VIEWDATA

Viewdata is a term used to refer to end-user targeted computer-based information services and products, which may include text, graphics, images, and video or moving pictures. Some authors refer to it as multimedia information delivery systems. However conceptualized, it is the ultimate in electronic full-text information delivery systems meant for the office or home. With the advent and upsurge of the Internet, especially the World Wide Web, access to viewdata is a major concern for systems design at both the computer systems level and the telecommunications networks level. Four major stakeholders interplay to facilitate viewdata: (1) users, whose demand for multimedia is not only variable but also insatiable; (2) service vendors, who are vying to deliver a multiplicity of products and services to the consumer market; (3) computer systems designers at various levels; and (4) telecommunications carriers, who provide the essential links between remote vendors and viewdata end-users. Viewdata traverse a broad computer and electronics spectrum, in which the roles of computer and telecommunications systems are so intertwined that it makes them at times almost indistinguishable.

VIEWDATA SERVICE PROVIDER

In order to perceive the viewdata mosaic in perspective, it is important to first understand the potential vendor who is constantly prying the current electronic information networks for possible product outlets. The Internet, intranets, extranets, and supernets, discussed later in this article, are currently criss-crossing the US telecommunications environment to provide vendor access to markets. Such networks service an extremely varied vendor clientele, with products and services so dynamically changing, volatile, and novel that new ones are invented almost every day . The term *vendor,* with respect to viewdata as well as other commodities, connotes a commercial, for-profit environment. However, government, nonprofit, and not-for-profit organizations do provide viewdata sometimes at nominal or highly subsidized fee structures. Within the United States, EDGAR, CENDATA, and MEDLINE, with data originating from the Securities and Exchange Commission, US Bureau of the Census, and the National Library of Medicine, respectively, are good examples of government nonprofit service providers' databanks. Such databanks are markedly different from those generated by Dow Jones Information Retrieval Service, LEXIS-NEXIS, University Microfilms International (UMI), Chemical Abstracts Inc., or Information Access Company, which render purely commercial information services and products intended for the serious, often research-oriented user. Another major category of viewdata providers is that of the private proprietary corporate databanks, accessible via intranets or extranets, for which corporate staff (including telecommuters) and loyal customers, respectively, would be the major target audiences. Yet another significant category is the entertainment group, whose products may range from electronic computer games to videos and other types of moving pictures. Given the several forms of information generation and provision, a more general phrase must be used to refer to these categories. For the purposes of this article, the phrase *viewdata service provider* is used instead of vendor, to indicate the broad connotation intended to cover the wide range of vendors.

The Internet, which is currently the most significant international viewdata conduit, has cut through political, economic, social, and geographical boundaries, with regard to the provision of information commodity services and products to the end user. This is a relatively novel feature of the late twentieth century. The potential market for many information products and services launched on the Internet is society-wide and often worldwide. Before marketing a viewdata product meant for worldwide consumption it is imperative to understand the telecommunications infrastructure of the key countries or regions to which it is directed. Some world regions have very unreliable telecommunications networks or may only be reached via satellite links. Even in countries with stable networks, the bandwidth or signal-carrying capacity of the physical networks, sometimes called data nets, may be so narrow that graphics or image-intensive viewdata are painfully slow to download. Broadband physical networks, which are ideal for graphics, images, video, and other moving pictures, are not universally deployed. A potential user can be put off when graphics or images do not transmit fast enough, and thus the need exists for a carefully researched marketing strategy for viewdata. When a new viewdata product is piloted via electronic information networks, first-time users may skew the vendor performance statistics. Sustained repeat usage leading to market stability for electronic graphics or image-intensive products depends on user satisfaction. This is, in turn, a function of ease of use and rate of downloading given a competitive environment, with several alternative products. Furthermore, some information systems, whether based on server or client technology, have built-in time-out mechanisms, and are known to cut off transmission during very slow downloads.

VIEWDATA ENABLING ELECTRONIC INFORMATION NETWORKS

Four logical generic networks as identified in literature have emerged over the years to transmit viewdata: (1) the Internet, (2) intranets, (3) extranets, and (4) overnets or supernets. Superimposed on these basic networks is another network, the World Wide Web—WWW, or simply the Web. The Web adds network capability to handle graphics, images, hyperlinks, and uniform resource locator (URL) features to the basic networks. The original backbone network for the Internet was founded by the National Science Foundation (NSF), a US government agency—which set up National Science Foundation Network (NSFNET) to link research organizations engaged in defense contracts so that they could share data. It was initially part of the ARPANET (Advanced Research Projects Agency Network), founded in 1969 (1). In the 1980s NSFNET was expanded to connect regional networks, such as New York State Educational and Research Network (NYSERNET) and Bay Area Regional Research Network (BARRNET) in the San Francisco Bay area of California. In order to facilitate transmission of viewdata at the national level, three levels of connectivity to the Internet had emerged in the United States by the 1990s (see Fig. 1). First there is the campus or corporate enterprise network, which serves an academic, a corporate, or other institutional community. In many instances, campus networks connect several local area networks (LANs) serving individual departmental needs. Figure 2 is a schema for a typical campuswide information system, usually referred to in literature as a CWIS. It is a distribution network for managing viewdata in colleges and universities. The viewdata may originate from within the institution or from external networks. Second are mid-level networks, mostly wide area networks (WANs), to which campus or enterprise networks ordinarily connect. Finally there is the backbone network, funded by the National Science Foundation (NSFNET), which initially connected supercomputing sites and regional networks. During the late 1980s and early 1990s, Internet services were further expanded to include general-purpose, public-oriented information delivery, in contrast to the original high-powered research of the NSFNET. The 1990s witnessed the progressive privatization of the Internet as well as international expansion. First, the ARPANET was officially dissolved in 1990, thus separating a military arm MILNET under the US Department of Defense and the civilian general-purpose Internet sponsored by NSF by contract to commercial organizations, initially IBM, Merrit Inc., and MCI. The civilian part of the Internet permitted US business and any other organizations to access the network. Several private organiza-

