web infrastructure enabled the development of highly interactive hypermedia systems for e-commerce, e-government, and mobile commerce. Such applications have much to gain exploring adaptation, through the use of adaptable and adaptive mechanisms to customize services and interfaces.

Adaptable systems are those that can be configured by the user before or during their use. Adaptive systems automatically acquire input data in order to infer adaptation opportunities and react accordingly. Adaptable and adaptive systems consider three different adaptation targets: human matters, interaction matters, and computer matters. The first target regards preferences, interests, and other personal information to allow system personalization. The second target regards goals and activities that are intended by the user in order to adjust the system according to the dialogue with the human being. The third target regards resource-availability discovery and optimization, such as needed by mobile applications due to limitations in computation and communication infrastructure.

The design of modern hypermedia systems requires an integrated approach contemplating modeling principles, evaluation frameworks, and reference models. Several approaches and methods exist, but it is difficult to understand how they complement or interfere among themselves during a design. Fischer (1989) considers that systems with strong interactive requirements, such as those related to usability, lack structure and present design instability. Adaptation aggravates this difficulty.

Tobar and Ricarte (2005) believe that one of the main reasons behind the difficulty in developing and evaluating adaptable and adaptive systems is the absence of a *reference* (normative) *model* for describing them from different perspectives. They provided some clues toward this missing type of model through the E-ACM (extended abstract categorization map), used to present modeling dimensions. It is a graphical representation to capture different aspects of hypermedia systems and models, considering all types of adaptation. It can be used before system authoring and design to a broad spectrum of hypermedia applications including e-commerce, e-government, and mobile commerce.

BACKGROUND

Complementing design dimensions is a strategy to model complex systems. For adaptable and adaptive systems, these dimensions help to:

1. identify coverage overlapping between modeling methods or systems, aiming potential integration;
2. compare modeling methods;
3. specify a new authoring methodology; or
4. assess the adherence of modeling methods to specific available tools.

Four dimensions concerned with adaptable and adaptive hypermedia design are considered: services, traditional concerns, abstraction levels, and goal conditions.

Services

Services, such as navigation and presentation, offer representation mechanisms to establish how users perform different data manipulation activities. They also support problem-modeling issues that are the kernel of some hypermedia modeling methods.

The Dexter reference model (Halasz & Schwartz, 1994) pioneered a dimension for modeling separating navigation from presentation and interaction issues. Brusilovsky (2001) also considers a similar dual vision for adaptive hypermedia services. This dimension is the most commonly used as orientation to develop and assess adaptable and adaptive systems.

Traditional Concerns

The traditional concerns dimension includes representations for structure (data), behavior (process), and constraints. It is the usual modeling dimension to develop software.

Oppermann (1994) introduced a *process-oriented* approach for adaptive systems, with three main components: to gather observation data (afferential), to deal with user characteristics (inferential), and to adapt the system (efferential). Several other authors, inspired by Oppermann's proposal, use layers for dealing with processes behind adaptivity, such as Weibelzahl (2003).

Other proposals presented *data-oriented* approaches. De Bra, Houben, and Wu (1999), based on the Dexter model, proposed the AHAM (adaptive hypermedia application model) reference model. It focuses on the storage functional layer, with models for domain, user, and teaching.

There are also hybrid approaches, such as the one proposed by Paramythis, Totter, and Stephanidis (2001) with two data-oriented components and several others process oriented.

Abstraction Levels

Different models can represent the same aspect, each with a different abstraction level. A pioneer work regarding abstraction levels is the reference database architecture defined by the American National Standards Institute (Tsichritzis & Klug, 1978).

Stephanidis and Savidis (2001) considered abstraction by proposing three levels of interaction at which adaptation is applied: semantic (different metaphors), syntactic (dialog patterns), and lexical (grouping and spatial arrangement). Benyon and Imaz (1999) exploited modeling methods developed toward one of three abstraction levels: intentional, conceptual, and physical. They consider *goals* as guidelines for the specification of entities at the intentional level.

Transitions between levels have been used in approaches for bottom-up or top-down development. Some proposals define mappings between adjacent levels to smooth detail generation (Tobar & Ricarte, 1999).

Goal Conditions

Goals are what the user has to accomplish using the application and represent the *why* of the system existence. Although important, the goal dimension is not well exploited in the literature.

Goal conditions are underneath application descriptions, and are related to external concepts to be considered by an application realization, such as a collaboration requirement to take into account. For instance, this goal condition affects the way services are provided to users, imposes new data and behavioral requirements, and requires ad hoc computational mechanisms.

Combination of Dimensions

Separation of concerns—that is, the use of dimensions—facilitates the reuse of successful design practices (Karagiannidis & Sampson, 2000). Mutually influenced design dimensions have long proved to be a powerful and helpful strategy.

Efforts to combine dimensions were initially directed toward open hypermedia systems (Rossi, Schwabe, & Guimarães, 2001) and required a combination of modeling methods. This same idea of combining methods has been exploited in development methodologies and respective supporting languages, such as the Unified Modeling Language—UML (Fowler, 2003).

A HYPERMEDIA AUTHORING SYSTEM: AHA!

AHA! (De Bra et al., 2003) is a representative tool to build adaptive Web applications. It is a generic and open adaptive hypermedia platform, originally developed to support educational applications, composed of an authoring system and an adaptive support system. Its goal is to offer guidance through explanations and conditional navigational options during user interaction. AHA! uses three techniques to achieve this goal:

1. a user model based on concepts,
2. the use of adaptive link hiding, and
3. the conditional inclusion of fragments.

To construct applications with AHA!, an author creates concept and page templates. Page templates contain the fragments to be conditionally included, coded with the standard language for Web pages, XHTML (W3C, 2002). Concept hierarchies and relationships are created using the *graph author,* a tool to create a domain-adaptation model in a high level of abstraction. AHA! also provides a *concept editor,* which offers low-level access to define condition-action rules and conceptual attributes.

The AHA! platform, in which adaptive applications are processed, has as its main functional component an inference engine, and as its main data components a user model and a combined domain and application (adaptation) model. The AHA! engine, responsible by adaptive effects, uses a Web server to provide user interaction and navigation. User requests are intercepted by engine servlets, small applications integrated to the Web server which access the combined models to trigger adaptation rules. Thus, page fragments may be included in a page according to conditions in these rules. Presentation of link anchors considers Boolean conditions over user model values.

USING E-ACM TO ASSESS ADAPTIVE HYPERMEDIA SYSTEMS

In the design of an adaptive Web application, the different degrees of support provided by tools and platforms yields a natural question: Which one is appropriate for the designer needs? The extended abstract categorization map aids to answer this question.

The E-ACM provides a chart with three layers and seven services to indicate the existence of modeling mechanisms in a system, tool, or platform. If present, the mechanism is classified according to its abstraction level, related computational service, goal condition, and traditional modeling concerns.

A categorization requires a set of orientations such as:

- Any mechanism that is oriented to one of the services, mainly to those strongly related to hypermedia (navigation, perception, and interaction), cannot be considered at the external level.
- The existence of a mechanism, no matter how simple, is always represented.
- The basis for defining the degree of sophistication could be a reference model, such as AHAM (De Bra et al., 1999), which should be highlighted as playing this role. Some of the services could stay without reference, when they are not considered among the possible chosen reference models. In this case, the analyst is responsible by defining the reference level explicitly.

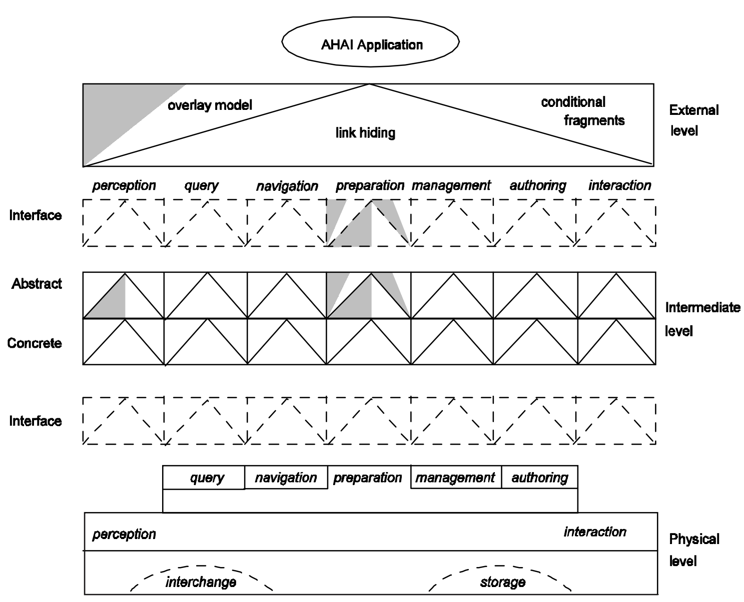
In order to indicate the sophistication of a mechanism to be represented in the map, a simple scale is proposed. Different patterns used to fill a region represent sophistication degrees. Total fulfillment of the region represents high sophistication. Half coverage of the region represents intermediate sophistication. A small solid circle inside the region represents basic sophistication.

AHA! categorization using E-ACM (see Figure 1) is used in the sequence to discuss the map structure. As can be observed in Figure 1, all represented mechanisms present the half coverage pattern, since the architecture of AHA! is heavily inspired by AHAM, which is used as reference model.

The External Level

The top dimension is related to goal conditions. Represented mechanisms in the external level depend on the application. External modeling methods on the top of the map help individuals to perceive and represent goal-oriented information in the problem domain. They are used to identify elements, their characteristics, and rela-

Figure 1. AHA! categorization



tionships, without any concern with low-level descriptions in a computational platform.

Considering AHA! techniques for goal achievement, there is in Figure 1 an indication regarding the user model. The graph author supports high-level definition of concepts and offers automatic translation to lower-level specifications.

The Intermediate Level

In the E-ACM, conditions and services are projected toward each other through the intermediate abstraction level and interfaces, creating columns and cross-regions. In Figure 1 there are seven columns and 12 cross-regions in each column. These regions are triangles, since three goal conditions were identified.

The E-ACM offers a separation of concerns strategy based on these cross-regions. Each one of them can be marked to point out the presence of computational elements oriented to the respective dimensions that curb the region. If several different mechanisms exist and relate to the same region, the indication of the most sophisticated prevails.

Mappings between levels and sublevels are required to progress from one level of description to another (Benyon & Imaz, 1999). The easiness of a mapping between modeling methods that belong to different abstraction levels depends on available mechanisms supported by the higher-level modeling method, and which are named *mapping facilitators*. A mapping facilitator presents some type of direct translation for elements specified through it into elements obtainable through a lower-level modeling method. The existence of mapping facilitators is captured in E-ACM by filling cross-regions in the interfaces between abstraction levels.

Through the AHA! graph author, it is possible to generate attributes and adaptation rules automatically whenever a concept is created. The translation from high-level constructs to the low-level adaptation rules is performed automatically, based on templates. These are considered mapping facilitators and are represented in the interface between the external and intermediate levels.

With the concept editor, a designer can associate a requirement expression with fragments in a page. Depending on the expression, the fragment is rendered or a second fragment is used. The indication of such facility appears in Figure 1 at the abstract intermediate sublevel.

The Physical Level and Data Manipulation Services

The bottom of the map considers physical data modeling methods. Computational elements are usually specified from already defined information elements and respective goal conditions, resulting in code and data structures at the physical level after a series of modeling through the intermediate sublevels. Physical data schemas, code, and software and hardware information sensors should be specified as a result of semantic mappings from higher abstraction levels for each service.

The two traditional services, presentation (here named perception) and navigation, are present in the map. The five additional services, which result from a deeper separation of concerns, are: interaction, query and search, management, preparation, and authoring.

Because AHA! specification mechanisms produce relatively high-level descriptions that are interpreted by AHA! itself, there is no indication in the physical level nor in the abstract intermediate sublevel.

Traditional Concerns

The traditional concerns dimension, although not visible in E-ACM, exists behind the map as an orthogonal and implicit dimension, which is considered from the intermediate abstract level to the physical level.

When using the E-ACM to categorize a modeling method, a complete framework is considered, with all possible data structures, functional modules, and constraints. Once one of the cross-regions is selected for a mechanism, it becomes implicit which framework components are going to be affected by the use of this mechanism under the dimensions that define the cross-region.

The AHA! adaptation model defines how to update the user model. The user model contains some user characteristics and an overlay model, which consists of a set of attribute pairs for each concept. The adaptation and user models are behind the authoring tools, whose constituents result from definitions such as new attributes for concepts created through the preparation and perception services. These mechanisms are represented in Figure 1.

FUTURE TRENDS

As can be observed in the previous section, a system such as AHA! does not need to provide modeling mechanisms for every service, or to cover all abstraction levels. Gaps in the categorization map show where other systems can be used to complement existing functionalities, as well as opportunities to extend the system.

Combining modeling dimensions, from the open hypermedia field to those already accepted by the adaptive hypermedia community, is a promising approach toward a more comprehensive normative way to describe adaptable and adaptive systems.

Separation of concerns applied to the services dimension restrains what information can be used to infer adaptation, offering a rich ground for adaptation opportunities. For instance:

- The query and search service needs stable personal data, such as personal intentions and task goals, to exploit adaptation through interest representation and updating, according to filtering parameters, and localization of information.
- The preparation service acts upon historical information that is highly mutable and is related to the user evolution on her/his interaction with the system to exploit adaptation during rendering and modality processing, through selection of media and content (optional explanations, optional detailed information, hints, etc.).
- The perception service is related to output devices and drivers concerned with presentation issues to exploit adaptation through spatial structure, background, color, fonts, sound level, and media synchronization.
- The navigation service is based on browser history and hyperspace visibility to exploit link structure, overview map and location, resources already visited, bookmarks, and so forth.
- The interaction service is concerned with input interfaces and devices to exploit adaptation through configuration of devices, hot keys, tool control, control and query languages, and so forth.
- The authoring service is concerned with authoring utilities and facilities that exist in an adaptive application, such as with a graphical editor for CSCW. Adaptation can be exploited with possession control, admission policy, election instrument, and also with authoring tool preferences.
- The management service is concerned with resource operation to exploit policies for configuration, and options for troubleshooting, security and privacy, and QoS (performance).

In the management service, there are interesting adaptation options to explore in mobile applications.

One other interesting effort to invest in is to investigate what existing modeling methods present the potential to be integrated in order to produce broader horizontal and vertical coverage of the E-ACM map.

CONCLUSION

Hypermedia applications, such as e-commerce, e-government, and mobile commerce, are beginning to explore adaptation techniques in order to offer attractive services and interfaces. Moreover, adaptation can be also exploited in situations where severe constraints apply, for example with bandwidth communication fluctuations or users with physical disabilities.

There are several proposed frameworks and models to help designing hypermedia applications. With almost no exception, they combine incomplete software functional components with abstraction layers or with information categories. These approaches must be extended to provide a consistent and integrated vision in the form of a normative model, which allows easing system development. Toward this end a tool, the extended abstract categorization map, is presented through an example.

The E-ACM provides graphical representations for the existence and sophistication of specification mechanisms according to their abstraction level, the computational service to which they are oriented, and the goal condition that must be considered to model elements that represent domain entities in computational terms. The proposed map is a step towards the integration of modeling dimensions that are not usually combined.

As an example, AHA! is categorized using E-ACM according to the two constituents of AHA!: authoring tools and the runtime system. It is possible to observe that modeling actually occurs through the authoring tools, and comprises the preparation and perception services. Only two of three abstraction levels are covered by AHA! modeling mechanisms.

The E-ACM tool can be used to perceive what modeling mechanisms can be included in a system such as AHA!, and thus it allows consideration of its integration to another system.

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KEY TERMS

Abstraction Levels: A model is an abstraction, and as such it may represent an aspect of reality with some level of detail. Different models can represent the same aspect, each with a different abstraction level. The abstraction level is directly related to the amount of detail represented in the model.

Adaptability: One says this of a system that can perform adaptation based on configurations set by the user before or during the execution of the system.

Adaptation: A system characteristic concerned with the capacity of adjusting its behavior according to one or a combination of targets: the user, the human computer interaction process, or the computational platform.

Adaptivity: One says this of a system that can perform adaptation automatically. Generally, the system acquires and analyzes external data in order to make inferences and execute adaptation actions.

Data Manipulation Services: A set of computational services responsible by some functional facility that could exist in a hypermedia system.

Design Perspectives: A designer can abstract characteristic types of the modeling object and exploit only one characteristic type, such as behavior, and using that dimension she/he develops a model that represents that object.

Goal Conditions: These are underneath application descriptions and are related to external concepts to be considered by an application realization, such as a requirement to contemplate collaboration.

Traditional Modeling Concerns: Traditionally, modeling concerns are related to representations for structure (data), behavior (process), and constraints.

W

Web Portal Gateways

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INTRODUCTION

The term *Web portal* is overused and takes on a different meaning depending on the view of the author. This article will investigate the concept of a portal, the various types of portal, and how portals are currently being used. A Yahoo search of the Web in February 2004 revealed 85 million entries for the word *portal,* and even allowing for a considerable degree of overuse and overlap, portals are seen everywhere and span a bewildering range of topics and interest areas. It would be difficult to make any use of the Web without encountering one.

In general terms, unrelated to the World Wide Web, the *Macquarie Dictionary* defines a portal as "a door, gate or entrance" (Macquarie Library, 1981, p. 1346). More specifically, a Web portal is seen as a special Internet (or intranet) site designed to act as a *gateway* to give access to other sites (Tatnall 2005a). A portal aggregates information from multiple sources and makes that information available to various users. In other words a portal is an all-in-one Web site whose prime purpose is to find, and to gain access to other sites, but also one that provides the services of a guide that can help to protect the user from the chaos of the Internet and direct them towards an eventual goal. More generally, however, a portal should be seen as providing a gateway, not just to sites on the Web, but to *all network-accessible resources,* whether involving intranets, extranets, or the Internet. In other words a portal offers centralised access to all relevant content and applications (Tatnall 2005b).