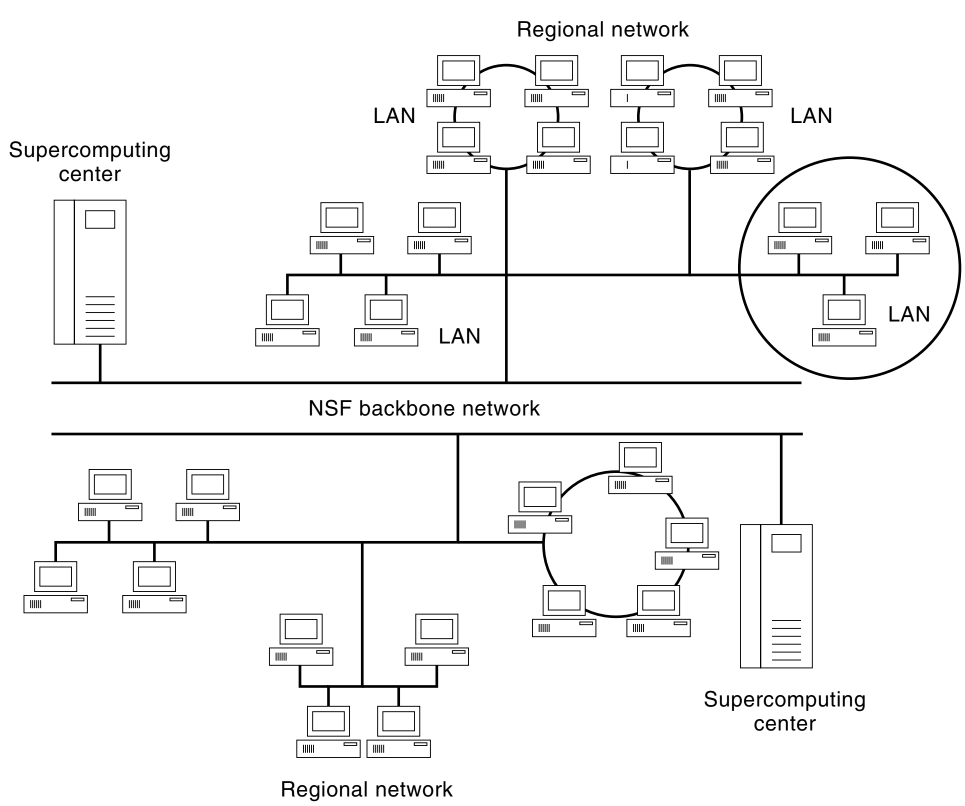

Figure 1. Networking levels for viewdata.

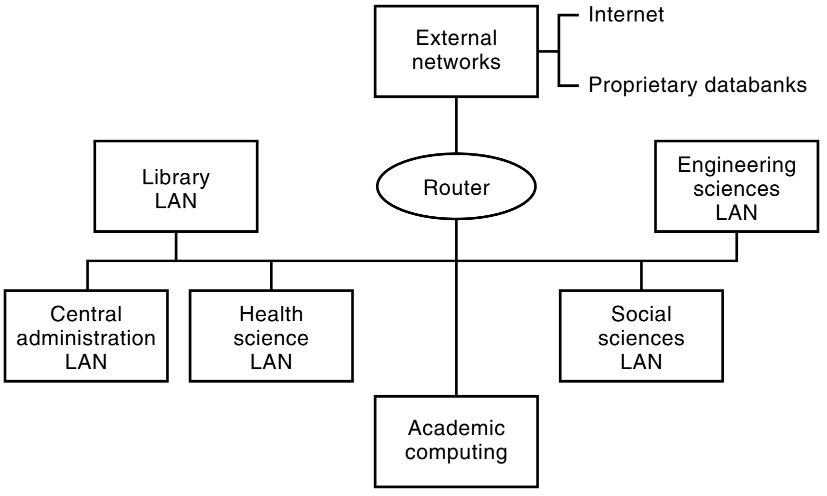

Figure 2. Campus-wide information system.

tions have developed general-purpose proprietary networks to manage viewdata needed to run their internal activities. Figure 3 illustrates such a network, which may be in one place or span a region or be global, depending on the size of the organization. Such a network may have many LANs as well as a variety of software and hardware platforms. International organizations were also later allowed to connect and nodes literary sprouted throughout the world, acquiring domain names or access addresses allocated under the Domain Name System (DNS), which were later converted into the Universal Resource Locators (URLs) of the World Wide Web (2). The viewdata mosaic thus changed from being predominantly scientific research in nature as transmitted on the initial ARPANET to containing almost any type of information imaginable.

The expanded Internet exerienced explosive growth during the 1990s. In 1982, what was then part of the ARPANET had just over 200 hosts. By 1992 the number of hosts connected to the Internet had surpassed the million mark. In the late 1990s the growth of hosts added to the Internet doubled almost every 6 months and it was estimated there were over 30 million by the end of 1998 (3).