Historically, the Web-portal concept probably developed out of search engine sites such as Yahoo!, Excite, and Lycos, which can now be classified as first-generation portals. These sites, however, quickly evolved into sites providing additional services such as e-mail, stock quotes, news, and community building rather than just search capabilities (Rao 2001). Eckerson (1999) outlines four generations of portals whose focus, in each case, is: generic, personalised, application, and role. The success of a portal depends on its ability to provide a base-site that users will keep returning to after accessing other related sites. As an entranceway onto the Web (or an intranet) it should be a preferred starting point for many of the things that a particular user wants to do there. A useful goal for those setting up a portal is to have it designated by many users as their browser start-up page.

BACKGROUND

There is no definitive and generally agreed categorisation of types of portal, but Portals Community (http://www.portalscommunity.com/) offers the following list: Corporate or Enterprise (intranet) portals, e-business (extranet) portals, personal (WAP) portals and public or mega (Internet) portals. Another categorisation (Davison, Burgess, & Tatnall, 2004) offers: general portals, community portals, vertical industry portals, horizontal industry portals, enterprise information portals, e-marketplace portals, personal/mobile portals, information portals and niche portals. Unfortunately, as the categories are not mutually exclusive some portals fit into more than one while others do not fit well into any. To further complicate any attempt at categorisation some implementations can span several different portal-types blended into a form of hybrid solution. A discussion of various different types of portals follows.

- **General (or Mega) Portals:** Portals aim to provide links to sites that can be either closely related or quite diverse. In the case of general portals the intent is to provide links to all sorts of different sites of the user's choosing. Many of these general portals have developed from being simple search tools (such as Yahoo), Internet service providers (such as AOL), and e-mail services (such as Hotmail). They now try to be the one-stop port-of-call for all (or at least many) user needs. An important goal of a general portal is to become the page a user returns to each time they want to access something on the Web. It will be successful if it can provide most of the services, information and links that users want. General portals often include services such as: free e-mail, links to search engines and categories of information, membership services, news and sports, business headlines and articles, personalised space with a user's selections, links to chat rooms, links to virtual shopping malls and Web directories. General portals make their money by selling advertising material. The success of a general portal depends on it generating a large volume of visitor traffic and this involves attracting new visitors, keeping them at the site for as long as possible, and on convincing them to return. The profitability of general portals, however, has not been high (Sieber & Valor 2002, 2005).

- **Vertical Industry Portals:** Usually based around specific industries. They aim to aggregate information relevant to particular groups, or online trade communities of closely related industries to facilitate the exchange of goods and services in a particular market as part of a value chain. Vertical industry portals often specialise in business commodities and materials such as chemicals, steel, petroleum products or timber. Some specialise in services like cleaning, food, transport, staffing or publishing. Others specialise in interest areas such as camping, hiking or fishing equipment.
- **Horizontal Industry Portals:** Portals can be described as *horizontal* when they are utilised by a broad base of users across a horizontal market. Horizontal industry portals are typically based around a group of industries, or a local area.
- **Community Portals:** Often set up by community groups such as eLaunceston (http://www.elaunceston.com/) and Cape Breton, Canada (http://www.centralcapebreton.com/) or based around special group interests such as GreyPath (www.greypath.com) (Lepa & Tatnall, 2002), iVillage (http://www.ivillage.co.uk/) and Women.com (www.women.com). These portals attempt to foster the concept of a virtual community where all users share a common location or interest, and provide many different services depending on their orientation. The extent to which some community portals represent the interests and views of their *entire* community is, of course, open to interpretation.
- **Enterprise Information Portals:** The term *enterprise* (or *corporate*) *information* portals is now often applied to the gateways to corporate intranets that are used to manage knowledge within an organisation. These are designed primarily for business-to-employee (B2E) processes and offer employees the means to access and share data and information within the enterprise (Stein & Hawking, 2005). They may include facilities such as: a categorisation of information available on the intranet, a search engine covering the entire intranet, organisational news, access to e-mail, access to common software applications, document management, links to internal sites and popular external Web sites, and the ability to personalise the page. Variations include business intelligence portals that are designed to act as gateways to decision-making processes and to provide competitive intelligence, business area portals that support specific business processes such as personnel or supply chain management, and facilities designed to support the field sales force.
- **E-Marketplace Portals:** These extended enterprise portals often offer access to a company's extranet services and are useful for business-to-business processes such as ordering, tendering and supply of goods. An example is provided by the Swiss company ETA SA Fabriques d'Ebauches (http://www.eta.ch/), a member of *The Swatch Group* that produces watches for brands including Omega, Rado, Longines, Tissot, Certina and Swatch. The group consists of a number of individual companies that focus on producing components and movements for watches. The portal was set up principally to improve cost efficiency and facilitate quicker order processing between members of the group (Alt, Reichmayr, Cäsar, & Zurmühlen, 2002). E-marketplace portals can also be used for business-to-customer transactions, and a classic example is provided by the bookseller Amazon.com (www.amazon.com). Another example comes from the Association for Computing Machinery (http://portal.acm.org/portal.cfm) digital library.
- **Personal/Mobile Portals:** Following the trends towards mobile (or pervasive) computing, personal/mobile portals are increasingly being embedded into mobile phones, wireless PDAs and the like. Some appliances are also being equipped with personal portals aimed at allowing them to communicate with other appliances, or to be used more easily from a distance.
- **Information Portals:** Although these, in most cases, can also be classified into one of the other categories, information portals can also be viewed as a category in their own right as portals whose prime aim is to provide a specific type of information. The Sports Information portal ESPN (http://msn.espn.go.com/) is one example of such an information portal. Another is Portals Community (http://www.portalscommunity.com/), a portal dedicated to providing information about portals.
- **Specialised/Niche Portals:** Designed to satisfy specific niche markets. In many cases these can also be classified as Information Portals. For example, ESPN (http://msn.espn.go.com/) is targeted towards 18- to 34-year-old males, while iVillage (http://www.ivillage.co.uk/) is targeted towards women. Other specialised portals provide detailed industry information, often available only for a fee.

WHAT IS NEW ABOUT PORTALS?

A colleague recently remarked that there is nothing new about portals. In this comment he is both partially right and completely wrong. A simple definition sees a Web portal as a special Web site designed to act as a gateway to give convenient access to other sites. In a sense there is nothing new about this as Web sites have contained hyperlinks to other sites since the Web's inception. What is new is the way that these special Web sites are now being used to facilitate access to other sites that may be closely related, in the case of special purpose portals, or quite diverse in the case of general portals. What is also new is that the marketers have discovered the portal concept and its advertising potential.

Research by Tatnall, Burgess and Singh (2004) indicated that small businesses can also benefit from the use of portals, especially in the provision of a secure environment for online trading, opportunities for new partnerships, and improved customer management.

SOME CURRENT USES OF WEB PORTALS

The uses of portals are legion. There are government portals such as: www.gouv.qc.ca (Québec) and www.vic.gov.au (Victoria). Science portals include: http://sdcd.gsfc.nasa.gov/ESD/portal (Goddard Space Flight Centre), www.eco-portal.com, and www.environment.gov.au. Community portals cover many regions and interest areas including: http://melbourne.citysearch.com.au/ (Melbourne), www.greypath.com (Greypath), and www.portalscommunity.com (Portals Community). Many portals relate to the IT industry, including: www.ifip.org (IFIP) and www.microsoft.com/sharepoint (Microsoft SharePoint portal). There are a number of education portals such as: www.educatorsportal.com and www.edmin.com (for educational administration), and www.sofweb.vic.edu.au/ (for schools). Portals relating to other interest areas include: libraries—http://portal.unesco.org, music—www.bach-portal.com, sport—www.thebaseballportal.com, health—http://www.betterhealth.vic.gov.au/, and genealogy—www.genealogyportal.com. There is even an antiportal portal for those who dislike portals—http://internetbrothers.com/aortal.

The marketing value of portals has not gone unrecognised, and Schneider and Perry (2001) note that Web managers have discovered that increased sales and advertising income can result from the portal's ability to attract more people and retain them longer. They point out that Web portal companies have added *sticky* features like chat rooms, e-mail and calendar functions, in order to retain visitors longer at their sites. Kleindl (2001) notes that portal sites will soon attract 40% of all commerce revenue and gain 67% of advertising dollars. The success of the portal industry is closely linked to marketing but Michael (2005) points out that advertisers and marketers are yet to understand the full potential of the Internet. Michael argues that a key function of marketing is to match buyers and sellers and to facilitate transactions, but that to do this a proper institutional infrastructure is required. He points out that marketers need to be aware of new demographic segments that are being attracted to the Internet for searching and shopping purposes and that portals should be regarded as strategic tools in the marketing process.

Government portals are rather like business enterprise portals, except being outward rather than inward looking, and Aitkenhead (2005) notes that government portals are becoming gateways or central access points for many e-government initiatives around the globe. They perform this task well as they provide a consistent and easy-to-use interface that allows citizens access to a range of government services. There are many business factors driving the implementation of government portals including the massive proliferation of Web sites, the large amount of duplicated information, the advantages portals offer in positioning businesses for future integration of information from a single point, and the strengthened security they provide.

Portals are also of interest to the scientific research community. An article in *Portals* magazine (Roberts-Witt, 2003) describes the National Biological Information Infrastructure (NBII) in the United States (www.nbii.gov and a number of private sites) as a government-to-government/partner/citizen portal, based on Plumtree Corporate Portal software. The NBII portal allows biologists (researchers and students) to share geographic and geospatial data, without the need to know exactly where the data is housed and to whom it belongs.

Moon and Burstein (2005) review the way portal technology can assist in the search for medical information and assist users in broader community contexts. In particular, they look at how portals are employed for meeting community medical information needs and how medical portals could be improved so that they could assist users with these needs. They explore the extent to which these portals behave intelligently in addressing users' needs, discussing what constitutes an intelligent portal, outlining the desirable components and attributes of such a portal and how these can be implemented to meet the needs of diverse users.

The Web has the potential to be a major source of information for older people, and Lepa (2005) describes Greypath—a portal aimed at serving the needs of older Australians. He notes that statistics show that the proportion of older people will increase dramatically over the next 25 years and that the Web has the potential to improve the lives of these people. Older people could use specially designed older person portals as their first port of call on the Internet and use the links provided to access the informational and recreational activities they are interested in.

Portals are being used to a significant extent in all levels and aspects of education. In one example, Bajec (2005) describes the use of portals in institutions of higher-education, and examines the motivating factors that drive these institutions to use portal-based solutions. He notes that almost all universities are either developing or purchasing portal solutions for systems integration, utilisation of e-business technology, and provision of wider access to data and services on existing systems.

FUTURE TRENDS

The demise of the portal has been predicted for a long time, and particularly since the dot-com crash of several years ago. Several years ago, *Online Publishing News* (1999) ran a story entitled: “The Portal is dead. Long Live the Vortal?” suggesting that general portals had seen the end of their usefulness and that vertical industry portals would grow in importance. A recent report by Gartner (Phifer, 2003) titled: “The Portal is Dead. Long Live the Portal” takes this theme further and argues that portals are evolving into integrated software suites containing portal functionality. White (2003) notes that portals are undergoing a metamorphosis in which they are merging with technologies such as content management, collaboration and business intelligence. Predictions that the portal would disappear into application servers have also proved untrue (Plumtree Software, 2003). Like Mark Twain’s (Partington, 1996, p. 706) exclamation in 1897, however, reports of the portal’s death appear to have been greatly exaggerated.

CONCLUSION

The concept of a gateway is one that is very relevant to the World Wide Web, and the importance of the Web portal has thus grown considerably in recent years. Because of the huge size of the Web, users need some assistance in finding anything useful, and the portal has moved to fill this role. Far from a concept that is dying as was suggested by several authors a few years ago, the use of portals continues to grow. The portal is an evolving entity that has an important part to play in the future of both corporate intranets and the World Wide Web.

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KEY TERMS

Community Portals: Often set up by community groups or based around special group interests, they attempt to foster the concept of a virtual community where all users share a common location or interest, and provide many different services.

E-Marketplace Portals: Extended enterprise portals that offer access to a company's extranet services.

Enterprise Information Portals: The gateways to corporate intranets that are used to manage knowledge within an organisation. These are designed primarily for business-to-employee (B2E) processes and offer employees the means to access and share data and information within the enterprise.

General (or Mega) Portals: Portals that provide links to all sorts of different sites of the user's choosing, often from a menu of options.

Horizontal Industry Portals: Portals utilised by a broad base of users across a horizontal market.

Information Portals: Can also be viewed as a category in their own right as portals whose prime aim is to provide a specific type of information.

Personal/Mobile Portals: Portals embedded into mobile phones, wireless PDAs, appliances and the like.

Specialised/Niche Portals: Portals designed to satisfy specific niche markets. Sometimes they provide detailed industry information, often available only for a fee.

Vertical Industry Portals: Usually based around specific industries, they aim to aggregate information relevant to these groups of closely related industries to facilitate the exchange of goods and services in a particular market as part of a value chain.

Web Portal: A special Internet (or intranet) site designed to act as a gateway to give access to other sites.

Category: Concepts, Trends, and Challenges

Web Services

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INTRODUCTION

Web services are changing the way in which the World Wide Web is currently being used. The Web was created originally to support human-to-computer interactions with textual and graphical data. Today, people use the Web to read the latest news, buy consumer goods, search for information, and obtain stock quotes. However, the Web does not yet support effective computer-to-computer interactions between software applications of different enterprises.

Web services can enable Internet-based software applications of different enterprises to interact with each other directly by providing application programs with the ability to invoke operations that otherwise would be invoked manually by a human through a browser. Web services can run not only on mainframe computers and server computers, but also on desktop computers and client handsets. Web services allow individuals and organizations to publish links to their software applications, just as they publish links to their Web pages.

Web services solve the enterprise application integration (EAI) problem by enabling interaction among different applications within the same organization. They can also enable computer-to-computer applications of different organizations to interact without human intervention. For example, Web services can be used for reservation systems, order-tracking systems, and business supply chains. In the example shown in Figure 1, Company A (a customer) orders goods from Company B (a distributor). Company B checks the availability of the goods from Company C (a supplier), and then arranges for payment and shipping of the goods to Company A without human intervention.

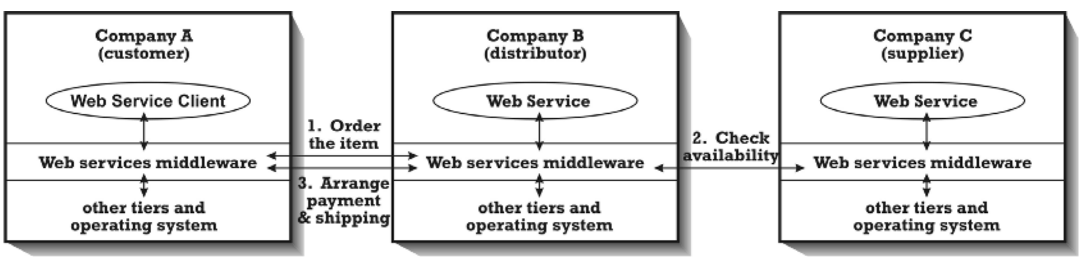
Performance, security, and reliability are factors that will limit the use of Web services unless those issues can be properly addressed. Nonetheless, the potential widespread use and benefits of Web services are very compelling. Web services allow disparate computing systems and applications to be coupled together, and they enable enterprises to streamline and automate their business processes.

BACKGROUND

The term Web services is used today with alternative meanings. Sometimes a Web service is considered to be any application that is accessible over the Web. This usage is very general and is not what we mean here by a Web service, nor is it a Web service as defined by the standards organizations.

The Universal Description, Discovery and Integration (UDDI) Consortium (2001) has described Web services as "self-contained, modular business applications that have open, Internet-oriented, standards-based interfaces." This definition emphasizes the need to be compliant with Internet standards. It also requires a Web service to be open, which means that it has a published interface that can be invoked by another computer program over the Internet.

Figure 1. Use of Web services in business-to-business interactions



The World Wide Web Consortium (W3C, 2002) has gone further to define a Web service as "a software application identified by a URI [Uniform Resource Identifier], whose interfaces and bindings are capable of being defined, described, and discovered as XML [eXtensible Markup Language] artifacts. A Web service supports direct interactions with other software agents using XML-based messages exchanged via Internet-based protocols." This definition emphasizes that a Web service must be capable of being defined, described, and discovered so that it is possible to create client software that binds to and interacts with it using the defined interfaces. It also states explicitly that Web services are based on XML.

Webopedia (Jupitermedia Corporation, 2004), an online technical dictionary, has given an even more specific definition of a Web service as "a standardized way of integrating Web-based applications using the XML, SOAP [Simple Object Access Protocol], WSDL [Web Services Description Language] and UDDI [Universal Description, Discovery, and Integration] open standards over an Internet protocol backbone. XML is used to tag the data, SOAP is used to transfer the data, WSDL is used for describing the services available, and UDDI is used for listing what services are available." In addition to XML, this definition requires the use of SOAP, WSDL, and UDDI.

Other useful Web-services references include Alonso, Casati, Kuno, and Machiraju (2004), Fisher (2002), Newcomer (2002), and Zimmermann, Tomlinson, and Peuser (2003).

WEB SERVICES TECHNOLOGY

Web Services Architecture

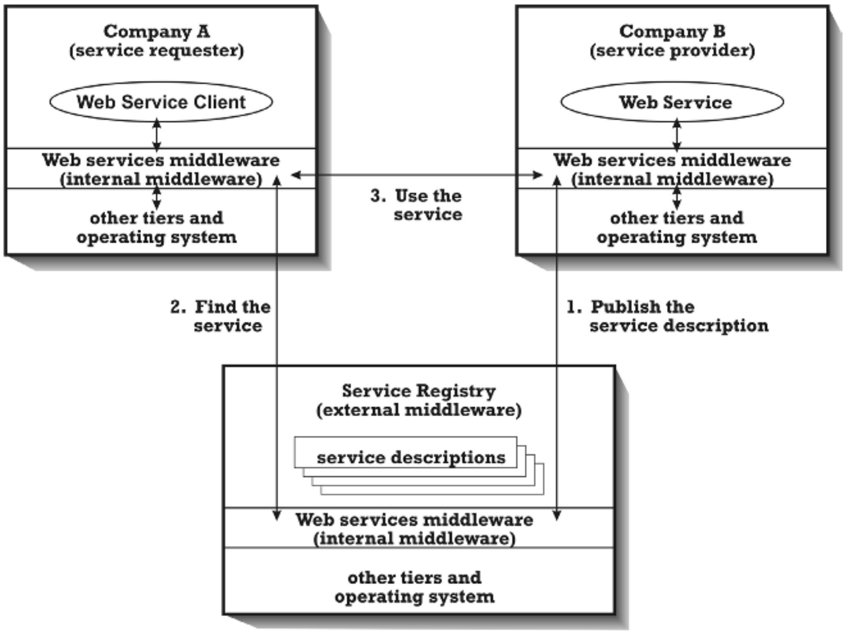
The Web services architecture, developed by the World Wide Web Consortium (W3C: ARCH, 2004), is described briefly below and is illustrated in Figure 2.

Viewed externally, a service provider creates a Web service and defines an interface for invoking that service. The service provider also provides a service description for the Web service and makes the service known to the world by publishing the service description in a service registry. The service registry uses the information in the service description to catalog the service and to search for the service when it receives a request for information about the service from a service requester.

When a service requester tries to find a service, it queries the service registry. The service registry replies with a service description that indicates where to find the service and how to invoke it. The service requester can then bind to the service provider by invoking the service. The service registry is itself a Web service, the address and interface of which are known a priori to the service requester.

Internally, Web services can be viewed as a tier on top of the other tiers of an enterprise architecture. The internal middleware for Web services packs and unpacks messages exchanged between Web services and converts

Figure 2. Web services architecture



them into the format supported by the underlying middleware.

The Web services architecture is based on the following technology and standards.

- Extensible markup language (W3C: XML, 2004), which defines the syntax of Web services documents so that the information in those documents is self-describing
- Simple object access protocol (W3C: SOAP, 2004), which provides a standardized way to encode different protocols and interaction mechanisms into XML documents that can be easily exchanged across the Internet
- Web services description language (W3C: WSDL, 2004), which is an advanced form of Interface Definition Language (IDL) that has been augmented to define aspects of a service description
- Universal description, discovery, and integration (Organization for the Advancement of Structured Information Standards [OASIS]: UDDI, 2004), which is used by the service registry and is where service providers publish and advertise available services, and clients query and search for services

The UDDI registry can be viewed as external middleware for Web services.

Extensible Markup Language

XML (W3C: XML, 2004) provides a common syntax for Web services documents and defines the rules to which a document must conform in order to be well formed. The goals of XML are interoperability, portability, and automatic processing with data independence for different programming languages, middleware systems, and database-management systems.

Like the HyperText Markup Language (HTML), XML has elements, attributes, values, and tags. XML elements and attributes provide type and structure information for the data. XML element tags describe the data items that they enclose. The following is an example.

```
<Supplier>
    <Name>Disco</Name>
    <PhysicalAddress>1 Hard Drive, San Jose, CA
     95131<\PhysicalAddress>
    <PhoneNumber>408-123-4567<\PhoneNumber>
    <URL>www.disco.com<\URL>
<\Supplier>
```

XML provides a standard way to define the structure of documents so that they are self-describing and, thus, are suitable for automatic processing. An XML parser can determine that a document contains a certain element and can extract the content associated with that element.

XML schemas and document-type definitions are used to define document types and to state that a document is of a certain type. An XML document verifier can be used to check whether the structure and content of a document is consistent with the prescribed type. Currently, XML schemas and document-type definitions do not provide semantic information about the document or the elements within it.

More precise tagging instructions have been defined for various vertical industrial sectors. In particular, the Organization for the Advancement of Structured Information Standards and the United Nations Center for Trade Facilitation and Electronic Business (OASIS & UN/CEFACT, 2004) have developed the electronic business XML (ebXML) standard as a successor to the electronic data interchange (EDI) standard. The ebXML standard defines an architecture and specifications designed to automate business-process interactions among trading partners.

Simple Object Access Protocol

SOAP (W3C: SOAP, 2004) underlies all of the interactions between Web services. SOAP defines how to organize information using XML in a structured and typed manner so that the information can be exchanged via messages.

SOAP supports loosely coupled applications that interact via one-way asynchronous messages using a protocol such as the Simple Mail Transfer Protocol (SMTP). It can also be used to implement conventional Remote Procedure Calls (RPCs). The procedure call is encoded in a SOAP request message, and the results produced by the procedure are encoded in a SOAP response message. For RPC, a synchronous protocol such as the HyperText Transfer Protocol (HTTP) is used to transport the messages.

SOAP messages are used as envelopes in which an application encloses whatever data it wishes to send. An envelope consists of two parts, a header and a body, as shown in Figure 3. The header is optional and the body is mandatory. Both the header and the body can have multiple subparts in the form of header blocks and body blocks.

A SOAP message has a sender, a receiver, and an arbitrary number of intermediaries (nodes) that process the message and route it to the receiver. The information that the sender wishes to transmit to the receiver is in the message body. Additional information needed for intermediate processing or for value-added services (such as transactions or security) is included in the message header.

The two interaction styles of SOAP, document style and RPC style, are also shown in Figure 3.

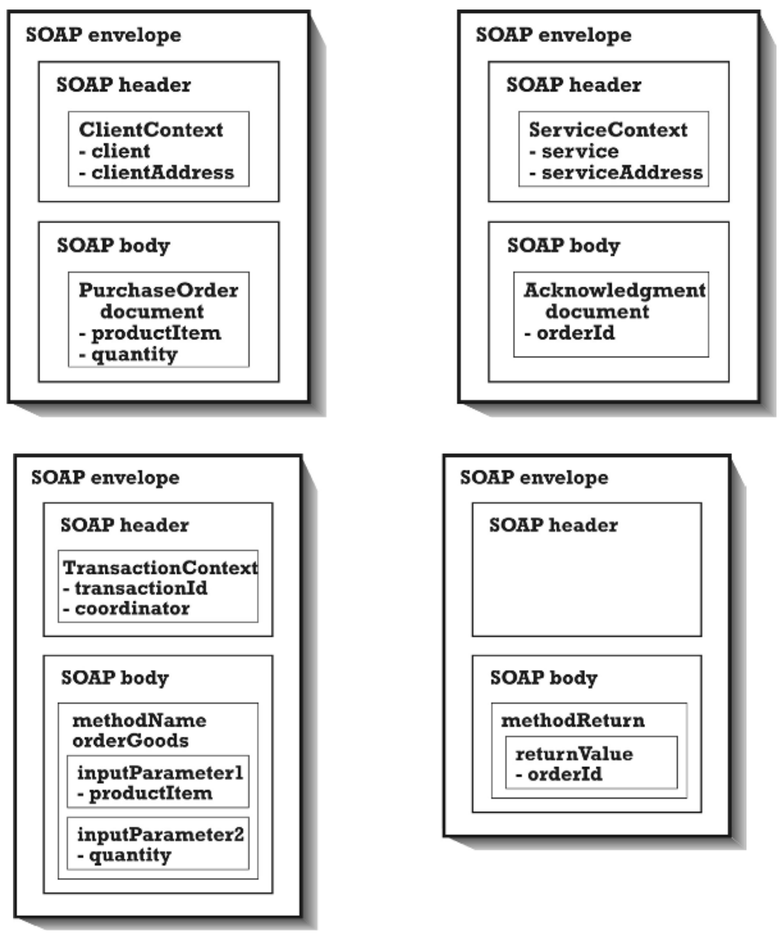
In document style, the two interacting applications agree on the structure of documents to be exchanged, and the documents are transported in SOAP messages from one application to another. For example, a client that orders goods from a supplier creates a PurchaseOrder document. The body of the SOAP message consists of the items and quantities requested. The header includes information that identifies the client to the supplier. The supplier creates an Acknowledgment document that contains the order ID of the confirmed order, and then sends it to the client in a SOAP message.

In RPC style, the body of the request message contains the procedure call, including the name of the procedure being invoked and the input parameters. The body of the response message contains the result and the output parameters. The two interacting applications must agree on the RPC method signature rather than the structures of the documents. For example, a client that orders goods from a supplier creates a SOAP message containing the procedure name orderGoods, as well as the parameters productItem and quantity, in the body of the SOAP message. The supplier creates a SOAP message containing a confirmation of the client's order as the response. Any additional properties associated with the RPC are included in the header. In particular, for a transactional RPC, the request header includes the transactional context, which enables the receiver to process the request.

Web Services Description Language

WSDL (W3C: WSDL, 2004) is similar in purpose to the IDL of other middleware platforms, such as the Common Object Request Broker Architecture (CORBA). A WSDL description specifies how to interact with the Web service, what data must be sent, what operations are involved, what protocol is to be used to invoke the service, and what data can be expected in return. A WSDL description can be used as input to a compiler that generates

Figure 3. Structure and content of a SOAP message showing an envelope with a header and a body, and two different interaction styles: document style at the top and RPC style at the bottom



stubs and skeletons, and can be used to capture information that allows reasoning about semantics.

A WSDL description consists of an abstract part and a concrete part, as shown in Figure 4. The abstract part is analogous to conventional IDL, and uses type, message, operation, and port type constructs. These four constructs are called abstract because there is no concrete binding, no encoding specified for them, and no definition of a service that implements them.

Types allow the exchanged data to be interpreted correctly at both endpoints of the communication. By default, WSDL uses the same basic and structured types as XML schemas.

A message is a typed document that is divided into parts, each of which has a name and a type. For example, a message for a procedure call with integer and floating-point-number parameters contains a part containing the integer and a part containing the floating-point number.

Operations are classified as one way, notification, request-response, and solicit-response. One-way and notification operations involve a single message, whereas request-response and solicit-response operations involve two messages. One-way and request-response operations are initiated by the client, whereas notification and solicit-response operations are initiated by the service.

A port type in WSDL is analogous to an interface in IDL. A port type consists of a set of related operations.

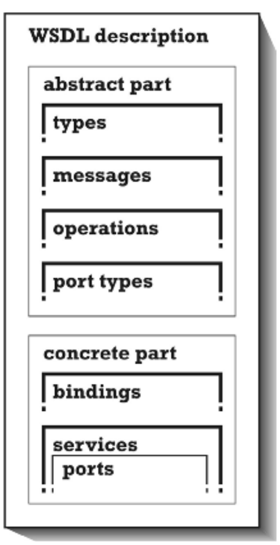
The concrete part of a WSDL specification defines an instance of a service and uses interface bindings, ports, and service constructs.

An interface binding specifies the message encoding and protocol bindings for all operations and messages defined in a port type. In particular, it specifies the encoding rules to be used in serializing the parts of a message into XML. It can also be used to specify that an operation is document style or RPC style, or that the messages of the operation must be communicated using SOAP with HTTP or SMTP bindings.

A port combines the interface binding information with the network address, specified as a URI, where the implementation of the port type can be accessed.

A service is a logical grouping of ports, typically related ports at the same address.

Figure 4. A WSDL description



Universal Description, Discovery, and Integration

The UDDI specification (OASIS: UDDI, 2004) provides a framework for describing and discovering Web services. UDDI is based on the notion of a business registry (essentially, a naming and directory service). UDDI defines data structures and APIs for publishing service descriptions in the business registry and for querying the registry to look for published descriptions.

UDDI supports application developers in finding information about Web services so that they know how to write clients that can interact with those services. It also enables dynamic binding by allowing clients to query the registry and obtain references to services in which they are interested. In addition, it supports the idea of a Universal Business Registry (UBR) where anyone can publish service descriptions and query the registry for services of interest.

The information within a UDDI registry can be categorized as follows:

- Listings of organizations, contact information, and services that those organizations provide;
- Classifications of companies and Web services according to taxonomies that are either standardized or user defined;
- Descriptions of how to invoke Web services, by means of pointers to service description documents, stored outside the registry, for example, at a service provider's site.

A UDDI registry contains Web services descriptions with four different kinds of information elements described as follows:

- **businessEntity:** An organization that provides Web services, including the company's name, address, and other contact information.
- **businessService:** A group of related Web services offered by a businessEntity. Typically, it corresponds to one kind of service (such as a procurement or reservation service). It might be provided at

different addresses, in multiple versions, or through different technologies (e.g., different protocol bindings).

- **bindingTemplate:** Technical information needed to use a Web service, such as the address at which the Web service can be found and references to documents (called tModels) that describe the Web service interface and other service properties. It also defines how operation parameters should be set and what the default values are.
- **tModel:** Technical model, which is a container for any kind of specification. For example, it might represent a WSDL service interface, a classification, or an interaction protocol, or it might provide the semantics of an operation.

UDDI registries have three types of users to which they expose their Application Program Interfaces (APIs): service providers that publish services, service requesters that look for services, and other registries that need to exchange information. Interaction with a UDDI registry takes place as a sequence of exchanges of XML documents, typically using SOAP.

As yet, there is little experience of software applications that use a UDDI registry to discover a Web service, and then invoke that Web service using its WSDL interface. Rather, in current practice, client applications are designed explicitly to invoke Web services with known WSDL interfaces and URIs.

FUTURE TRENDS

Today, Web services are used mainly for conventional enterprise application integration within a single enterprise rather than between different enterprises. Most systems that support Web services employ XML, SOAP, and WSDL, and to a more limited extent UDDI. It is generally accepted that UDDI registries will be used by humans to find interface information rather than by computer programs to create dynamic bindings.

In the future, Web services will move from the client-server model of distributed computing to the peer-to-peer model, with protocols that the interacting parties execute cooperatively. Peer-to-peer interactions will require more coordination among the Web services, which requires correspondingly more coordination among business partners rather than simply interfaces between service requesters and providers.

Major factors that will limit the use of Web services are performance, security, and reliability unless those issues can be properly resolved.

Performance is an issue because Web services consume large amounts of network bandwidth, memory space, and processing cycles because XML documents are text-based (rather than binary-based), self-describing, and interpreted. Even precompiled distributed computing middleware, such as CORBA, has quite high overheads; Web services incur much higher overheads. Special hardware, such as new types of routers and accelerators, might offset the adverse performance impact of Web services. The use of binary attachments to XML documents in SOAP messages might address the performance issue, but it loses the self-describing and interoperability advantages of XML.

Security is a major concern for Web services when software applications in one enterprise invoke software applications in another enterprise over the Internet. Even if the messages pass through the firewalls of the enterprises, they must pass all the way up the protocol stack to the applications, where security breaches can occur. Web services are vulnerable to several kinds of attacks: identity-based attacks in which a hacker poses as an authorized user to access a Web service, malicious-content attacks in which an intruder forces a server to perform an unauthorized activity, and operational attacks in which a hacker manipulates an XML message to tie up server resources. Security appliances that parse XML messages, ensuring that known business partners originated them and that they contain no hidden instructions, can help to address the security issue, as can the Secure HyperText Transfer Protocol (HTTPS), Internet Protocol (IP) filtering, and the new Web services security standard (OASIS: WS-Security, 2004).

Reliability is also a concern for Web services. There is no guarantee that SOAP messages sent over HTTP or SMTP will be reliably delivered to the applications. End-to-end reliable delivery requires that the intended destination applications receive the messages exactly once and in the correct order. The Web services community is currently working on several different reliable messaging specifications, including WS-Reliability (OASIS: WS-Reliability, 2004) and WS-ReliableMessaging (IBM, BEA, Microsoft, & TIBCO, 2004). In addition, Web services must support long-running business transactions across multiple enterprises that provide data consistency and protection against faults. Work on such business-transaction standards includes the WS-Coordination, WS-AtomicTransactions, and WS-BusinessActivity specifications (IBM, 2004). Without agreement on specific standards, reliable messaging and business transactions will be implemented in ad hoc manners, unnecessarily complicating interoperability, portability, and extensibility.

The ultimate goal of Web services is dynamic interaction among businesses in an open community, with automated clients that browse UDDI registries, find services and service providers, discover how to interact with those services, and invoke those services without human intervention. Automated dynamic interactions among business partners will not be possible until the partners agree on the semantics of the documents to be exchanged. Currently, the Web and Web services specifications focus primarily on the syntactic aspects of representing and communicating information. Semantic Web services (McIlraith, Son, & Zeng, 2002; W3C, 2001), in contrast, aim for the complete automation of Web services by standardizing the representation and handling of semantic metadata to describe Web services and how to use them. Semantics are very difficult even for humans, and initial use of semantic Web services will be restricted to very narrow, well-defined domains.

The ability of an application to locate an appropriate Web service, and to select among competing alternative Web services, will require major advances in the automated analysis of semantic information, an activity that is currently research rather than practice.

CONCLUSION

Web services are intended to provide computer-to-computer interaction of software applications over the Internet. Web services depend on the use of XML to structure and tag information so that it is self-describing, SOAP to convey XML documents in messages between service requesters and providers, WSDL to describe Web services so that they can be easily accessed, and UDDI to publish and discover Web services. Web services aim to establish and maintain interoperability between applications within a single organization and between organizations over the Internet.

Extensions to Web services standards are needed before Web services can be used for dynamic business interactions among business partners rather than only for conventional enterprise application integration. The use of Web services is likely to grow as these extensions are added and as Web services standards become more widely accepted. The development of semantic Web services will facilitate the movement from the existing Web of unstructured information without semantics to a semantic Web of services through which the computer systems of customers and service providers can conduct business automatically without human intervention.

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KEY TERMS

Electronic Business XML (ebXML): An architecture and set of specifications designed to automate business-process interactions among trading partners.

eXtensible Markup Language (XML): A standard language for defining the syntax and structure of documents with the goals of interoperability, portability, and automatic processing of applications among different enterprises; the data in an XML document are tagged and thus are self-describing.

Semantic Web Services: Web services that incorporate semantic metadata that describe Web services and how to use them in a standard way in order to achieve the automation of Web services.