The collective information networks that form the Internet carry viewdata to incredibly diverse virtual international communities. For example, the entertainment group may serve people less concerned with downloading times, but serious users who are operating mission-critical services do not tolerate communication delays caused by the expanded popular consumer markets. Consequently, a schism has developed between these two groups, that is, researchers and businesspeople with rigid deadlines on one hand, and casual users on the other. In addition, unauthorized access to institutional computer systems poses a major threat to the security and integrity of institutional viewdata. Most information systems (IS) managers resort to protective fire walls as remedies to the computer hacking threat. Computer hackers develop programs which are used to destroy remote organizational computer and information systems. While the use of fire walls may fend off some of the external intruders, it does not guarantee complete security. Determined, experienced hackers, who happen to be some of the best systems programmers in the field, are known to have cracked some of the most robust fire walls. With over 100 countries connected to the Internet, the viewdata field is full of on-line hackers, pranksters, and virus-happy, malicious individuals. Several US institutions have had their computer systems penetrated by hackers operating outside the country (4). This is also true of other countries' computer systems connected to the general-purpose Internet. As a result of the hacking activity, viewdata may be pirated, deliberately corrupted, or otherwise illegally altered. Alternative networks have thus had to be developed to cater

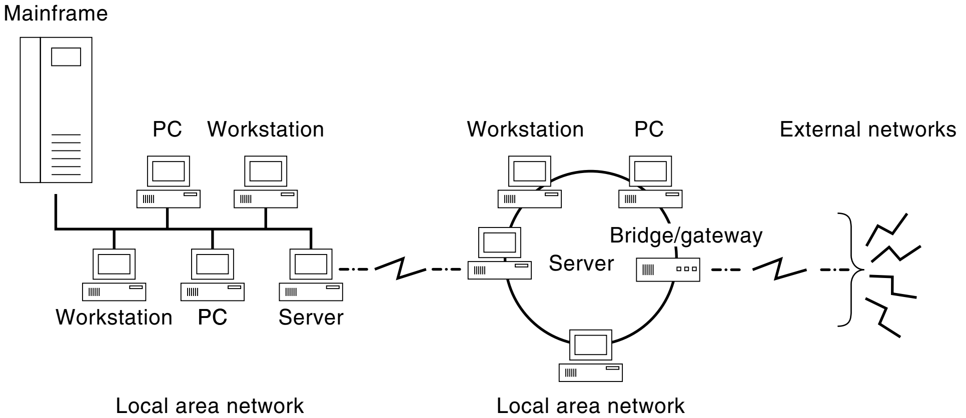

Figure 3. General-purpose organizational network.

to mission-critical user communities, such as research institutions, business corporations, and some government agencies. While using Internet protocols like Transmission Control Protocol/Internet Protocol (TCP/IP) and hypertext transfer protocol (HTTP), similar transmission methods, and similar telecommunications networks, new names have been coined for a new breed of logical networks for this purpose, discussed in the following sections.

Intranets

New networking strategies have been used to alleviate the Internet glut. The intranet was one of the first alternative networks to cater to institutional needs for mission-critical environments. It was a concept that was implemented in the late 1990s. Corporations, whether national or multinational, have traditionally had proprietary computer-based information networks. Access methods and protocols developed for the Internet have been superimposed on some existing networks, for instance, the addition of browser-based hyperlinked features, to facilitate viewdata processing. Other institutions have built new information systems using high-speed leased telecommunications lines to carry institutional viewdata. Very high security corporate intranets may be implemented as logical or physical networks independent of the general-purpose Internet as illustrated in Figure 4. In spite of this limitation, they may also span a region, or be global for multinational corporations. The distinguishing characteristics of an Intranet are: a proprietary telecommunications network; institutional viewdata databanks to be accessed by an internal user clientele; and no access privileges for individuals who do not work for the parent organization. When properly designed and fully integrated in the organizational functions, institutional effectiveness has been enhanced by intranets. Massive viewdata are moved on the Intranet to provide timely information on demand for making critical decisions. National and multinational organizations have benefited most from the intranet strategy by setting up “virtual task forces,” sometimes called project teams. Members of such teams may be anywhere in the corporate branches scattered throughout the world. The type of viewdata transmitted and how they are applied depends on the level of technological advancement the parent corporation has and how much it is willing to spend on a virtual team. Ordinarily, virtual task teams are disbanded at the end of the project. Any of the remote collaborative electronic decision-making models have been utilized, including teleconferencing, electronic mail, and video conferencing, all of which may involve exchanging viewdata containing graphics, images, or moving pictures.

Extranets

Extranets are established for customers or users who have contractual obligations with the parent organization. In this case, the user has access to limited viewdata resources which the parent organization has set aside for this purpose. By definition, access to extranets is password-enabled. The 1990s ushered in an unprecedented success of Internet browser-based commerce. Organizations declared several magnitudes of scale in the increased volumes of business transactions attributed to the ads as well as public relations information published on their Websites. Viewdata available on extranet websites are a catalyst in Internet commerce in many ways. First, vital information needed by the customer can be updated immediately as the need arises, thus obviating the requirement to send bulletin or manual updates to valued customers via the postal system or other courier services. Second, specific products may be displayed in color and multidimensions on the vendor Website and, depending on the technological sophistication of the customer base, publication of mail-order catalogs in hard-copy form may not be needed any more. If needed, the end user may download only carefully selected relevant viewdata portions of the on-line products catalog. Third, the cost of printing, packaging, and shipping product advertising information is markedly reduced, as most of it is already available on the Website. Fourth, a list of frequently asked questions (FAQ) is prepared for current or potential customers.

A list of FAQs is a major time- and cost-saving feature of the extranet, as it answers most common questions and thus reduces corporate staff's customer contact hours. With such an arrangement, technical and customer-service staff need only attend to the more intricate questions. If prepared carefully, FAQs do, in fact, answer most of the fundamental questions customers ask. Before a list of FAQs is compiled, staff in customer service should record the most common questions encountered as they interact with customers on a daily basis. During the design phase, an organizational task force, which eventually puts the institutional extranet together, should be a carefully selected team composed of computer and telecommunications systems experts as well as customer service and public relations personnel. Such a team ensures that the extranet has adequate bandwidth, runs on efficient computer systems with effective response time, has user-friendly interfaces for the end user, and the viewdata on it respond to the user information needs.