Simple Object Access Protocol (SOAP): A standard protocol that defines the way in which information is formatted and packaged before it is exchanged.

Universal Description, Discovery, and Integration (UDDI): A specification that provides a framework for describing and discovering Web services based on the idea of a business registry.

Web Service: A software application identified by a URI whose interfaces and bindings are capable of being defined, described, and discovered using XML, and that supports direct interactions with other software applications using XML-based messages via an Internet protocol. Web services provide a standard way of integrating Web-based applications using XML, SOAP, WSDL, and UDDI over the Internet.

Web Services Description Language (WSDL): A standard language that is used to describe Web services and service interfaces as XML documents, including the operations offered by a service, the mechanisms that can be used to access the service, and the location of the service.

Web Services and B2B Collaboration

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INTRODUCTION

Web service technology is moving into the mainstream. HTTP-based integration is proving more useful than prior approaches for integrating heterogeneous and distributed systems. Web service architectures are quickly advancing beyond and becoming more complex than their initial XML (extensible markup language)/SOAP (simple object access protocol)/UDDI (universal description, discovery, and integration) architectures. With added specifications, Web services are creating a service-oriented computing paradigm with their attendant terms and concepts, such as Web service networks, Web service management platforms, and service-oriented architectures (SOA), among others. Aided by Web services, business-to-business (B2B) integration topologies are growing in diversity to support various options for B2B collaboration. Web services are now the primary technical direction enabling this diversification of B2B collaborations (e-collaboration) among value chain partners and customers. They form the foundation for the development of a new generation of B2B applications and the architecture for integrating enterprise applications (Kreger, 2003). Web services promise to increase these partnering companies' flexibility, agility, competitiveness, as well as opportunities to reduce development cost and time.

BACKGROUND

B2B Collaboration

The Internet has reshaped industry value chains and redefined e-business as collaborative commerce. In this environment, companies collaborate with suppliers, distributors, service providers, and customers to produce value for customers. Such collaboration turns participating companies into virtual enterprises that emphasize rapid exchange of information among participating companies and inter-organizational systems to facilitate communication, coordination, and collaboration. A new IT-enabled intermediation and an integrated virtual value chain are emerging. The Internet facilitates supply chain integration through greater coordination and collaboration among all members of a company's supply chain (Lee & Whang, 2001). Such integration emphasizes information sharing, transparency, data integrity, and flexibility. Its benefits are clear: cost and time reduction, real-time communication, lead-time reduction, and improved collaborative planning and forecasting.

Web Services Growth

Businesses have indicated strong interests in deploying Web services in the near future. A recent Yankee Group survey of 437 companies reports that 48% of respondents have already deployed Web services and another 39% expect to deploy the technology within a year (Scurmacz, 2004). The top reasons for early adoption include: (1) the ability for an enterprise to enhance its capability to collaborate with external partners (77%); (2) the ability to reduce complexity in distributed applications (66%); (3) the ability to drive increased revenue in the next two years (66%); and (4) the ability to lower development costs (58%).

In a February 2002 Gartner survey, 27% of the IT respondents indicated that they would be using Web services in a systems integration project within 12 months. By February 2003, that number had risen to 42% (Cantera, 2003). The technology research firm, IDC, predicts that Web services will spur software, hardware, and service sales of $21 billion in the U.S. by 2007 (Muse, 2003).

WEB SERVICES TODAY

B2B e-commerce is entering a phase of technological maturity in which major open standards are adopted to enable inter-firm integration and collaboration. Web services are a significant enabler of this move toward inter-firm cooperation by promoting technology trust between enterprises through their deployment and use. The role of Web services in B2B e-commerce builds technology trust and indirectly influences performance outcomes.

Types of B2B Collaborations

Companies have various options in pursuing B2B collaborations (Ranganathan, 2003). Web service technology can be implemented to support these collaborations through various means. Table 1 identifies these options and the opportunities to adopt Web service technology for each option.

Web Services Standards

Web services can be thought of as a means by which an application service may be provided to other applications on the Internet. XML is the foundation technology in Web services, as all access to the services are delivered in XML documents via HTTP. Web services are described in the Web services description language (WSDL). Web services can optionally be registered in the UDDI repository where other applications can both register and discover services. Web services can be revealed and accessed within a company and between companies, as well as on the public Web.

Web service technologies address heterogeneity problems that previous technologies could not overcome. For years, IT organizations have sought increased system reuse and interoperability between systems (Lim & Wen, 2003). Since Web services operate via the HTTP protocol, they are more firewall-friendly than older object-oriented technologies. With UDDI, Web services have a consistent approach to introspection that older object-oriented technologies do not. And with SOAP, access to objects can be standardized as well, unlike object-oriented technologies such EJP, CORBA, and COM+.

Web services are now increasing in sophistication. Service-oriented computing and architectures are taking Web services beyond supporting simple XML interactions to more robust business interactions within and across enterprises (Curbera, Khalaf, Mukhi, Tai, & Weerawarana, 2003). Specifications for quality of service and service composition such as business process execution language (BPEL) for Web services (BPELWS) currently authored by IBM, Microsoft and BEA, WS-Coordination, WS-Transaction, WS-Security, WS-Reliable Messaging, and WS-Policy will allow for far richer, higher-level delivery of computing services via a Web services management platform (WSMP). Papazoglou and Georgakopoulos (2003) describe three layers of services: basic services, composite services, and managed services. Basic services manage publication, discovery, selection, and binding. Composite services facilitate coordination, conformance, monitoring, and quality of service. Managed services provide market certification, rating, service-level agreements, and operations support.

Business Drivers for Web Services

Because Web services can be layered on top of existing software applications and accessed across a value chain, Web services are a modest, incremental technology investment with a fast return. Development time for solutions spans weeks, not months. Different industries will have different drivers for Web services. For example, financial services will need business process improvements over the next four or five years. Web service solutions that support supply chain integration and collaboration first require streamlining business processes. Some companies will find a way to offer their core competencies as Web services to customers, enhancing their revenue streams (Boynton, 2003).

Organizations can benefit from Web services at three levels—infrastructure, operations, and strategic (Huang & Hu, 2004). Infrastructure values stem from using industry-accepted standards and protocols to ensure interoperability among diverse systems. Standardization facilitates information sharing and knowledge transfer within and across firms. Operational values stem from efficient applications development and reuse, based on standards, resulting in efficient and effective business operations. Strategic values relate to SOA, which facilitates the adaptation of IT functions to exchange data internally and with collaboration partners. A flexible IT infrastructure can enhance organizational agility. The

Table 1. Web services for B2B collaboration: Options, requirements, and value propositions

Collaboration Options	**Requirements**	**Values of Web Services**
Buyer-based, one-to-many private exchange	Forge a strong collaboration with supply chain partners	Lower cost of transactions, increased integration
Seller-based, one-to-many private exchange	Foster collaboration with the end customers	Customer retention
One-to-one proprietary linkages	Extend a firm's traditional EDI- or EAI-integration	Enhanced application integration
Independent, public many-to-many exchange	Strengthen the role of intermediary in the exchange	Economies of scale, security, access
Consortia-based many-to-many exchange	Attain common goals of participating companies	Process integration, flexibility

adoption of SOA promises to have significant benefits for e-business collaboration.

Enterprise Adoption of Web Services

Enterprises face various barriers to the adoption of Web services for B2B integration. These challenges include: limited returns on return of investment, inadequate employee skills to support implementation, insufficient senior management support, a lack of technical standards, concerns over security, and poor application interfaces (Charlesworth & Jones, 2003). A multi-case study by Ciganek, Haines, and Hasemanet (2005) of Web services adoption in the financial industry reveals that environmental factors—un-readiness of business partners, industry inertia, security, and standards—seem to play a dominant role in delaying the adoption decision. In comparison, innovation factors of Web services—visibility, complexity, and tools—pose marginal challenges to adoption decisions. Organizational factors, such as IT skills, software development, IT architecture, and financial justification, only have modest effects. Therefore, a strong business need fueled by the demand of key customers or suppliers could drive the growing adoption of Web services.

Gap in Public Web Services

Public Web services also promise to facilitate e-business collaboration. These services are available on the public Web as opposed to applications in intra-corporate scenarios. However, a review by Fan and Kambhampati (2005) of current public Web services reveals that most of the available services (84%) are for data sourcing, number conversion, sensing, or data processing. Only seven public *e-business* Web services were identified. Currently, the industry does not offer sophisticated public Web services that have the potential to interact with other services to support e-business collaboration. Furthermore, very few ways of composing services are available online, mainly due to the lack of services and the correlations among them.

Integration Models

Web services for e-collaboration require the integration of data, application, and business processes. Data-level integration requires an understanding of both database structure and its usage. An enterprise-wide metadata repository will help to define the mappings and necessary transformations required to move data between applications. Application-level integration enables integration of messages from any source, often using an asynchronous message flow to reduce dependency between applications. Process-level integration, which defines the business processes underlying corporate strategies, addresses business processes crossing application boundaries (Charlesworth & Jones, 2003). Business process integration is essential to e-business collaboration.

Security and Standardization

Security is usually viewed more as a business or standards issue rather than a pure technological issue. However, the perceived immaturity of standards poses a substantial challenge for Web services adoption. Organizations are hesitant to provide Web services publicly outside their firewalls. Attention must be paid to rigorous authentication, integrity, non-repudiation, encryption, and security matters. Key threats include: (a) the security of information that is shared between the broker, the requester, and the provider; (b) the security of the network; and (c) the security of the programming model at design time. Trust in e-business also incorporates the notion of trust in the underlying technology infrastructure for facilitating transaction. The dynamic nature of the Web services architecture presents new opportunities for technology trust building (Ratnasingam & Pavlou, 2002).

Standards for Web services security are continuing to mature. Most Web transactions today use secure sockets layer/transport layer security (SSL/TLS) protocols for basic security. However, to address more complex business requirements, designers of Web services have found the SSL/TLS protocols inadequate to address enterprise security concerns. For those complex transactional models involving many trading partners or needing more granular security control over the data, implementers are now beginning to use WS-Security, a maturing standard in Web service transaction security. WS-Security mechanisms are embedded within data objects and persist with the transaction whenever it is moved, including whenever transactions are archived. In contrast, SSL/TLS security can only protect a point-to-point transmission. WS-Security can be used in conjunction with SSL/TLS, and both sets of standards are likely to continue to evolve (Wagner & Heiser, 2005).

FUTURE TRENDS

Web Service Network Providers

Web service network (WSN) providers are emerging to support different business needs. A WSN provides security, services tracking, integration and application services, and trading partner services such as provisioning, non-repudiation, and support. WSNs support different topologies: (a) hub and spoke topology in which a management platform is resident within the WSN; (b) hub and spoke topology in which each partner maintains unilateral control over Web services provisioning and security; (c) unilateral peer-to-peer (P2P) topology; (d) facilitated P2P topology; and (e) facilitated switched-based WSN topology (Lheureux, 2002). Companies will begin to consider a WSN product to manage the exchange of Web services between applications in its internal environment and a WSN service to manage the exchange of Web services with trading partners (Lheureux, 2002).

Web Services Management Platforms

While initial implementation of Web services may be simple, over time B2B integrations will become complex. To alleviate the challenges in managing meshed and chained Web services, Web service management platforms are likely to become mainstream technologies by 2006 (Smith, Andrews, & Abrams, 2003). This increase is also being fueled by Microsoft's aggressive distribution programs, and the entry into the Web service management market of major vendors such as Hewlett-Packard. Business process integration may be aided by the increased adoption of BPEL or other standards such as business process management for Web service flow composition (Smith et al., 2003).

Impact on ERP Vendors

Web services may contribute to the decline of ERP vendors for numerous reasons. Web services can integrate dissimilar systems and enable rapid acquisition of innovative applications. These services can reduce large development budgets by allowing companies to implement change at a pace the organization can absorb, not the pace the ERP vendor demands. Web services accept diversity in architecture, but its adoption rates are slow and will only increase after an IT organization is restructured to shift attention away from computing and onto communications (Strassman, 2003).

Web Services Technology for Private Exchange

Web services will be increasingly used within private exchanges, on either the buyer-side or seller-side one-to-many exchanges. Factors include: the need for companies to maintain agile relationships with partners and the need to protect the identity of services the business offers from anonymous access, and to cement relationships through business agreements, not simply through business process integration. Web services are a more dynamic architecture for enabling a business to rapidly adjust its services, and the private exchange allows companies to maintain some level of secrecy in services (Plummer & Andrews, 2001).

Alignment with E-Business Strategies

An organization needs to align Web services with its strategy in order to realize the strategic benefits of these services. Using these services to improve innovation and learning could result in information sharing and collaboration, and organizational agility. Web services could lead to process automation and acceleration, interoperability, integration, and process redesign. Improved value propositions strengthen relationships with customers and e-business partners. Thus, the alignment would result in better financial performance and shareholder value through reduced operational cost and increased revenue (Huang & Hu, 2004). Enterprise adoption of Web services is expected to evolve over four levels—from technical solution (level 1), IT solution (level 2), internal business solution (level 3), to external business solution (level 4). At level 4 adoption, an organization will engage in process integration with customers or suppliers. This is the case when Web service technology is used for substantial B2B interaction, such as in supply chain applications (Haines, 2004).

Businesses frequently cooperate with one another at all phases of a product's lifecycle in a transient or temporary manner. Instead of forming enduring structures binding the businesses together, businesses form virtual enterprises to reduce costs, increase flexibility, and focus on core competencies (Tolle & Bernus, 2003). For example, Web service technologies are being used to streamline process integration in financial services through a concept known as "straight through processing," reducing cycle times on transactions from several days to one (Khoshafian, 2002). Workflow, business process management standards, and dynamic lookup and binding provide the infrastructure to support the agility and flexibility that virtual enterprises require.

To facilitate rapid creation of virtual enterprises, designers of Web services will increasingly rely on reference models and ontologies. Reference models are system design patterns which can be readily copied and implemented. Many ERP modules are reference models that businesses frequently have to customize for a specific advantage. Ontologies, a formal specification of a shared set of concepts, reduce or eliminate confusion in concepts and terms, and may play a key role in Web collaborations (Gu, Chen, Yang, & Zhang, 2004). For example, e-commerce marketplaces, which bring together many suppliers and buyers, require participants to integrate complex product catalogs. Companies are beginning to apply emerging ontology-based knowledge management tools to assist with the mapping of concepts and syntactical rules between trading partners (Omelayenko, 2001). This fusion of virtual enterprises, Web services, ontologies, and reference models is helping businesses execute flexible, agile, and rapid business strategies.

CONCLUSION

Information technology is again shaping and accelerating the convergence of many forces. Various standards bodies are creating new, higher-level specifications. Nearly every major vendor has committed to a Web service architecture strategy. P2P technologies and Web services are beginning to blend naturally. Service-oriented computing and Web service architectures are allowing companies to deliver more business services across the Internet. Web service technology is supporting a wide variety of collaboration relationships across simple and complex value chains. Despite the challenges that Web services are facing in reaching ubiquity, they are already allowing a rich arrangement of B2B collaborations and new dimensions of competition.

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KEY TERMS

Peer-to-Peer Architecture (P2P): An approach to building distributed systems characterized by an increasing decentralization and autonomy of components.

Service-Oriented Architecture (SOA): A component model that integrates the different functional units of an application (services) through well-defined interfaces and contracts between those services. The interface is independent of the hardware, operating system, and programming language.

Simple Object Access Protocol (SOAP): The current industry standard for XML-based messaging in Web services. SOAP consists of three parts: an envelope that defines a framework for describing the contents of a message, a set of encoding rules for expressing instances of application-defined data types, and a convention for representing remote procedure calls.

Universal Description, Discovery, and Integration (UDDI): A mechanism for holding descriptions of Web services. UDDI defines a data structure standard for representing Web service description information in XML. It is also a mechanism, or a directory, for finding Web services.

Web Services Description Language (WSDL): An XML-based language for describing Web services and their interfaces.

Web Services Management Platform (WSMP): Software for managing and monitoring the quality of service in a Web services environment. It manages faults, capacity, availability, performance, service-level agreements, and service levels of Web services.

Web Services Network (WSN): An intermediary brokering service that supports electronic collaborations between applications based on Web services standards (WSDL, SOAP, and UDDI).

Category: Concepts, Trends, and Challenges

Web Services' Security

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INTRODUCTION

Web services provide a standard architecture for heterogeneous systems to share and exchange information over the Internet (Iyer, Freedman, Gaynor, & Wyner, 2003). In this context, Web services are based on the building-block approach of using prior Internet protocols and standards as components of Web services. The building blocks include HTTP, adopted as the transport protocol, and XML, used as the format of the messages that are transferred between cooperating applications (Lim & Wen, 2003).

For e-businesses to fully realize the benefits of Web services, security issues need to be addressed. Security has become a major concern for all enterprises exposing sensitive data and business processes as Web services (Bhatti, Bertino, Ghafoor, & Joshi, 2004). In this regard, this research proposes an integrated security approach for Web services architecture.

The proposed approach, which is an addendum to the Web services security specifications, is built on XML-role-based access control (RBAC) for Web services business processes. Basically, it supports protocol-independent declarative security policies that can be enforced by Web service providers, and descriptive security policies that clients can use to access the services in a secure manner.

BACKGROUND

The sharing of information and knowledge resources is the main motivation for constructing distributed systems. According to Coulouris et al. (2001), a distributed system is one in which components located at network computers communicate their actions only by passing messages. Today, e-commerce is evolving into a dynamic business network where participants have distinct IT platforms and applications. The problems associated with heterogeneity in platforms and applications require technological solution that provides integration without sacrificing past IT investments. In this context, Web services can be considered as the best choice from the different options among distributed environments (Iyer et al., 2003).

Before entering into the security aspects of Web services, it is of vital importance to understand what Web services are. Sleeper (2001, p. 1) defined Web services as "loosely coupled, reusable software components that semantically encapsulate discrete functionality and are distributed and programmatically accessible over standard Internet protocols." In other words, Web services provide a standard way for heterogeneous applications to share and exchange information. Web services are based on the following open standards (Iyer et al., 2003):

- Simple object access protocol (SOAP),
- Extensible markup language (XML),
- Web services description language (WSDL),
- Application programming interface (API), and
- Universal description, discovery, and integration (UDDI) (See Key Terms for more information).

Web service is conceived as a new paradigm for distributed computing environments. However, Web services architecture is still vulnerable to potential security threats (Chatterjee & Webber, 2004). For instance, some of the message level security threats include: message alteration, confidentiality, man-in-the-middle, snooping, denial of service (DoS), and reply attacks.

The most common security techniques used for overcoming these issues are the following: authentication mechanisms, authorization, data integrity and data confidentiality, integrity of transactions and communications, non-repudiation, end-to-end integrity and confidentiality of message, audit trial, and distributed enforcement of security policies. However, such techniques by themselves are not sufficient because they do not consider the holistic view of the e-business processes' security.

The foundation of Web services security is the Web services security plan and roadmap developed by IBM and Microsoft (IBM & Microsoft, 2002). The specifications of this security roadmap are WS-Security, WS-Policy, WS-Trust, WS-Privacy, WS-SecureConversation, WS-Federation, and WS-Authorization.

Several models to address Web-Services security issues have been proposed. In this regard, Joshi et al. (2001) provided an evaluation and comparison of the discretionary access control (DAC) model, the mandatory access control (MAC) model, and the role-based access control (RBAC) model.

The RBAC models have received wide acceptance. They classify the elements of the system into users, roles, permissions, operations, and objects. Because the administration of RBAC is separated from its access control functions, the security administration is made easier and more efficient (Bhatti et al., 2004; Sandhu, Coyne, &Youman, 1996). In addition, a very important characteristic of RBAC models is that they are able to represent organization policies. Chen and Sandhu (1996), who established the foundations for constraints RBAC, explained how organizations policies can be represented and enforced using constraints. In the context of Web services, RBAC does not incorporate the content and context of the information workflow; therefore, RBAC is not appropriate to secure Web services transactions.

Koshutanshi and Massacci (2003) proposed a security architecture for orchestrating authorization and security of the Web services processes (see Figure 1).

The XML-based RBAC approach proposed by Bhatti et al. (2004) provides access control for Web services at the element-level granularity. This approach includes the core RBAC primary elements (users, roles, permissions, operations, and object) as well as the role hierarchies and separation of duty constraints (Bhatti, Joshi, Bertino, & Ghafoor, 2003; Ferraiolo, Sandhu, Gavrila, Kuhn, & Chandramouli, 2001). Moreover, in order to capture the context information, this approach utilizes a location-based technique. Bhatti et al. (2004) uses XML-based specification language to represent each RBAC element and their relationships.

As it was mentioned earlier, Web services still present security issues that need to be addressed. According to Joshi et al. (2001), in order to take care of the Web-based security issues, comprehensive security frameworks are required. Hondo et al. (2002) stated that a Web service security model must support protocol-independent declarative security policies that Web service providers can enforce, and descriptive security policies attached to the service definitions that clients can use in order to securely access the service.

Even though Koshutanshi and Massacci (2003) approach addresses many security issues related to Web Services processes and information flows, it is still not sufficient. The framework by itself secures only the Web services processes and information flows from the client, which can be seen as an enterprise to the application server and vice-versa. As a result, the security of the Web services processes and information flows within the client (enterprise) is neglected. However, using the access control model created by Bhatti et al. (2004), the Web services process and information flows within the enterprise can be secured.

Using Bhatti et al. (2004) and Koshutanki and Masacci (2003) models as a foundation, an integrated architecture for Web services security is developed. Such architecture allows Web services business processes and information flows to be secured across enterprises, and at the same time inside of each enterprise.

A NEW APPROACH FOR EXTENDING THE WEB SERVICES' SECURITY

Essentially, the proposed approach provides for controlled access, secure sharing and distribution of information based on content and context, secure workflows, and secure interoperation in a Web services environment. It is important to keep in mind, that the proposed approach is an addendum to the Web services security specifications. Moreover, it is assumed that for securing the message the W3C and the IETF specification for the XML-signature (Bartel, Boyer, Fox, MaMacchia, & Simon, 2002) and W3C XML-encryption (Imamura, Dillway, & Simon, 2002) are being used. Figure 2 shows the proposed architecture.

The proposed architecture for Web services security consists of different components that interact in two different stages: client registration and client authorization. Figure 3 presents the building blocks of the pro-

Figure 1. Cross-section view of the architecture (Koshutanshi & Massacci, 2003)

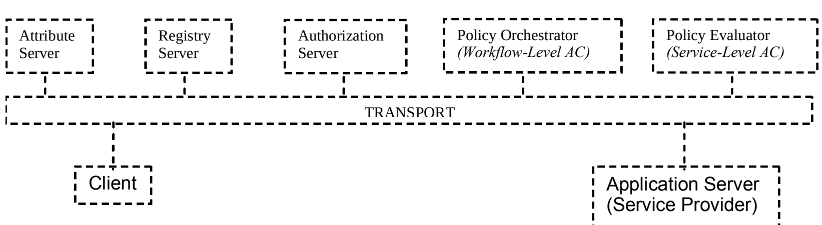


Figure 2. Web services security: Proposed architecture

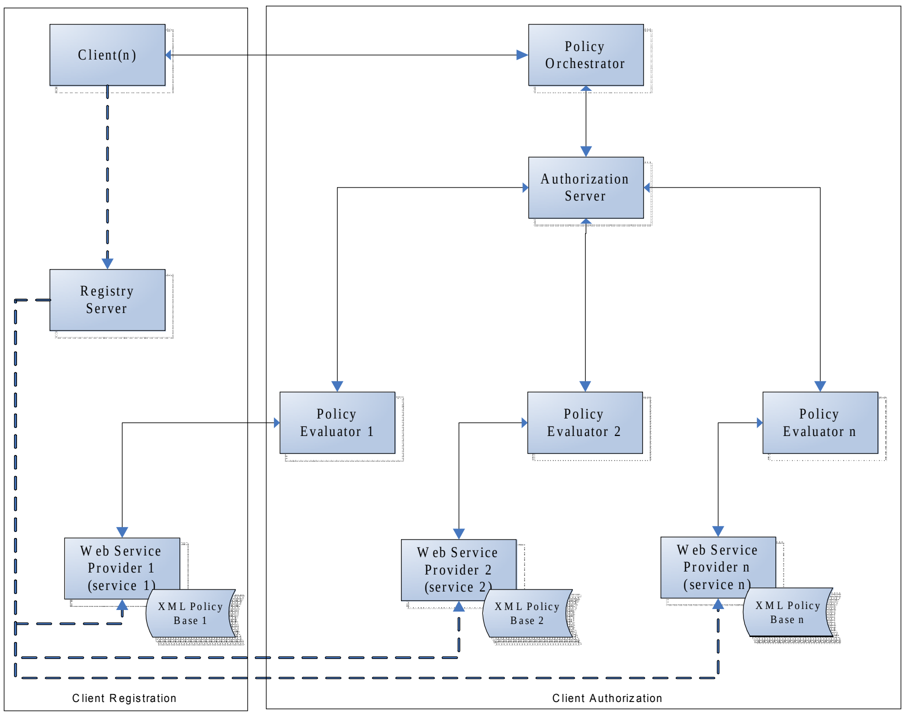
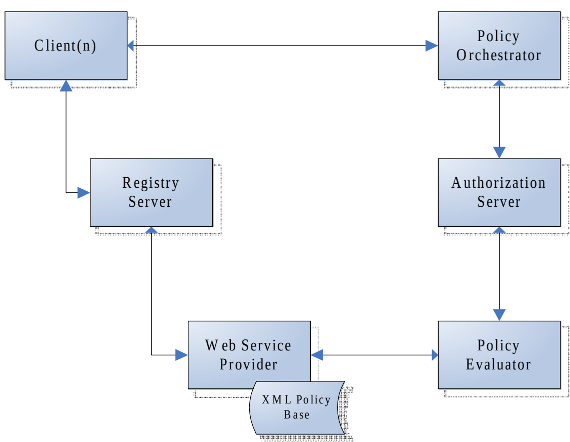


Figure 3. Building blocks of proposed architecture



posed architecture and Figures 4 and 5 show the client registration and client authorization process respectively.

This architecture consists of the following building blocks:

- **RegistryServer:** This component maintains the information related to the relations between services and service provider instantiating a particular service (Koshutanshi & Massacci, 2003).
- **AuthorizationServer:** It is in charge of locating, executing, and managing all needed *PolicyEvaluators* and giving an appropriate result to the *ApplicationServer*. In addition, the *AuthorizationServe* runs the actual authorization process by querying each *PolicyEvaluator* (Koshutanshi & Massacci, 2003).
- **PolicyEvaluator:** This element is responsible for attaining endpoint decision on access control. It is

important to keep in mind that each partner involved in the business process is represented by a *PolicyEvaluator* (Koshutanshi & Massacci, 2003).

- **PolicyOrchestrator:** It is one of the most important components of the architecture. It is in charge of the workflow level access and release control. In addition, the *PolicyOrchestrator* is responsible of the Policy Composition Service (Koshutanshi & Massacci, 2003).
- **XMLPolicyBase:** It is a repository which contains the security policy base. The policies relate to activities, roles, and resources are expressed in XML documents, so that, the *PolicyEvaluator* is able to understand and execute them (Bhatti et al., 2004)

Moreover, it is important to keep in mind that the information flows inside the client and Web service provider is made secure by using Bhatti et al. (2004) XML-based RBAC approach, which consists of the following components:

- **Document Composition Module:** It allows for composing XML schemas for RBAC elements and policy administrator documents.
- **Access Control Module:** It is the heart of the architecture. It interacts with others components and makes authorization decisions based on the policy base.
- **Session Management Module:** It monitors session activities and captures dynamic context information that updates user credentials.
- **Document Classification Module:** It manages the classification and clustering of all documents. In addition, this component handles the classification of new documents entering the source.
- **Credential Evaluator, Context Extractor, and Role Mapper:** The credential evaluator component assesses the credentials presented by the access control module and assigns the user to an existing credential type or creates a new credential type if there is not a match of the user credential type and the existing ones. In addition, the credential evaluator component, with the help of the role mapper, maps the credential to a role based on the assigned credential type. The context extractor evaluates the context information.
- **Repositories:** Three main repositories are used in this approach. The first repository is the referenced object base, which contains the physical objects from which the system administrator builds the XML document. The second one is the XML schemas and instances, which contains actual XML sources. The third one is the XML policy base, which contains all policy-related XML documents.

As it was mentioned earlier, the information flow logic in this architecture is a two stage process. In step 1, each

Figure 4. Web service security: Client registration

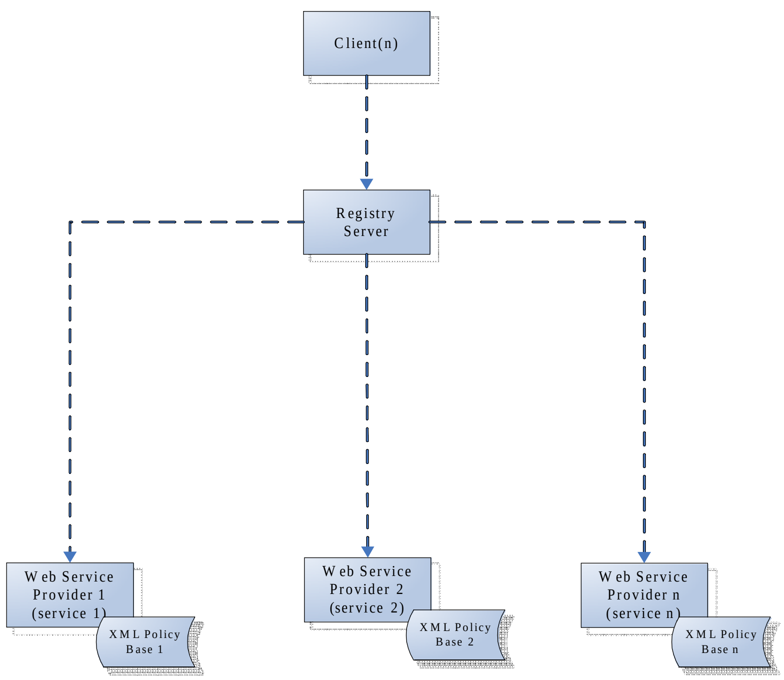
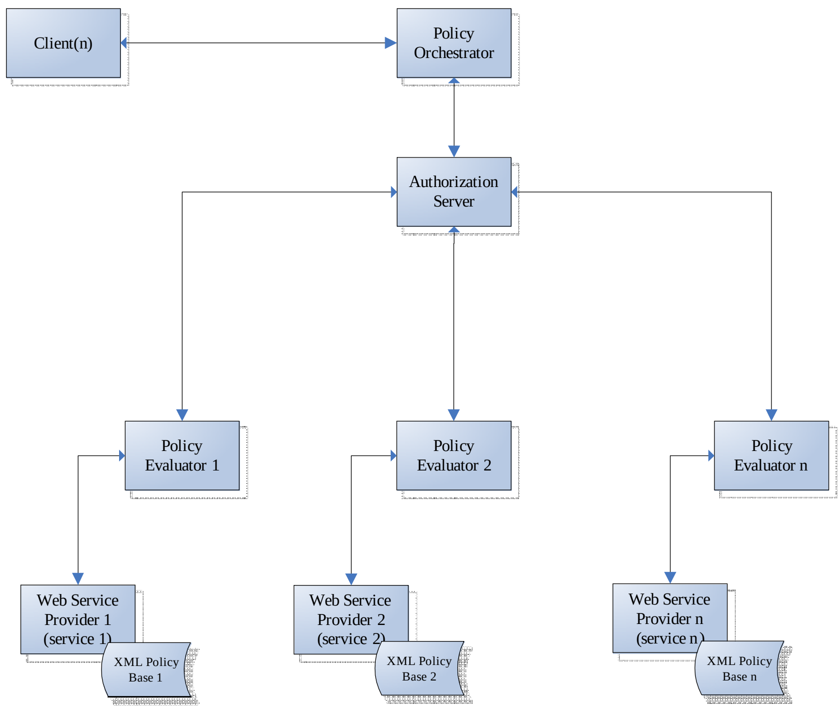


Figure 5. Web service security: E-business process authorization



enterprise (client) must be registered at each Web service provider involved in a business process, prior to access the service. This activity is performed through the *RegistryServer*. By using a XML-based RBAC the Web service provider examines its *XMLPolicyBase* and creates a XML document with access control specification (user-to-role mapping) for that particular client. This document is stored along with the user credentials at the *XMLPolicyBase* for later use. Figure 4 depicts the data flow logic for step 1, which is also depicted in Figure 2 as *Client Registration.*

After the client has been properly registered at the different Web Service providers involve in the e-business process, the step 2 which is the process of client authorization takes place. In this step, an enterprise (client) requests to execute a specific e-business process, which encompasses multiple activities (services) taken place at different partners (Web service provider). Figure 5 shows the data flows for step 2, which is also depicted in Figure 2 as *Client Authorization.* In this context, the client asks the *PolicyOrchestrator* for executing a workflow. The *PolicyOrchestrator* determines all the services involved in the workflow and then passes the information to the *AuthorizationServer,* which determines whether or not the client has the right privileges to access and execute the Web Service.

The *AuthorizationServer* queries the *PolicyEvaluator* of each Web service provider involved in the workflow and forwards the client credentials to each *PolicyEvaluator*. Subsequently, each *PolicyEvaluator* examines its *XMLPolicyBase* and determines the right privileges for that particular client and service.

After the *AuthorizationServer* had assessed the response from each *PolicyEvaluator* involved in the workflow, the client is either granted or denied to execute the services. The authorization to execute the e-business process is granted if and only if the client has the right privileges to access/execute all the services required by the workflow. By doing this, the business process as a whole is made secure.

FUTURE TRENDS

Future developments in the area of Web Service security should include technology such as intelligent agents and autonomic computing. A limitation of the proposed approach to secure Web services is that it still needs the human intervention to work properly. In fact, a security administrator for the Web Services architecture is required. Future e-businesses will require discovery, selection, and execution of business process in a dynamic way.

By using intelligent agents and the principle of autonomic computing, a secure Web Service architecture that dynamically changes depending upon new security polices, new business partners, and security threats could be designed.

Information transparency is needed in order for initiatives such as e-marketplaces works efficiently and effectively. However, a secure environment is mandatory as well. Web services are clearly a new paradigm and they will play an important role in the integration of disparate information systems in a secure way.

Finally, Web Services is paving the road for service-oriented architecture (SOA). Under SOA applications are designed and developed as reusable building blocks (services) that react to changing business condition. The research opportunities in the SOA area seem to be unlimited. For instance, the proposed Web services security approach could be extended in a way that SOA is made secure using the e-business process view.

CONCLUSION

Web service is conceived as a new paradigm for distributed computing environments. Web services allow the integration of heterogeneous networks and systems. However, in order for e-businesses to fully realize the benefits of Web services, security issues need to be solved. Even though many models have been proposed to address Web services security issues, they have failed in providing a complete and integrated solution. In order to properly secure Web Service architecture, a holistic view of the e-business processes needs to be considered.

This research proposed a security integrated approach that combines the orchestration authorization of web services processes and information flows with the XML role-base access control. Such approach guarantees an end-to-end secure Web services environment by providing controlled access, secure sharing and distribution of information based on content and context, secure workflows, and secure interoperation. The key of the proposed approach is that the authorization to execute the e-business process is granted if and only if the client has the right privileges to access/execute all the services required by the workflow. By doing this, the interorganizational business process as a whole is made secure.

Some of the advantages of the proposed approach include:

- The proposed approach is protocol-independent because it is based on XML RBAC.
- It leverages in the existing Web service security specifications; therefore, it can be easily integrate with existing standards and implementations.

Although the proposed approach is based on solid grounded theories, future research should be aimed at testing and improving it.