Overnets or Supernets

Overnets, or supernets, are yet other attempts to bypass the overloaded general-purpose Internet. *Overnet* is a generic

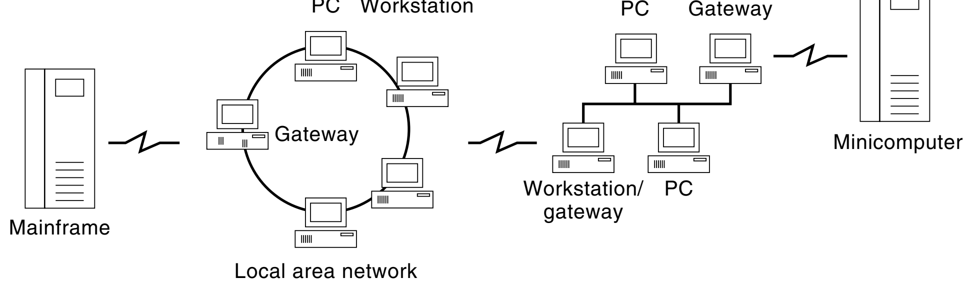

Figure 4. High security corporate intranet.

name for telecommunications networks that have been developed to speed up signal transmission for viewdata outside the confines of the Internet. National Semiconductor Corporation in California and Cisco Systems Inc. have for some time used a data net provided by Digital Island with the trade name Overnet. The use of such a name has caused confusion, as some authors use it as a generic concept rather than Digital Island's proprietary product. Corporations with graphics or image-intensive viewdata will find solutions provided by telecommunications companies like Digital Island attractive, as it bypasses the conventional Internet service nodes, thus eliminating the congestion associated with the public electronic information superhighways.

Another ambitious strategy within the United States is to isolate academic and government research from the general Internet, and has the blessing of the National Science Foundation and several leading US academic institutions. It is a supernet, which has been dubbed Internet 2 or simply I2. Initial institutional collaborative sponsors of Internet 2 included the University Corporation for Advanced Internet Development (UCAID), US Department of Energy, NSF, and the Georgia Institute of Technology. By the late 1990s, UCAID support had increased to more than 100 members. Its advanced connectivity is based on GigaPoPs (giga points of presence). Research universities and government agencies connect to Internet 2 via GigaPoPs, which perform comparable functions to the regional regular Internet access points. The network superhighway backbone is provided by NSF through its Very High Performance Backbone Network Service (vBNS) with MCI Communications Corporation as the main contractor. GigaPoPs provide the necessary bandwidth capacity for switching and routing of graphics and image-intensive viewdata transmitted among high-performance research laboratories. Internet 2 is a major component of the US federal government's information policy initiatives. Such initiatives have over the years included the visionary National Research and Education Network (NREN), the National Information Infrastructure (NII), and promotion of a heavily funded Next Generation Internet Initiative (NGII) (5). Government implementation of these initiatives involves channeling grants and contracts funding through the National Science Foundation and other federal agencies to public and private organizations. The main advantage of the Internet 2 project is speed, partially because of restricted traffic and the use of newer telecommunications technologies. The vBNS, which is mostly optical fiber, is a good example of technological improvement, as it upgrades backbone bandwidth from 45 Mbps of the conventional Internet to 622 Mbps for Internet 2 (6). As viewdata are evolving to become truly multimedia and multidimensional, the delivery networks are also evolving in the functions they perform and the modes in which they operate. The monolithic Internet is gradually being replaced by high-performance, fast-throughput networks, most of which are characterized by password-enabled access.

VIDEOTEX APPLICATIONS DATA NETS

The transmission of viewdata via videotex applications forms a data net category that has, over the years, eluded the US general market, but is used in Europe, especially France, and in some parts of Canada. From the mid-1970s to the late 1980s, videotex encompassed a variety of information services aimed at delivering information to the home (7). Television was the prospective delivery and display device, and a menu-driven interface was envisaged. Over the twenty years or so it was in vogue, several variations of videotex were implemented, using both dumb terminals and television sets. It may however be argued that, by the late 1990s, electronic information services described under the purview of videotex had been adequately covered by the various Internet services. The French Minitel is the best-known example in the world for videotex applications and may justifiably retain the appellation, as it has grafted the Internet to an essentially videotex environment. Videotex, sometimes referred to as videotext, is a complex implementation of a set of multimedia delivery systems, which may include provision of software, hardware, and the telecommunications network all in one package from the same vendor. To market an information service or product, for instance an on-line information search-and-retrieval service, one may access an appropriate telecommunications channel from a central carrier and software or hardware from the same or different suppliers.

The historical development of videotex is closely associated with viewdata. Some analysts have treated them synonymously, for instance, in 1973, when the British Post Office (BPO)—now British Telecom—introduced a television-service-based teletext system it called viewdata, which became the CEEFAX System and later Prestel. It was, however, not as comprehensive as the viewdata conceptualized in this article. Early videotex concept development and projection focused on delivering information to the end user, whether at home or in the office. While the potential market seemed sizable, the search for appropriate products that were superior to the competing paper products consumed the time of most videotex systems developers in the international information arena. Depending on the national customer base and penetration, videotex planners tackled the question of whether to use cable television (CATV) networks or the telephone networks to deliver the services to the consumer. It was never decisively determined which of the two networks was the most ideal. Much of the research and experimentation for videotex occurred in the 1980s in the major industrial regions of the world—Europe, North America, and the Pacific Rim, mainly Japan.