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KEY TERMS

Access Control: According to Hondo, Nagaratnam, and Nadalin (2002), it is a process by which the use of resources is regulated based on security policies and is permitted by only authorized system entities according to that policy.

Extensible Markup Language (XML): It was created as an extensible data format to address the limitations of HTML; however, it has become a standard for communication (Hondo et al., 2002). XML has been named "the universal format for structures documents and data on the Web" (http:www.w3c.org/XML). Some of the most important characteristics of XML are that XML resembles HTML, XML is human readable, XML is verbose, XML is a suite of technologies, XML is modular, and XML is license-free, platform-independent, and well supported (Chatterjee &Webber, 2004).

Security Policy: It is a set of rules and practices that establish how a systems or organization provides security services to protect resources (Hondo et al., 2002). Furthermore, security policies can be considered as the criteria used to grant or deny access to critical information resources.

Semantic E-Business: According to Singh, Iyer, and Salam (2005), semantic e-business is defined as "*an approach to managing knowledge for coordination of e-business processes through the systematic application of Semantic Web technologies*" (p. 20). The foundations of Semantic e-business are semantic Web technologies, knowledge management, and e-business processes.

Simple Object Access Protocol (SOAP): It is a simple, lightweight, and extendable XML-based mechanism for exchanging structured data between network applications on top of widely used Internet standards such as XML and HTTP (Hondo et al., 2002). A SOAP message is an XML document whose root element is called envelope. The envelope includes two elements: the first one is the SOAP header, which contains data from various Web services protocols that augment the basic of SOAP infrastructure. The second element is the SOAP body, which carries the application payloads (Chatterjee & Webber, 2004).

Universal Description, Discovery, and Integration (UDDI): UDDI is an industry standard that allows users to find Web services in a dynamic way. A UDDI registry is used by businesses that want to publish services, and by businesses that need to get certain services (Lim & Wen, 2003).

Web Services Description Language (WSDL): In short, WSDL is a language for describing Web services. WSDL is an XML IDL (interface definition language) that provides a way to describe the function and interface of a service. WSDL can be used to specify the interfaces of the Web services bound to a number of protocols including HTTP GET and POST. In addition, a WSDL interface logically consists of two parts: The abstract parts that describe the operations the Web service supports and the types of messages that parameterize those operations; and the concrete parts that describe how those operations are tied to a physical network endpoint and how messages are mapped onto specific carrier protocols which that network endpoint supports (Chatterjee & Webber, 2004).

Web Traffic Aggregation

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INTRODUCTION

One reason for registering domain names is for use in funneling Web traffic to a particular destination. Procter & Gamble (P&G) owns many domain names based on generic words that can be used to funnel visitors toward P&G brands. Cough.com, germs.com, and sinus.com all currently bring visitors to a page that takes United States visitors to the single Web site, vicks.com. Vicks.com in turn promotes P&G's Vicks-branded line of products that are associated with cough, germ, and sinus remedies. Gooogle.com, gogle.com, goolge.com, googel.com, and foofle.com are all owned by Google, used to *redirect*, or automatically take, visitors to a single Web site, google.com. In this way, Google is *aggregating* Web traffic, generated from all people who type these misspellings, to a single Web site.

Unfortunately, such *traffic aggregation* is sometimes used in ways that can create victims. A child who uses the URL (uniform resource locator) whitehouse.com with the intention to research a school assignment on the American White House (at http://whitehouse.gov) will be taken to a Web site with adult content. Someone who believes that he or she is using the URL of a Web site devoted to gun control could end up at a Web site with a threatening message by an opposing group (cf. "Hacker Intercepts," 2000; Montgomery, 2000). Someone who types what is thought to be the name of a popular children's Web site might be taken to a site that tricks people into downloading malicious software (cf. Happy Trails Computer Club, 2004; "IIS Exploit," 2004; MIT IS&T, n.d.; Spector, 2002). People might click on an index link or a personal bookmark to visit a school or church Web site, not knowing that the organization is using a new Web address, and be taken to a Web site with adult content (Markovich, 2001; cf.Bryant, 2001; Hardy, 2001).

BACKGROUND

Through the careful selection of domain names, P&G is possibly attracting visitors to Web sites that promote brands related to the generic words that it has registered. Through the selection of domain names related to common misspellings of its brand name, Google is attracting visitors who might otherwise get lost and not find its Web site. In either case, if these organizations were not using these domain names, someone else might. While attracting visitors to its Vicks brand with the use of domain names based on generic words, P&G is able to keep a competitor from using these words to push visitors toward a competing brand. If Google had not registered misspellings of its brand name, someone else could use those domain names to gain visitors to increase traffic to Web sites that are completely unrelated, such as those presenting pornography or gambling.

A *traffic aggregator* can, then, acquire domain names that generate traffic, but which will take visitors to Web sites with a purpose or theme that is unrelated to the apparent content of the domain name. The aggregator can then push ideological or commercial messages that Web visitors might otherwise not seek, can sell products that the visitor might not otherwise have purchased, can trick the visitor into divulging personal information (e.g., a credit-card number), or can download malicious software to an unsuspecting visitor's computer (cf. Marsan, 2002). Such a scheme can cause visitors to be victims.

In many cases, a traffic aggregator will acquire old, existing, abandoned domain names to redirect traffic to and thereby increase traffic to Web sites with gambling and adult content. In this scheme, the acquired domain names are often ones that have been deliberately abandoned by organizations that no longer need them. The abandoning organization probably does not realize, however, that the abandoned name has value to an aggregator because it still generates some traffic by being listed in link indexes, in peoples' browser favorite lists, and such. The victims in these cases are not only visitors, but also those who maintain link lists that include the abandoned domain names. The abandoned domain name is not simply a dead link when it is reacquired by such a traffic aggregator; it is now a link to objectionable material. In this way, organizations such as the United Nations and the U.S. Department of Education have found themselves accused of maintaining Web sites with links to pornography (Marsan, 2002).

THE EMERGENCE OF TRAFFIC-AGGREGATION ACTIVITIES

Domain-name speculators registered domain names in the early days of the World Wide Web on the expectation that they had future value either for personal use or for resale. Procter & Gamble was once the owner of dozens of domain names such as armpit.com, beautiful.com, diarrhea.com, and flu.com, reportedly asking for more than $1 million each for at least some of the nearly 100 names that it auctioned in 2000 (Associated Press, 2000; McCarthy, 2000; Oppenheimer, 2000; VeriSign, 2000). The purchaser of the $7.5 million domain name Business.com, eCompanies, believed that its high purchase price for this name was a wise investment because the name would drive traffic and thereby lower advertising expenditures (Mack, 1999). But such names were long ago registered, and the resale values are now high enough that few can afford to make such an investment.

Domain-name squatters register the names of famous trademarks, organizations, or people on the hope that those identified with these might someday want to purchase them or on the expectation that these could be used to drive traffic to a Web site with unrelated content. Ron Gonzalas, candidate for mayor of San Jose, CA, found that the domain name Gonzalas2002.com had already been registered to someone who had similarly registered future dates with the names of mayoral candidates in other large U.S. cities as well as the names of U.S. senators. San Francisco mayor Willie Brown's name was registered on multiple domains as a way to drive traffic to content that was unfavorable to the mayor (Learmonth, 1999). Arbitration decisions that have favored a challenge by someone who would appear to have more legitimate rights to the name, existing trademark laws, and new laws, however, will probably decrease such interests in domain-name squatting in future years (cf. Mariano, 2001; *Anticybersquatting Consumer Protection Act*, 1999).

Typosquatters and *Web spoofers*, however, rely on using traffic that is already generated by a particular name or Web site. Spoofers and typosquatters register an alternate spelling or a misspelling of a name or Web site that generates traffic (visitors). This could be through transposing words or inverting a phrase. Whitehouse.com, for example, is an adult site that is deceptively similar to whitehouse.gov. Cartoonjoe.com is a transposition of joecartoon.com, and dinsey.com is a misspelling of disney.com; these domains were used by the convicted porn peddler John Zuccarini. The U.S. government alleged that Mr. Zuccarini earned as much as $1 million annually through typosquatting variations of Web sites associated with entertainers, celebrities, and cartoon characters popular with children. Mr. Zuccarini was eventually jailed, but only after the passage of a law that now makes it a crime to use a misleading domain name with the intent to attract a child to a pornographic Web site (Edelman, 2003a; "Report on Reaction," 2003; *Truth in Domain Names Act*, 2003; Whois Source, 2004). Typosquatting and Web spoofing are not in themselves illegal and are not necessarily always unethical, but as can be seen in this case, these can be lucrative ways to aggregate traffic to a revenue-generating Web site if no laws are broken.

Domain-name grabbers watch for names that are about to expire and immediately grab or register them when released by the registrar. Domain-name grabbing is different from *domain-name hijacking*, the latter being an increasingly difficult scheme in which the registrar is fraudulently tricked into transferring ownership of the name. In many cases, grabbed names had been deliberately abandoned by the original owners who did not realize how much value the name might have. The most desirable grabs to traffic aggregators are domain names that are highly linked from other Web sites, that are highly placed in search engines, or that were once popular and are likely to be saved in bookmark or favorite lists on personal Web browsers. Two years after the American River College deliberately abandoned an old domain name, it found that some people were still linked to the old name, but that the links now pointed to an adult-content Web site (Hardy, 2001). The Catholic Diocese of Brooklyn, New York, and the Ballet Theater of Maryland similarly found that their abandoned domain names were grabbed to point to adult content (Markovich, 2001; cf. Bryant, 2001; Hardy).

Tina's Webcam perhaps best illustrates the value of abandoned Web sites to traffic aggregators. Edelman (2003b) conducted an archival analysis on the Tina's Webcam site, finding 4,525 distinct domain names that redirected to it. Prior titles were available for 2,991 of these names, and none were found to have previously hosted content related to what was on Tina's Webcam. These domain names were found to have been very popular previously with regard to being linked and accessed. Links from search-engine listings and from others' Web sites could provide pointers for such traffic aggregators for years.

FUTURE TRENDS

Emerging schemes for taking control of domain names for use in traffic aggregation are based on issues that are not easily regulated by industry practice or law. Possibly the most serious issue is that it is not uncommon for organizations—churches, schools, children's groups, or families—to deliberately abandon a domain name, perhaps in favor of a new name. The abandoned name might still have value to a traffic aggregator, however, if it is linked from many other Web sites or if it is still bookmarked by many people. A traffic aggregator could use a *domain back-order service* to automatically reregister the name immediately after it expires as a way to drive traffic to an unrelated and perhaps image-tarnishing Web site. Although it is possible to argue in arbitration proceedings that a domain name should be returned to the first owner after it is allowed to expire either accidentally or deliberately, such an argument has been more difficult to make in recent years.

Domain names are more likely in the future to be taken "fairly" by parties who are interested in traffic aggregation and to be taken through ways in which harm to a third party is not immediately apparent. Domain-name misspellings that are registered by typosquatters are likely to go unnoticed for a long time or even to go completely unnoticed because they will not be something that individuals would bookmark or post on Web-site link lists. A domain name that is grabbed upon expiry and release might be more quickly noticed by those who keep Web-page link lists and such, but this, too, can go unnoticed until a visitor takes the time to complain.

Except in the case of large corporations with the resources to wage costly trademark lawsuits, most domain-name owners are likely to only have the resources to use arbitration in asking for the domain name to be taken away from a typosquatter or grabber (ICANN, 2001). Winning such a case is not guaranteed, whether through arbitration or through the courts. Arbitration cannot award damages, but can merely decide who should be permitted to own a domain name. To a small organization that chooses to use arbitration rather than the courts, the cost will still be a minimum of $1,500 and will require a lot of time and annoyance.

A traffic aggregator who has registered a domain name, on the other hand, is not required to invest any time or financial resources in responding. Although a nonresponse to arbitration will cause a forfeit in the complaint, a traffic aggregator has nothing to lose in such cases. The cost of registering a domain is now less than $10. The traffic that is generated through redirection to, say, an adult site needs only to generate a single $10 order to pay for itself before it is lost to arbitration. A loss through forfeiture in arbitration could take months if an issue ever even moves to this level. While the cost in time and money is relatively great to a small organization that is attempting to gain control over a disputed domain, it is almost nothing to a traffic aggregator who views the domain name as a disposable, cheap, and easily replaced commodity that need not be defended. The traffic aggregator actually has a greater incentive to hold out for the payment of a modest ransom than to agree to an arbitration settlement.

CONCLUSION

Domain names often have greater value to traffic aggregators than many realize. Schools, churches, children's groups, or individuals with personal Web sites often do not realize that an abandoned domain name, a spoofed domain name, or a typosquatted domain name can have value to someone with unwholesome interests. More publicity is needed regarding the interests of traffic aggregators and the trouble that they could cause to innocent and unwary parties.

For those who have a concern about an organization's reputation:

- Alternative domain names and spellings (spoofs and typos) should be registered to redirect at the primary Web site as Google has done.
- Abandoned domain names and spellings (spoofs and typos) should be registered to redirect at the primary Web site as Google has done.
- Links from search engines, indexes, and link lists should be checked to ensure that the organization's name is not being used by a traffic aggregator in ways that will tarnish the organization's name.

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KEY TERMS

Domain-Name Back Order: A service provided by domain-name registrars that will watch for a domain name to be released upon expiration and will automatically register that name for the client when this happens.

Domain-Name Grabbing: Registering an abandoned or lapsed domain name immediately after it is released by a registrar.

Domain-Name Hijacking: Obtaining a domain-name transfer of ownership through fraud.

Domain-Name Speculation: Registering or purchasing a domain on the speculation that it could be used in the future to drive traffic or can be resold in the future at a higher amount.

Domain-Name Squatting: Registering a trademark, an organization's name, or a person's name as a domain name with the intention to profit from traffic to an unrelated Web site or by reselling the domain name back to the person or organization.

Malicious Software: Harmful software, such as applications that set the user's browser home page to a Web site (e.g., points to an adult content) without the user's intentions, applications that install viruses without the user's knowledge, or applications that report information about the user without permission to do so (spyware). Some applications can also be known as malware.

Redirection: Sending a visitor to a Web-site address that is different from what was typed into the browser URL window or a link.

Traffic Aggregation: Using a domain name, often multiple domain names, to drive traffic (visitors) to one Web site.

Typosquatting: Registering and using a domain name that is a misspelled variation of a trademark or organization name.

Web Spoofing: Registering and using a domain name that is deceptively similar to a trademark or organization name. This could be through transposing words or inverting a phrase.

Category: Concepts, Trends, and Challenges

Web-Enabled Portals for E-Business Workplace

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INTRODUCTION

Portals are information systems that support the user in his or her individual process with information production and communication. The term portal, in information technology terms, appeared in late 1990s at a time of the widespread use of the Internet by individuals and organizations (Finkelstein & Aiken, 1999; Dias, 2001; Bristow, Dickinson, Duke, Henry, & Makey, 2001; Collins, 2001, 2003).

There are many types of portals on the Internet: portals for general consumer use and entertainment (my.yahoo.com), for specialized information (www.brint.com), for specific communities (Austrian Academic Portal at www.portal.ac.at/), for business enterprises (NEC global portal at www.nec.com, NEC US portal at www.necus.com/, NEC European portal at www.neceurope.com). In general, portals can be divided into two categories: public and enterprise (Goodman & Kleinschmidt, 2003; Forrester, 2003).

Public portals started as Internet directories (Yahoo!) or search engines (Excite, Lycos, AltaVista, and InfoSeek). Services that require user registration such as free e-mail, customization features, and chat rooms were added to allow repeated use, and to make users stay longer at the site.

Enterprise portals started as intranets and extranets, the "enterprise webs" that were intended to provide easy-to-use, secure, and personalized sites that may extend to an organization's employees as well as to its customers and business partners. Enterprise portals evolved to include collaboration tools so that customers, business partners, and employees are empowered to maximize their value to the organization. Portals that combine Web communications and thinking inside large enterprises are considered as both a labor-saving and a cost-saving technology. Enterprise portals are also referred to as corporate portals. Some corporate analysts predict that portals spending will be one of the top five areas for growth in the Internet technologies sector.

BACKGROUND

While there are multitudes of enterprise portal deployments, each can be assigned to one of three distinct groups. These groups, in increasing order of complexity, are classified as fundamental, integrated, or collaborative (Strauss, 1999; Terra & Gordon, 2002; Moore, 2002; Plumtree Software, 2005; *Portals Magazine,* 2005).

Fundamental Portals

Fundamental portals are those that offer a framework where users can find Web applications from a single entry point. They provide very little functionality and are essentially a means to connect legacy applications. Portals of this type do not attempt any type of enterprise process integration and typically function as a list of links.

Integrated Portals

Integrated portals integrate the applications and the delivery of customized, role-based content, while providing access to information across the organization.

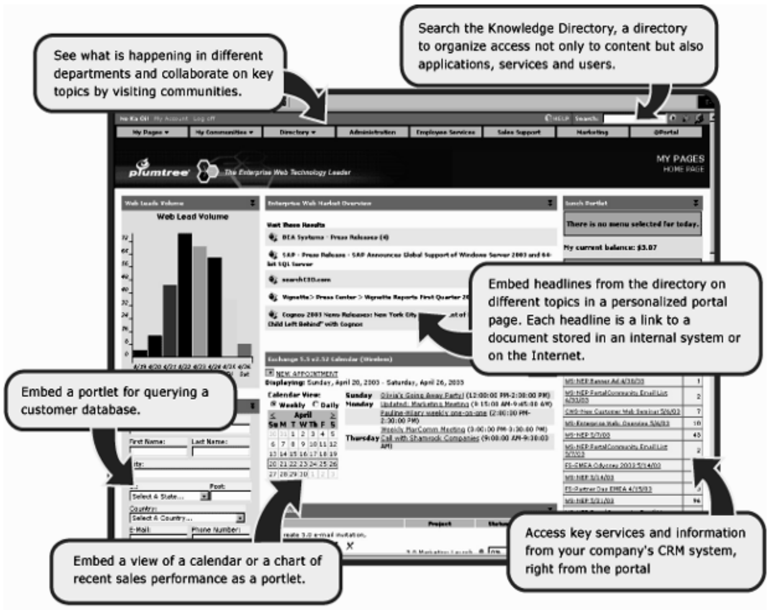
Integrated portal initiatives in organizations focus on providing access to information and to streamlining information technology and business operations. However, these types of solutions are not able to integrate fully people, processes, content, and applications.