Perception of the role of videotex in society has had a strong link with the socioeconomic revolution promulgated by visionaries like Daniel Bell, Fritz Machlup, and Marc Porat. Starting in the 1960s through the 1970s, these theorists predicted the coming of the postindustrial society, ushered in by a revolution which would result in the societal metamorphosis from the industrial age to the information age. In an information age, information services and products must be distributed to the widest market possible for the information society to be nurtured. Building on these socioeconomic concepts, early definitions of videotex were both perceptual, which depended on what the analyst perceived it to be; or predictively prescriptive, whereby the analyst predicted what it would be given the information trends. An early 1980s generic definition was that videotex is an electronic interactive information system which would be used to disseminate textual and graphic information to users using low-cost terminals. Since the television was one of the most widely distributed devices in homes, offering mass-audience text over a cathode ray tube

(CRT) was also used to define videotex in the late 1980s. As of that time, the available technologies for electronic signal transmission and display were not adequately sophisticated to advance the precepts of an information society. Neither the existing telecommunications systems—basic physical networks and switching devices—nor the display devices—TV sets, dumb terminals, or microcomputers—could effectively be utilized to fully implement the videotex concepts as envisaged.

Videotex applications underwent extensive experimentation and trials during the 1970s and 1980s in Europe, North America, and Japan. Available literature reveals that several factors interplayed to contribute to the degrees of failure or success achieved in different parts of the world. While technology was important, it was not necessarily the major factor in all cases. Rather, political, social, and economic issues played a significant role in the final outcomes of the technological experimentation. The first videotex application experiment, which later developed into Prestel, is credited to the British Post Office in 1970. Concurrently the French were experimenting with the videotex terminal and introduced Antiope, which preceded the Teletel/Minitel in 1976. The following year (1977), the Federal Republic of Germany launched its videotex experiments, which were based on the British software. Japanese experiments were started about the same time.

By the early 1980s enthusiasm for videotex was high in the world regions that had active experimentation and predictions of nationwide acceptance in different countries were rampant. However, dismal failures followed the high-spirited launches of the systems and many had slow growth or were folded within ten years of operation. For instance, when the British Post Office started Prestel in 1979, it was forecast that it would have 100,000 subscribers by 1981, but by 1989 it had only 90,000. The German Bundespost started the Bildschirmtext videotext trials in 1979, with the prediction of one million subscribers by 1986, but by 1989 it had only 151,000 users. Most US trials did not fare better either, as several of the prospective services were terminated within less than ten years of introduction. The Knight-Ridder Viewtron service, which was based on a special adapter for the television set, was introduced in Southern Florida in 1983, with expectations of millions of subscribers and had 5,000 by the end of 1984, but had ceased operation by 1986 with a loss of $50 million. Southern California had the Times-Mirror Gateway system, which used the same technology as Knight-Ridder's, started in 1984 and stopped in 1986, and the sponsors lost $30 million.

A number of explanations have been given for the demise or slow growth of the videotex systems. Only the most germane are briefly mentioned, to illustrate how current viewdata are flourishing in a most favorable environment. First, the lack of unique sustainable electronic information consumer products, which would compete effectively with paper products, was a major factor. Many of the services on the videotex initially provided news, stock quotes, and sports scores, which were very well covered by the newspapers or regular television and radio at less cost, with no technological literacy needed to access them. Home banking was introduced, but none of the suites of information products and services contained what has been dubbed the "trigger" service that almost everybody, or a sizable portion of society, must subscribe to. Second, many of the failed systems used proprietary single-purpose equipment—terminals or television adapters that were relatively expensive for the functions they performed. None of the access devices provided anywhere near the versatility provided by the personal computer of the mid- to late 1990s, which is used to access the Internet. Third, the entertainment function was lacking for most of the products provided on the videotex systems. Some of the most popular viewdata products on the current mass-market electronic information networks include personal communication—typically electronic mail, chat services, electronic bulletin boards and travel services—which may include schedules and on-line reservations. Most of these services were absent in the early videotex implementations. Some analysts have argued that entertainment programs do serve as "trigger" services and serious programs follow them when the user is "hooked" on the electronic on-line access services. Fourth, early videotex systems tied up the most popular devices in the home, either the telephone or the television, or both. Few households could tolerate lengthy tie-ups of these devices. Finally, videotex standards at both the national and international levels were lacking. Meetings on setting international standards were not in short supply, however, for in 1979 the International Standards Organization (ISO) had 15 proposals for coding text on videotex systems. Other groups involved were: the Conference of European Postal and Telecommunications (CEPT) administrators, and the International Telegraph and Telephone Consultative Committee (CCITT). These standardizing agencies sponsored several international standards conferences, which deliberated on videotex coding schemes for both text and graphics, but no consensus was reached. According to Case (7), proposals were not acceptable, as delegates preferred their own standards, not due to technical superiority, but mainly because of national pride. Consequently, videotex systems retained a chaotic status quo, in respect to standards, either at the national or international levels. In some cases, within the same country, users in one region using one system could not share data with users in another region using a different system, because of incompatibility. In contrast, viewdata transmitted on the Internet, the use of TCP/IP transmission protocol suite, HTTP, and ASCII plus graphics coding schemes, which have been widely adopted, have made surfing the Internet an international all-purpose activity.

French Minitel/Teletel

The most stalwart original videotex system which has survived is certainly the French Teletel/Minitel, started by French Telecom in 1982 (8). The circumstances in which it flourished are so unique that few countries may use it as a model for developing nationwide mass-oriented electronic full-text information-delivery systems. Several analysts have documented the success story of Minitel, giving the rationale for profitability, and nationwide acceptance where other European and U.S. equivalents failed. First, the Minitel was an offer to the French public that it could not refuse. During the 1970s, the French government revamped its national telephone system by installing an efficient digitized packet-switched network backbone called Transpac based on X.25 packet switching communications protocol. At the grass-roots level, several new telephone lines to homes were installed and connected to the regional hubs which, in turn, connected to the backbone. This effort established the telecommunications foundation, which is a prerequisite for a mass national electronic consumer market. By 1989, 95% of French households were connected to the renovated telephone system. Second, in 1978, the Direction Generale des Telecommunications (DGT), the national telecommunications authority, started work on the on-line electronic national telephone directory and, by the time Minitel was launched, the directory was one of the major stable on-line services offered. Undoubtedly, the on-line telephone directory was a typical "trigger" service. In order to stimulate the use of the on-line directory and its on-line directory assistance, equipment and software for gaining access to the Minitel were initially given out free to customers. Millions of Minitel terminals were freely distributed and it was not until 1989 that a small highly subsidized customer fee was introduced (9). Customers who insisted on getting the printed hard copy of the telephone books were charged for them, which was a great deterrent. Third, the Minitel terminal interface was designed to be simple. The typical dumb terminal, which is the most ubiquitous, has a monochrome display, a full alphanumeric keyboard with dedicated function keys, and an internal 75/1200 bps modem. Recent terminal access improvements include the use of personal computers and advanced terminals equipped with smart-card readers. Smart-card readers are computer chips which are installed into the latest Minitel intelligent terminals, called Magis, to facilitate authentication of the user at log-on and other functions. This added intelligence introduces a degree of distributed computing, in contrast to the original dumb terminals, in which user ID verification was done centrally at the mainframe.

Finally, Minitel has a simplified end-user charge system for the telecommunications carrier and user services provider. The agency bundles telecommunications and on-line services costs together and bills the subscriber. The on-line service charges are monitored, recorded, and charged according to the rates established by the service provider, who is reimbursed by French Telecom rather than billing the customer directly. The ease of payment for Minitel-based information services is certainly an inducement for prospective customers. The transmission of viewdata, as defined in this article, faces a serious problem using the conventional Minitel terminal. At 75/1200 bps rate the terminal may be ideal for text, but image- or sound-intensive data would take forever to upload or download. To improve throughput, especially for the business communities, the French Telecom has deployed the integrated services digital network (ISDN) in some parts of the country. ISDN improves the communications speed and is at optimal when used with intelligent terminals—mostly personal computers.

Telecommunications Technologies for Viewdata Transmission

Perhaps the most pervasive drawback to effective transmission of viewdata at the international level is the disparity in the distribution of physical transmission technologies in different countries or regions of the world. It is one thing to entertain a starry-eyed view of how a global village already exists with viewdata conveniently flowing to and from all parts of the world. The stark reality is that the nature and the ease of the flow of viewdata at the international level is governed by the sophistication of the physical telecommunications networks available in different parts of the world. Understanding such networks and how they function is an imperative for analysts who grapple with the worldwide proliferation of viewdata (10). Advanced countries in North America, Europe and the Pacific Rim, may have broadband signaling systems such as: asynchronous digital subscriber line (ADSL); asynchronous transfer mode (ATM); cable modems; frame relay; and the integrated services digital network (ISDN) and other techniques. These systems are already implemented or implementable options in developed countries' physical networks (see Table 1). In addition, the plain old telephone system (POTS), the conventional telephone network, which may be used to access remote viewdata using a modem, is more reliable and has a higher national installed base in developed countries than the less developed countries. Ignoring such disparities tends to exaggerate the claim to potential worldwide access to viewdata. While the gradual transfer of the prerequisite technology to the less developed countries may eventually narrow the gap, it is safe to say that easy access to viewdata, as articulated in this article, will be predominantly in the developed countries in the foreseeable future.

Within a given country, the mode of implementation of the transmission technologies in the physical networks does dictate the ease with which viewdata are accessed. Two major elements interplay to determine the rate at which viewdata are effectively transmitted to the enduser. First, a long-haul signal transmission network, which includes signaling and switching techniques, must be in place and operating efficiently. Second, the access terminal used, which in many countries is currently an intelligent personal computer (PC), must have the capacity to handle viewdata. Assuming that the intelligent PC is readily available, albeit in a variety of configurations and degrees of penetration per capita, the physical networks become more significant elements. Starting with the most basic element, POTS, as the delivery network for viewdata, there is an analog modem-based access system with maximum delivery of 56 kbps. This is relatively slow for multimedia viewdata and is certainly inadequate for teleconferencing, video conferencing, or other viewdata modes that have moving images and sound.

ISDN in Viewdata Transmission

To augment the POTS, ISDN was one of the earliest broadband signaling systems developed in the 1980s by the telecommunications carriers. It does indeed transmit viewdata at a faster rate than the analog modem-based networks (11). The ISDN signaling algorithm works on the regular telephone network and requires ISDN switches at the telephone company's central office and an ISDN capable terminal at the user end. As it establishes a virtual digital network it achieves high efficiency because there is no signal conversion,

Table 1. Broadband Technologies for Viewdata

Technology	Capacity
Cable modems	30 Mbps
ADSL	9 Mbps
Frame relay	56 kbps–1.536 Mbps
ISDN	128 kbps–1.5 Mbps
Analog modems	56 kbps

comparable to the analog POTS, at either end—carrier or subscriber. Its two main types; the basic rate interface (BRI) and the primary rate interface (PRI) carry signals at maximum rates of 128 kbps and 1.544 Mbps, respectively. Such rates are a great improvement on the POTS analog modem-based viewdata transmission.