Collaborative Portals

Collaborative portals integrate users, content, and collaborative tools. Collaboration services such as presence awareness, instant messaging, Web conferencing, and third-party applications in the context of business processes are integrated into the portal. The user of the collaborative portal can tap into different resources throughout the enterprise, leveraging various collaborative tools through a consistent interface.

A collaborative portal requires that an enterprise looks at itself as a collection of business processes (financial management, product development, etc.) rather than functional departments (marketing, manufacturing, or human resources) or simplified segments (business-to-employee or business-to-customer). Collaborative portals offer more than just access to applications and content. The most evolved collaborative portals enable key business processes, appear integrated and personalized for each individual's roles in the organization, and allow access to

Figure 1. Plumtree portal page example



people and expertise through collaboration (Plumtree, 2005).

FEATURES OF ENTERPRISE PORTALS

The features of enterprise portals include (Sribar & Lynn, 2003; Pushmann & Alt, 2004):

- **Single Touch Point:** The portal is the delivery mechanism for all business information services.
- **Collaboration:** Portal users can communicate synchronously, through chat or messaging, or asynchronously, through e-mail and blogs.
- **Content and Document Management:** Services that support the full lifecycle of document creation and provide mechanisms for authoring, approval, version control, scheduled publishing, indexing, and searching.
- **Personalization:** The ability for portal members to subscribe to specific types of content and services. Users can customize the look and feel of their environments.
- **Integration:** The connection of functions and data from multiple systems into new components.

Figure 1 shows an example of the customized and personalized component of an enterprise portal from Plumtree Software (2005). Through a personalized portal page such as this one, the user is able to access services and content (both static and dynamic), as well as aggregate disparate applications (these are identified in Figure 1 with heavy arrows and boxes containing explanatory text).

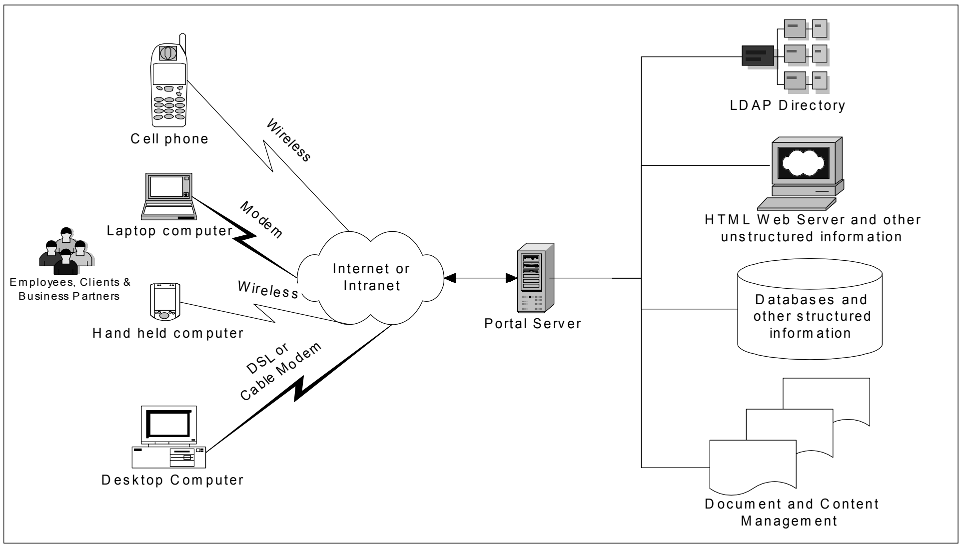
Since the enterprise portals are now designed to allow collaboration, a portal's content (or part of it) should be accessible on multiple platforms such as personal computers, personal digital assistants, and cell phones (Portals Community, 2005). Generic portal ecosystem components are shown in Figure 2.

The Working of a Portal

When a user requests actions, such as searches or information retrieval, the portal server locates and initiates the appropriate gadget. These gadgets perform the requested task and send the results back to the portal server, which formats and sends the reply back to the client. Gadgets can be a simple pass-through to an HTML page or they can be complex applications. Both the portal itself and the gadgets run on a servlet engine inside an HTTP Web server. An HTTP Web server is software that renders and presents HTML pages to browser applications.

A servlet engine is a computer program that runs within an HTTP Web server and takes specific requests from the Web server, processes them, and then hands them back to the Web server in HTML format for it to render.

Figure 2. Generic portal ecosystem components



The open source Apache HTTP Web server (http://httpd.apache.org/) is an example of a Web server. The servlet engine could be the Tomcat (http://jakarta.apache.org/tomcat/index.html), which is written in Java (http://java.sun.com).

Portal Environment

The elements of the portal environment are these:

- **Application Server:** An application server provides the underlying development and runtime infrastructure for the portal. Examples of J2EE application servers include Sun ONE, BEA WebLogic, IBM Websphere, Oracle 9iAS, and JBoss. Many of the application server vendors incorporate portals as add-ons to their base product. For example, IBM Websphere Portal Server, Oracle Portal, and BEA Portal are all built on top of the corresponding application server and in some cases are sold as one package. Several of the stand-alone portal products, such as Plumtree, Epicentric, and Corechange, have Java components or are Java based and take advantage of an application server.
- **Web Server:** A Web server works in conjunction with an application server to provide the runtime environment for client requests. The HTTP Web servers used with portals include Microsoft Internet Information Server (IIS), Apache, and so on. When a customer brings up the portal page, the Web browser makes a request of the Web server. The Web server then passes the request to the application server. The portal (and its associated gadgets) runs on top of the application server.
- **Database:** Most portals have an underlying database (such as Oracle, DB2, Sybase, or SQL Server) that they use to keep track of information specific to the portal—such as users, personalization settings, available Web services/gadgets, and security. This use of the database is in addition to the use of the database by a transactional system (for example, ERP, CRM, or SCM system) that a portal might query in order to present application-specific data to customers.
- **Taxonomy:** A taxonomy is a classification scheme to organize a collection of information. Ideally, a taxonomy would take a set of documents and make it easy to browse, search, or otherwise navigate information in which the user is interested. A taxonomy is analogous to a folder structure, with the additional functional components of metadata for document classification as well as the rules for categorization. Most enterprise portals have a taxonomy for this purpose; some may have automatically generated taxonomies based on the metadata provided.
- **Crawler:** A crawler is an automated process that reads, indexes, and classifies documents at a predetermined interval. A Web crawler, for instance, would crawl target Web pages periodically to determine if the content has changed. The content is then indexed into the taxonomy so that customers

can easily find it. The crawler does not necessarily make another copy of the crawled document; rather, it indexes it by creating a virtual card that describes the document. The card then lives in the portal index.

- **Metadata Repository:** A metadata repository contains metadata about the content within the portal and the structure of that content. This includes metadata about the taxonomy, as well as metadata for the individual documents. For example, each document placed in a folder called Clients might have a metadata field called "Client" which would have one or more values. The value of the Client field for a particular document is metadata about that document.
- **Gadget:** This is a user interface for presenting data and functionality from multiple applications on a single Web page. Gadgets encompass the presentation layer and business logic. They also tie into back-end data sources and are given different names by vendors (portlets, blocks, Web modules, Web parts). Many portal vendors have gadgets for connecting to enterprise systems (such as SAP) as well as for collaboration, news, and other functions.
- **Categorization Engine:** A categorization engine is used for sorting documents into the folders of taxonomy. The categorization engine may do this based on metadata in the documents, business rules, the content of the document, search criteria or filters, or some other scheme.
- **Filters:** A filter is generally available in a taxonomy to restrict the documents that are admitted into a particular folder or that are returned as part of a search. A filter can be word based (for example, if a document has the word "IBM"), concept based (for example, if the document is like another document), or rule based (for example, if the field called Client has a value of IBM).
- **Index:** An index is a collection of information that allows for fast query and retrieval of information. Within the context of a portal, an index is usually a combination of a full-text index and a metadata repository for the documents/content that are included within the portal.
- **Virtual Card:** Within an index or metadata repository, a virtual card is a description of a single document or piece of content within the portal. The card usually contains information about where the content physically resides and contains the values of one or more metadata fields about that document. The card is the "placeholder" for the document within the portal.
- **Web Service:** A Web service is a program that accepts and responds to requests over the Internet. Typically, a Web service accepts requests in an XML-based format. The actual format of the request and the response depends on the XML standards that are being used. One such standard is SOAP. There are public registries and languages—such as UDDI, WSDL—which are used to catalog the different available Web services. A calling program can query the UDDI registry to find an appropriate Web service, then use WSDL to determine which parameters the service needs, and finally use a calling protocol and XML standard like SOAP to make the call to the Web service.
- **User Profiles:** Each portal contains a profile for each of its users. This profile is used for customization and personalization. Each of the gadgets in a portal has access to this user profile and can use it to store preference information about a user or a class of users. This profile determines how the user configures the home page of a portal, and chooses which gadgets show up and what information they show.
- **Content Management System:** Most enterprise portals contain a content management system, which allows approved users to submit information into the portal. There is typically an approval process that eventually results in the content becoming available in the correct part of the portal's taxonomy. A content management system can deal with documents in their original formats (for example, Microsoft Word or PDF) or might contain Web editing features to allow users to author Web pages.
- **Enterprise Application Integration (EAI):** EAI is an umbrella term for all software and services meant to integrate enterprise applications with one another. An EAI layer is needed so that queries can be coordinated, and results consolidated. Given the complexities of each type of application (for example, sales, manufacturing, service, purchasing), this can be a difficult and expensive process. A number of vendors have released software that makes this process much simpler, including Crossworlds, WebMethods, Tibco, NEON, and IBM. EAI impacts the portal because the portal ideally will show consolidated information from multiple backend systems.

On Portal Vendors

Portal technology is both infrastructure and a software application. Those who want to implement portals in organizations are faced with various levels of vendor, technology, and budget risk. Moreover, portals, like any information technology purchase in an organization, are required to prove their value. Valuation of portals is especially difficult because the portal market is always in a state of flux. An excellent site, www.portalscommunity.com/ (Portals Community, 2005), is highly recommended for those interested in an unbiased view concerning portal technology and the portal market.

FUTURE TRENDS

Portal software is maturing from a simple interface for accessing multiple systems to a powerful platform for delivering new, composite applications. The survivors in the portal market have grown by incorporating new technologies for content management, collaboration, search, and single sign-on. The result is the emergence of an enterprise-wide working environment on the Web (Plumtree, 2005). This environment may remain open, or may yet become part of application servers, which have begun to offer functionality beyond the Java 2 Platform Enterprise Edition standard (Pushmann & Alt, 2004). At stake is whether the portal, and the entire enterprise Web, is merely an extension of client-server infrastructure, based on a single type of application server, or an environment that is open in a fundamentally new way. This openness is in the interests of any organization that anticipates having to support multiple application servers. For this reason openness will triumph in the portal market, as it has in virtually every other information technology market.

CONCLUSION

Interest in portal solutions remains strong, and 'enterprise portal software' is one of the 'highest priorities', ranked only behind security technology and wireless networks (Sribar & Lynn, 2003). Two types of players are currently competing to gain control of the enterprise portal market: pure-play and infrastructure. The pure-play vendors offer an independent layer to accommodate various competing systems. Vendors in this segment promote flexibility and claim to solve business problems of enterprises that are running operations on various platforms and building services in a range of programming languages. Examples of the key pure-play vendors include Plumtree and Epicentric. On the other side, the infrastructure vendors claim to deliver portal technology as an essential link in the emerging Web services market. This segment includes IBM, BEA Systems, Sun Microsystems, Oracle, and Microsoft. These vendors advocate scalability and access to serious application server resources, including load balancing and clustering. They consider the portal as a vital part of the infrastructure, tightly linked with the application server and Web services. According to infrastructure vendors, pure-play portal technology cannot utilize all the reliability, scalability, and development tools of an application server. In our opinion, however, a business selecting a portal vendor should look to meet the core purpose of the portal first. Then the business should look for portal products that can be used to meet some of the organization's other needs.

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KEY TERMS

Communities: A destination within the portal used to deliver applications and group workspaces. For example, portal users can create communities to bring a team of people together to collaborate on a project or to deliver an employee services application to the entire company. Communities are assembled using portlets, and can be created from templates that control the community's functionality and appearance.

Corporate Portal: Corporate portal and enterprise information portal descriptors are used interchangeably.

Collaboration Server: Helps users work together via the Web, supporting tasks, projects, communities, calendars, discussions, and document sharing with version control.

Content Server: Allows publication and management of Web content for portals and Web applications, with forms-based publishing, templates, and workflow.

Knowledge Directory: An enterprise-wide taxonomy for organizing content from Web sites, document databases, and file systems, as well as portlets, communities, and user profiles.

Personalized Pages: Personalized view of content and applications assembled by the portal. A personalized page can, for example, highlight a user's deadlines across many Collaboration Server projects or the latest resources added to a Knowledge Directory topic. The page typically also shows the user key services from a wide range of applications, such as call center queues from a customer support application or expense report requests from an employee services application. Such a page may also include personal productivity services such as the user's e-mail or stock quotes. Personalized pages are assembled from portlets.

Portlet: A reusable Web component that displays relevant information to portal users.

Search Server: Indexes and searches all the documents, information, applications, communities, Web sites, and other content accessible through the portal.

User Profile: A profile on a portal for each user that defines customization for that user.

Web Services Integration Technologies: Technologies that connect the portal to enterprise systems, repositories, and resources, with equal support for both .NET and Java integration.

Category: Concetps, Trends, and Challenges

Wireless LAN Access Technology

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INTRODUCTION

During the last decade mobile communication networks follow the evolution of fixed networks in order to provide moving subscribers with all the services and applications of fixed subscribers. This however is unfeasible due to restrictions and limitations imposed by the hostile radio channel. The global system mobile (GSM) network, known as 2G technology (Mouly & Pautet, 1992), is adequate in meeting voice communication speeds of a typical subscriber since it offers limited communication capabilities (< 9.6 kb/s). The ideal mobile network would be able to provide moving subscribers with continuous access to every possible voice or data network, leading to the realization of a "mobile office." The result of this effort (although somewhat restrictive in terms of realizable bit rates) was another evolution in mobile networks, the general packet radio service (GPRS) network (usually referred to as 2.5G), with available data rates of approximately 40 kb/s up to 100 kb/s.

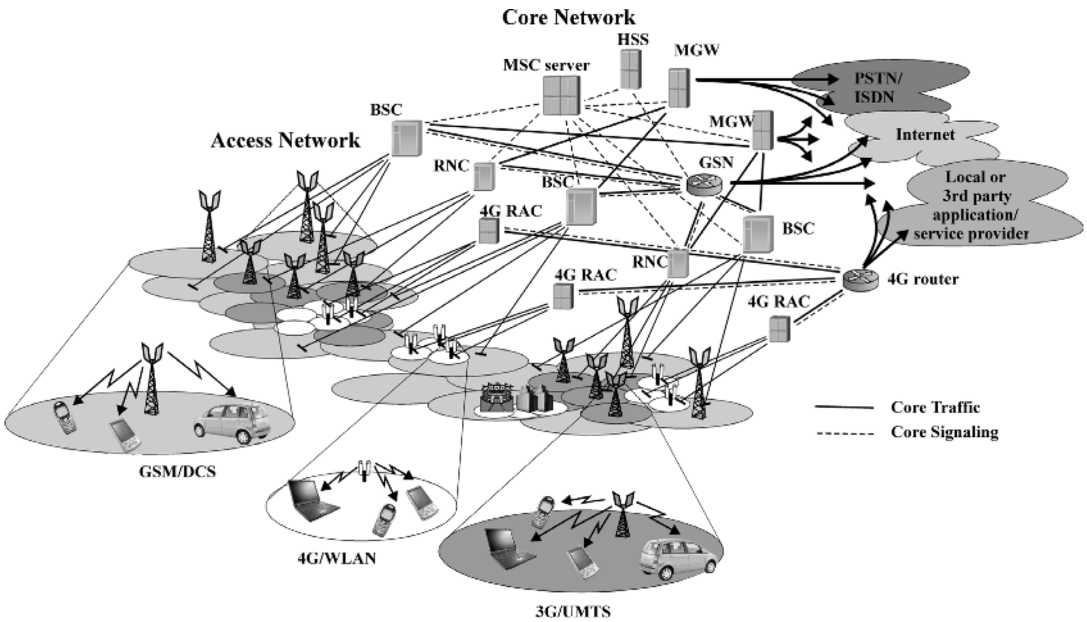
The universal mobile telecommunication system (UMTS) (usually referred to as the third-generation cellular network or 3G), with competitive rates of 300 kb/s and a future possible upgrade up to 2 Mb/s, is the realization of a new generation of telecommunications technology for a world in which personal services will be based on a combination of fixed and mobile services to form a seamless end-to-end service for the subscriber. Its realization at least requires provision of a unified presentation of services to the end user, mobile technology that supports a very broad mix of communication services and applications, and finally on-demand flexible bandwidth allocation reaching 2Mb/s per subscriber. Moreover the exploitation of pure (not tunneled) Internet protocol (IP) interconnection of network elements between each other for data exchange and operation and maintenance purposes should be available, along with the provision of flexible end-to-end all-IP connectivity in terms of user information.

3.5G and 4G (Esmailzadeh, Nakagawa, & Jones, 2003) systems are already under investigation. Aiming to "context-aware personalized ubiquitous multimedia services" (Houssos et al., 2003), 3.5G systems promise rates of up to 10Mb/s (3GPP Release 5), while with the use of greater bandwidth, these rates may raise even more in 4G (Esmailzadeh et al., 2003). On the other hand, the last five years a standardization effort has started for the integration of Wireless local area network (WLAN) in order to support higher bit rates in hotspots or business and factory environments, with a cell radius on the order of 100m. In any case, 4G and WLAN technology are going to be based on an IP backbone between access points (APs) and access controllers or routers and the Internet. Mobile IPv4 and IPv6 are already under investigation (Lach, Janneteau, & Petrescu, 2003) to provide user mobility support for context-type services.