Although it has been on the market for almost twenty years as an alternative technology for transmitting viewdata, ISDN has been slow to develop. Among the reasons often given are cost of equipment and installation, uneven deployment, and lack of "trigger" user application at its critical developmental period—the 1980s. Even in countries like the United States, with highly sophisticated telecommunications infrastructures, ISDN has not taken off as anticipated by the telecommunications carriers. Internet user demand for high bandwidth to accommodate viewdata, as well as the threat of other technologies such as cable modems, accounted for the heightened interest by telecommunications companies in ISDN in the 1990s. The trend was accentuated by the 1996 US Telecommunications Act, which encouraged competition among telecommunications companies. A flurry of advertising efforts extolling the broadband transmission qualities of ISDN and offering discounted or free installation ensued. But, by the time ISDN became affordable, alternative technologies like ADSL and cable modems were on the market and offered a better viewdata operational environment, with higher bandwidth and faster throughput (12).

ADSL in Viewdata Transmission

Asynchronous digital subscriber line (ADSL) is a relative newcomer to the telecommunications market, but perhaps the most promising to transmit viewdata to the end user in offices as well as homes. It is one type of a group of several digital signaling techniques that have been developed in the past decade to utilize the existing telephone network to carry high bandwidth. The generic name of these systems is digital subscriber line (DSL). They are sometimes collectively treated together as xDSL, where "x" is a variable replaceable by any specific character for the particular type of DSL (13). Some examples from the family of DSL signaling systems include: symmetric DSL (SDSL) and very high rate DSL (VDSL), which differ in both the mode of transmission and bandwidth. Within the advanced countries of Europe, North America, and the Pacific Rim, DSL technology has been in experimental labs and beta tests or trials for more than a decade. In the 1980s, Joseph Lechleider at Bellcore (former AT&T Bell Labs) conducted intensive research on the high-bit-rate DSL (HDSL). In addition, in the early 1990s, the Regional Bell Operating Companies (RBOCs) in the United States, as well as their European counterparts, had many xDSL trials using interactive TV and video on demand as the base services. Until the late 1990s, widespread deployment of xDSL did not materialize, partly due to lack of a "trigger" service. The renewed interest in especially ADSL is attributable to the Internet demand, particularly for the Web-based viewdata.

Since it is based on a signaling algorithm that uses the regular telephone twisted copper wire network, the very foundation for POTS, ADSL has an international appeal for transmitting viewdata. Some analysts have asserted that it ". . . holds the greatest potential for mass deployment" (14), as it introduces the broadband characteristics needed for high-volume viewdata transmission on a network, which is associated with a conventionally narrowband signal transmission. ADSL's asymmetric mode of transmission is well suited for Web viewdata access. Most users request viewdata from remote servers using few textual commands, thus requiring minimal use of bandwidth upstream. At the server end, the downstream, massive multimedia viewdata are often requested, requiring heavy use of the available bandwidth. ASDL is designed to serve such environments. The excitement with ADSL is justifiable in advanced countries as well as the less-developed countries, because the copper-based telephone network is the most ubiquitous in both groups of countries. Assuming that a reasonably stable POTS infrastructure exists, ADSL is poised to be one of the gems of the telecommunications industry for the twenty-first century. The often-quoted transmission speed of 9 Mbps is faster than analog modem speeds as well as ISDN. The use of satellites discussed in the following paragraphs accentuates access to viewdata at the international level, especially in countries not served by intercontinental under-ocean fiber optic data communications cables.

Communications Satellites in Viewdata Transmission

Communications satellites are an alternative medium for transmitting viewdata (15). They are ideal for sparsely populated areas or areas that have not been adequately covered by the regular telephone or cabling networks. They are also the technology of choice for linking less-developed countries to advanced countries databanks for viewdata access. Their mode of transmission is based on high-frequency radio waves with very high bandwidth. Their mechanism includes a space satellite and two or more ground stations. The earth stations used for viewdata communications are similar to dish antennas commonly used by individuals or organizations to receive television signals. Two typical terminals have characterized satellite viewdata access by the end user. Very small aperture terminals (VSATs) are mainly for text, while T-carrier small aperture terminals (TSATs) can carry viewdata as they achieve a 1.544 Mbps data rate (16). Most communications satellites are placed in a geostationary orbit—an orbit timed to the earth's rotation. Within such an orbit, the satellite stays in a fixed position with regard to the earth antennas. This removes the need for constant reorientation of the earth stations in order to remain in touch with the communications satellite. A common distance for geostationary communications satellites is approximately 23,000 m above the earth's surface.

One advantage of satellite viewdata communications is the high bandwidth, which is suitable for full-text information-delivery systems. Their transmission mode is essentially broadcast in nature. This implies that messages beamed to the earth may be picked up by any station tuned to a given radio frequency and pointed to the communications space satellite. Although this allows the satellite to send signals to many earth stations simultaneously, within its footprint, privacy of data is hard to maintain. For corporate or otherwise confidential viewdata, scrambling or encryption is normally used. At the receiving station, such viewdata must be deciphered using special conversion algorithms. Yet another serious problem with satellites is propagation delay caused by transmitting signals through space. All satellite signals using a relay station in ordinary geosynchronous orbit are subject to a quarter-of-a-second delay in both directions. While the delay may be vital to some real-time interactive viewdata applications, file transfers can be done with relative convenience. When combined with optical storage (discussed in the next section), satellites can be an effective medium for information transfer from the advanced countries to the less-developed countries.

Optical Storage Alternative for Viewdata Delivery

In an ideal environment, optimum access to viewdata would be to connect to a databank on-line and in real time. One also assumes that the databank administrators update its databases frequently to provide the end user with the most current viewdata. In many cases, however, it may not be possible to have a real-time access to databanks with the requisite leading-edge viewdata. Several reasons may be cited. First, the available telecommunications infrastructure may not be able to carry heavy viewdata traffic. Second, the user community may not afford subscribing to the expensive on-line connections to the appropriate databanks and the associated telecommunications costs. This is especially true of users in the less-developed countries. Third, equipment needed for access, for instance, VSATs and TSATs satellite access terminals and relevant software, may be too expensive for the user environment. Finally, the expertise needed to maintain servers and high-end workstations needed for effective viewdata manipulation may be lacking. In such situations, optical storage on CD-ROMs, either as stand-alone or as networked devices on CD-ROM LAN, may be the main and, at times, the only alternative to accessing viewdata. Either method of providing access to viewdata ensures that the end user does not have to wait indefinitely for material identified via indexes—printed or on-line bibliographic databases.

Several companies have taken advantage of the CD-ROM niche and sell optically stored viewdata in many forms. The beauty of the CD-ROM-based viewdata is that the CD-ROM is shipped with the appropriate search programs as well as the substantive data. Many on-line full-text databases have CD-ROM versions, for instance, Disclosure, a database with financial information on US corporations has a CD-ROM version. ICC International Business Research (developed in the United Kingdom), which covers international stockbrokers and investment bankers, also has a CD-ROM version. Furthermore, directories like *Standard & Poor's Register, Thomas Register,* and encyclopedias like *Kirk-Othmer Encyclopedia of Chemical Technology* and *Compton's Interactive Encyclopedia,* to mention a few, have both on-line or CD-ROM versions.

Optical storage of viewdata has advantages and limitations. One of the main advantages is that, once the appropriate CD-ROM has been installed end users can use it indefinitely, with no telecommunications or database connect costs which are normally charged for real-time on-line remote viewdata access systems. A second advantage is that, when carefully selected, CD-ROM databases provide instant access to viewdata ordinarily available via on-line services. Among the limitations is the lack of currency, which depends on how often the content, the substantive information on the media, may be updated. Data are often two or more months behind the on-line version. Another disadvantage is that CD-ROMs acquired from different companies will ordinarily have different search languages which may baffle a user unfamiliar with searching syntax. Like other viewdata access enabling technologies, CD-ROMs may inundate the end user with a tremendous amount of information, from which the relevant viewdata are hard to extract.

As discussed in the following paragraphs, various techniques have emerged in an attempt to control the extensive information.

VIEWDATA AND THE INFORMATION OVERLOAD

Accessing viewdata on the Internet, especially the Web and other networks, presents the enduser with a tremendous amount of data from which to sift pertinent information for decision making. The enduser is faced with a deluge of information from Web self-publishing (17). Prior to the proliferation of Web-based publishing for an anticipated national or international market, an individual or organization had to go through a long process of finding a publisher or agent to approve a manuscript and work with an editor until a publication was completed. We have now reached a stage when anything that appears on a publicly accessible Web page has, in effect, been published, and is searchable. Perhaps the most serious problem caused by the democratization of publishing is that, using a general browser or search engine, a NASA research engineer's paper on "nuclear reactors" in a refereed electronic journal has an equal chance of retrieval as an undergraduate or high school student's papers on the same subject appearing on their home pages. Thus as one considers information on the Internet, and particularly the Web, the issues of quantity and quality become apparent.

Various remedies have been developed to address the information overload problem with regard to viewdata. Two levels may be identified at which IS personnel have attempted to tackle the issue for the enduser—the general Web page design level and the viewdata retrieval level. Some institutional webmasters have made efforts to identify sites that are particularly relevant to their user clientele, and made links to them with annotations highlighting the most significant features. While this effort may help, the Web is so vast and changes so frequently that unless the list of links is updated daily, it may omit new sites or relevant contents from sites that are not obvious through their published titles. So far the most promising remedy has been the use of artificial intelligence (AI) to design expert systems with the generic name "intelligent agents" (IAs). IAs are incorporated in Internet Website interfaces and perform a variety of sifting functions. At the individual level, an intelligent agent may search the Web in the background and suggest links to the user depending on the key words in the search topic. Some "learning" agents use heuristics to restructure their search after the user has indicated relevant or irrelevant hits. More of the same—relevant items, if any, are generated while none of the irrelevant are presented. Results are achieved through semantic pattern matching rather than simple keyword searching. Agents have also been designed to facilitate decision support systems in organizations using intranets. Such agents parse group interest to establish patterns based on semantic elements and search the intranet, a process often referred to as data mining (18) to find matching resources that are flagged for groups for extracting viewdata on demand. IBM's

Globenet is an example of an IA, which searches news groups for information posted about the company and "alerts" the relevant division or department for possible action or response when relevant viewdata have been identified.

SUMMARY AND CONCLUSIONS

With the exponential growth of the Internet and other information networks, especially the World Wide Web, access to viewdata containing graphics, sound, and moving pictures has become extremely significant. The four stakeholders: (1) users, (2) viewdata service providers, (3) telecommunications carriers, and (4) computer systems designers will continue to consider the most convenient ways of identifying and accessing relevant viewdata. While the concept of the global village, in which viewdata are freely exchanged throughout the world is espoused, excitement must be tempered by the stark reality of the fact that the less-developed countries are not fully participating in the plethora of Internet and Web viewdata. Similarly, within a given country there may be regional disparities in viewdata access, depending on how the enabling physical telecommunications have been deployed.

As the twenty-first century begins, the amount of viewdata potentially available for decision making will continue to overwhelm individual or even corporate capacity to harness.The information overload is a real drawback to the ability to utilize all the relevant viewdata for making optimum decisions with perfect information. Solutions lie in the careful design of institutional Websites, which are properly guided to highlight the most significant links to a given organization for which the Website is designed. In addition, users must resort to a relatively mature science of artificial intelligence to design expert systems or intelligent agents to help sort through the viewdata users encounter daily.

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VIRTUAL SIMULATION. See AEROSPACE SIMULATION.
VIRTUAL STORAGE. See VIDEO RECORDING.