BACKGROUND

In Europe, the delay of 3G cellular networks deployment and the large investment demand for a new spectrum led mobile operators to search for innovative ways to improve the current offerings to customers with services similar to those of 3G. Today cellular networks seem to offer data services to customers using GPRS as the global and successful solution. However GPRS has the main disadvantage of the limited potential of supporting high data rates, required in business and multimedia applications. Therefore, since 2.5G technologies are insufficient to meet market needs and 3G cellular data technology is not yet (with moderate future employment) available, mobile operators are becoming interested in the WLAN technology. This recent interest of mobile operators is justified because of the recent global evolution and successful deployment of WLAN networks. This worldwide approval of WLAN networks is a result of very high data rates providing superior bandwidth compared to any

Figure 1. Integrated cellular/WLAN network architecture



cellular technology. As a result, IEEE 802.11 variants face data rates of up to 11Mb/s (802.11b) and 54Mb/s (802.11a/g), while rates in excess of 100Mb/s have already been acknowledged (Simoens, Pellati, Gosteau, Gosse, & Ware, 2003). On the other hand a GPRS handset offers a theoretical data rate up to 172 kb/s (typically 42 kb/s) and the third-generation terminal up to 2 Mb/s (typically 144 kb/s). The future mobile operator networks shall be a combination of several radio communication technologies, such as GPRS/UMTS/WLAN.

WLAN penetration is expected to be widely deployed in public locations such as hotels, commercial centers, airports, ports, and enterprise buildings. The architecture of deployment is based on the hotspot solution. In order to increase the revenue, operators must provide a seamless experience among current cellular and WLAN access networks. The target is to utilize infrastructure investments of existing cellular networks and interconnect the WLAN network architecture into the core cellular network. The operator WLAN system should maintain compatibility with the existing GSM/GPRS mobility management procedures (location update, authentication, roaming, and billing functions), minimizing the investment in the merging network deployment. A universal subscriber identity module (USIM) (Spiros, Louvros, & Iossifides, 2004) is a natural choice for WLAN subscriber management, since it is widely deployed and enables roaming to existing GSM/GPRS handsets and networks. Moreover, subscriber identity should be used in all access networks to enable seamless service availability.

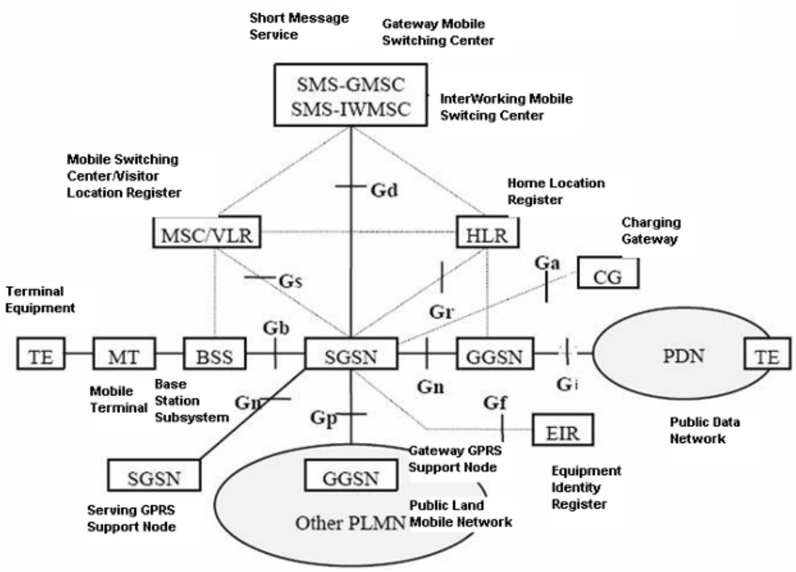
An example of future mobile network architecture, engaging almost all forms of aforementioned technologies, is presented in Figure 1. All the technologies will coexist in the next decade, and smooth transfer of end user services and information rate among them has to be considered carefully (3GPP is already under a standardization process of interoperability between GPRS/UMTS and WLAN) (ETSI TR 101 957), (3GPP TR 22.934 v1.2.0).

INTERWORKING SYSTEM ARCHITECTURE

Presentation of the Idea

The general idea is that a cellular data customer can use the resources of WLAN whenever possible in order to increase its data rates and to make use of all the available multimedia services without delays. Of course the deployment of the WLAN network is based on Hotspots architecture. Hence the coverage of a WLAN network will be limited in special places, where most of the customers can use a laptop or a PDA to use the offered services. Such places are commercial centers, city center areas like cafeterias or hotels, enterprise buildings or airports, and finally crowded domestic areas. There is no need for full coverage of the whole geographical area of a city or a country, since in the areas of no WLAN coverage, GPRS solution is enough to provide the mobility freedom to

Figure 2. GPRS interfaces



cellular customers with satisfactory moderate data rates. In such a case the cellular customer might start a session with the best network coverage, say WLAN in a hotspot area. While the customer is waiting, he can take advantage of the high bandwidth of WLAN in order to gain access to the offered services. As the customer moves away from the coverage area of the hotspot, the end device detects the failure of service provision and seamlessly should switch the data flow to the next available data network—that is, GPRS. What is important is that this flow switching is seamless to the end user, and also that when the end user gets back to a place with WLAN coverage, the flow should be handed back to the WLAN network. Generally speaking, the integration of the WLAN network within cellular networks always depends on the ownership or management of the WLAN network. There are two general scenarios. The first case is that the cellular operator owns and is responsible for the management of the WLAN network. In such a case the operator has the advantage of providing preferred billing and customer management policies. Additionally operators can use the existing cellular authentication and billing mechanisms with the customers that are using the WLAN access network. The other case is that the WLAN is not owned by the cellular operator, but by a Wireless Internet service provider (WISP). In such a case there must be certain roaming contracts in order to allow the usage of the WLAN access network in certain hotspots. In this solution, it is more difficult to implement the seamless session and flow switching, as discussed earlier, since in most cases of roaming, the IP-based session should be broken down and restarted.

Interworking Architectures

The integration of WLAN with cellular networks has been specified by the European Telecommunication Standards Institute, ETSI (ETSI TR 101 957), (3GPP TR 22.934 v1.2.0) in two general approaches, so-called *loose coupling* and *tight coupling*. In the loose-coupling approach, the deployment of WLAN is designed as a complementary access network to GPRS, using the subscriber GPRS databases without using the core network (3GPP TS 23.060 v3.12.0). In Figure 2 the GPRS architecture is presented with all the interfaces between building elements. The interface connecting GPRS to other IP networks, bypassing the core elements of serving GPRS support node (SGSN) and gateway GPRS support node (GGSN), is the Gi interface from GGSN to PDN, which is also connected to database home location register (HLR). Hence it is obvious that the loose coupling would be to the Gi interface. Tight coupling integrates the WLAN network towards the GPRS core network in the same way as any other access network. Access networks are connected to the core elements, bypassing all other wireless radio environments.

In Figure 2 the interface to GPRS core network element (SGSN) is the Gb interface. As a result (3GPP TS 23.060 v3.12.0), it is obvious that the tight coupling uses Gb interface to interconnect the WLAN access controller to SGSN. The current preferred solution by the operators seems to be loose coupling, using a USIM-based authentication and billing. With this solution the customer may use his USIM card to access a set of wireless data services over the WLAN network. There are also two main advantages for using loose coupling vs. tight coupling. First, the WLAN network may be owned by a WISP operator; in that case roaming/billing agreements have to be enabled through a dedicated connection between the cellular operator and the WLAN operator. Also, the interoperability is guaranteed and there is no need for a cellular operator to deploy a WLAN network and invest more for the services. On the other hand, tight coupling exists only when the WLAN network is owned and managed by the cellular operator, since the integration is inside the cellular architecture. Second it is not necessary to introduce cellular technology firmware in the WLAN network as it is with the tight coupling.

Loose-Coupling Solution Overview

In Figure 3 the integrated WLAN/GPRS (IWLAN) system architecture is presented, consisting of the WLAN access network that is interconnected to the existing GPRS cellular core network, through Gi interface, towards the IP backbone. A single USIM should be used in all access networks to enable smooth roaming and seamless services availability. In order to use the potential of the already deployed GPRS core network, authentication, billing, roaming, and security issues of WLAN should be compatible. In that way the effort is to minimize the modifications in the already deployed GPRS network and to allow less infrastructure additions in the WLAN interworking boundary.

The authentication server (AS) is the major control point of IWLAN subscriber management. A single AS entity in the network may support several access controllers (Rigney et al., 2000) providing authentication and billing services for thousands of roaming users. When the user disconnects, the authentication server works as an inter-working entity. It receives accounting data from the access controller, converts them into GPRS billing format (ETSI TS 101 393), and issues the charging data records (CDRs) to the cellular billing system. The authentication server interconnects in a seamless way the core cellular infrastructure with the WLAN access network. It provides a gateway to the cellular core network elements (HLR and GPRS charging gateway). The authentication server sends standard GSM authentication signaling to the HLR using Common Channel Signaling # 7 (CCS#7) protocol that connects various operator networks together. The cellular network uses the standard identification procedure with GSM International Mobile Subscriber Identity (IMSI) code stored in the USIM card. The authentication server always checks if the roaming user has subscribed to the WLAN service.

The access controller (AC) provides an Internet gateway between the radio access network and the fixed (WISP provider- or operator-owned) IP core. It functions in the same way as the SGSN node in GPRS network, allocating IP addresses to the mobile terminals and maintaining a list of the authenticated terminals' IP addresses. The AC tracks the addresses of each incoming or outgoing IP packet and discards the packets that come from a

Figure 3. The Integrated WLAN/GPRS network architecture using loose coupling

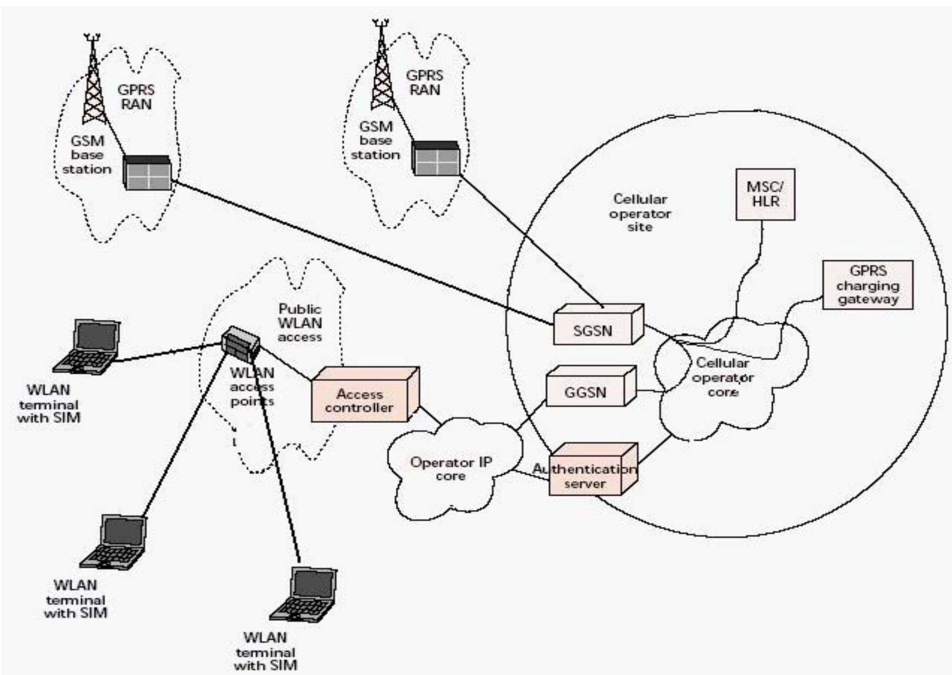
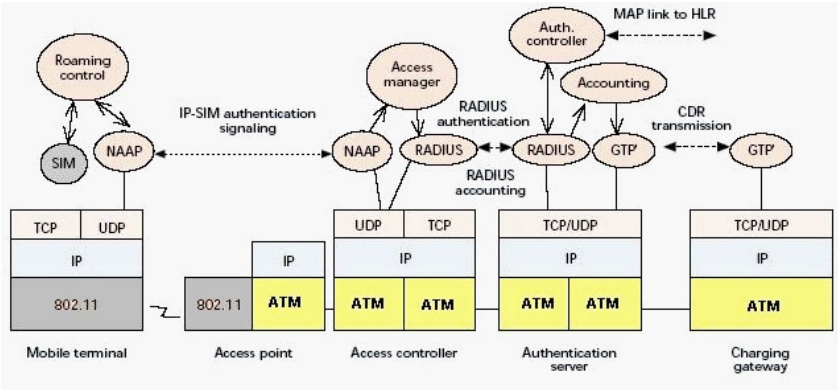


Figure 4.



non-authenticated terminal. The access controller separates the mobile terminals using a terminal IP address and a unique WLAN link-layer-specific medium access control (MAC) address. The MAC address verification works as a filter for a duplicate IP address that might be used by a hostile user. The AC gathers accounting information for billing purposes and forwards them to the AS.

The access point (AP) offers a wireless link between the mobile terminal and the fixed local area network (LAN). The access points are the hardware infrastructure to provide the electromagnetic coverage to a hotspot area. During the network deployment, several APs are connected to the same core LAN with the AC. The typical coverage range of a single AP is 50-100 meters indoors or up to 500 meters hotspot outdoor coverage. The coverage can be extended using directional antennas and radio network planning tools.

IWLAN customer terminal might be available for any terminal with WLAN radio access capability and a USIM reader. The customer terminal technology may develop either an integrated WLAN card with a USIM reader or a WLAN card and an external smart card reader. Laptop vendors might in the future develop laptop models with integrated smart card readers. The IWLAN terminal may detect the correct roaming WLAN network by using predefined network profiles that contain the list of the roaming partners' radio network identifiers. When entering a new location, the terminal compares the names of available WLAN networks with the roaming profile and associates to the correct WLAN. The operator may distribute the profiles by using a Web server.

FUTURE TRENDS

The mobile operators have extremely high error tolerance and resilience requirements for the networking infrastructure. To meet these requirements the operation of the AP, AC, and AS must be reliable and the system has to offer sufficient redundancy characteristics. The critical part of the operator WLAN system is the fault tolerance of the authentication server since a single AS may serve several radio access networks and thousands of mobile users simultaneously. The loose coupling has been presented in this manuscript and the major design issues have been discussed, resulting in a specific architecture. The loose coupling is, from the operator's point of view, the cheapest and most reliable way to meet the integration requirements since the cost is limited, the infrastructure requirements are limited, and the revenue is augmented. The already functioning GPRS/UMTS network, used in this proposed integration as a core network, is the warrantee of the functionality, integradability, and scalability of the network.

Future research has to be done towards the tight-coupling solution. The advantage of this solution is the connection of WLAN as a typical access network to the GSM/GPRS/UMTS platform of a cellular operator. However, from the operator's point of view, this is not the best since much firmware has to be included in the APs of WLAN and the access part of the cellular network, increasing the deployment cost. Recently, several WLAN standardization bodies (ETSI BRAN, IEEE 802.11, IEEE 802.15, MMAC) have joined a Wireless Inter-Working Group toward specification proposals for the integration of WLAN and cellular networks. From the cellular networks representatives, the Third Generation Partnership Project (3GPP) standardization body evolves the UMTS specifications towards WLAN/GPRS integration (3GPP TR 23.934, volume 3.0, June 2002). During this research six inter-working scenarios have been specified according to the operator's requirements and infrastructure.

Moreover the intersystem handovers (Krishnamurthy et al., 1993, 1998; Pahlavan et al., 2000) have to be studied deeper since, according to Figure 1, the intersystem handover in heterogeneous networks is still under consideration (Karaboulas, Louvros, & Kotsopoulos, 2005) to minimize complexity and to integrate already used protocols in a general proposed solution.

CONCLUSION

In the last decade the customer's demands are not in voice applications, but mainly in data applications and multimedia services. The cellular operators have failed to provide satisfactory data rates to the customers, even with the latest technological evolution of third-generation networks. The operator's community is looking for the ultimate solution to increase the offered data rates to the customers, hence increasing the revenues. WLAN seems to be the most promising technology so far regarding the data rates (11 Mb/s). The main disadvantage of the WLAN network is the high demanding deployment cost. Due to tremendous investment requirements, WLAN is initiated mostly as an "hotspot" architecture in crowded areas and not as a wide area coverage network. Moreover, so far there is not a general strategy among the different WISPs to design a universal network with specific roaming procedures and interoperability capabilities. The most familiar idea to deploy the WLAN coverage in a large geographical area is the merging of WLAN with different cellular network technologies, as the cellular operator's GSM/GPRS network. The key idea is the use of USIM for both GPRS and WLAN networks. From the operator's point of view, this solution is feasible with loose coupling since the infrastructure demands in both GPRS and WLAN are minimized and the revenues are increased. From the cellular subscriber's point of view, this is a very attractive solution, allowing the entrance to the broadband access market using the same subscriber management agreements of the cellular network.

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KEY TERMS

Authentication: A signaling procedure in cellular networks to identify the subscribers when access to certain services are demanded.

Billing: A signaling procedure in cellular networks to transfer call-related data to the billing center for charging the subscribers.

CDR (Charging Data Record): A specific file format that contains call-related data readable from the billing center server.

IMSI (International Mobile Subscriber Identity): A specific number of subscriber, used exclusively in GSM network, according to international numbering standards referred as E.212.

Location Update: A signaling procedure in cellular networks to locate the subscriber in the geographical area of coverage and update the location information to specific databases.

Roaming: A signaling procedure in cellular networks to allow the provision of services in different networks.

Session: Flow of IP data packets between the end user and the network.

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A

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Symbols

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