

The Video Communications Decade

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Video entertainment in the home grew tremendously during the 1970s and 1980s, but the 1990s will be the *video communications decade*. The video material—coordinated images and sound—will move from mostly passive presentation to interactive origination and selection. The technology and infrastructure that already support all modern telecommunications will be used to communicate this video material to homes and businesses for personal, business, educational, and entertainment use. This paper provides an overview of some of the image- and sound-compression standards, components, and AT&T products and services that will enable the video communications decade to occur. Greater detail is presented elsewhere in this issue of the *AT&T Technical Journal*.

Introduction

During the decades of the 1970s and 1980s, video entertainment grew tremendously in the home. The video content—i.e., the coordinated presentation of images and sound—was provided by broadcasters through over-the-air and cable systems, by movie and speciality interest producers through video tapes, and by games makers through television adjuncts and personal computers. Except for those who were playing the games, consumers were generally passive receivers and, thus, not involved in originating or changing the video.

The 1990s, however, will be the video communications decade. Two-way telecommunications connections will be used, in whole or in part, to provide video communication among friends and business colleagues, and to provide a wide variety of educational and entertainment video material to homes, schools, and businesses. Consumers will originate and create video material, as well as interactively select and receive it.

AT&T's Visual Communications Vision—as first announced in January 1992 by Group Executive Robert M. Kavner—will enable the video communications decade to be realized with an array of technologies, components, communications networks, products, and services that meet the needs

of customers. (See Figure 1.) These needs span the gamut:

- From emotional closeness with family members in people's personal lives
- To rapport and interaction with customers, suppliers, and coworkers in people's business and professional endeavors
- To learning the latest concepts and technologies in a field in a convenient, efficient way.

This issue of the *AT&T Technical Journal* explores image- and sound-compression technologies and international standards, and a comprehensive set of communications products and services that can turn this vision into reality. (Panel 1 defines acronyms and terms used in this paper.)

Technology and Standards

The same technology and infrastructure base that supports all modern communications enables the video communications decade to happen. With this base, analog signals that represent sound, still images, and motion images can all be converted into digital bit streams. These streams can be merged with additional digital data and then transmitted and switched with common equipment. Just before use, the sound and image digital streams are separated out and converted back to the corresponding analog signals.

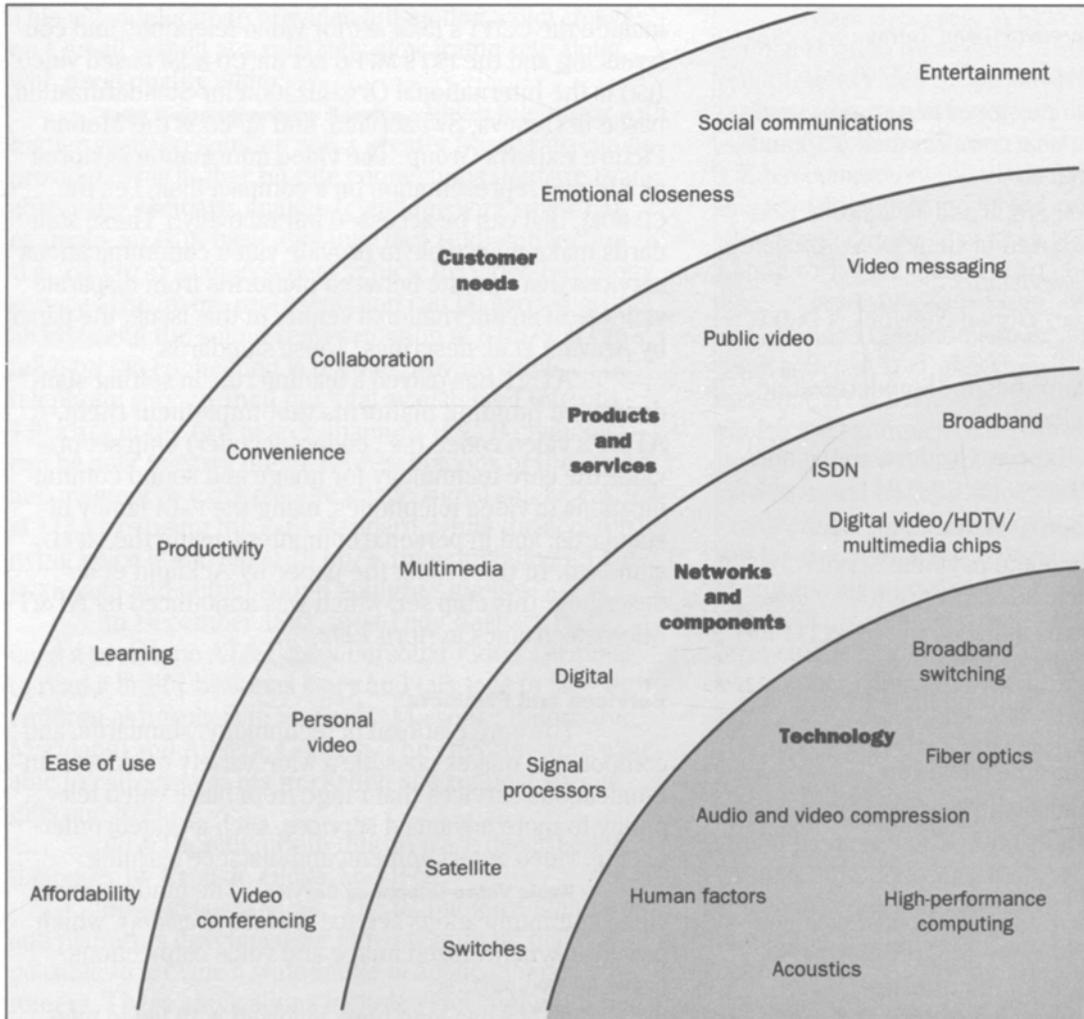


Figure 1. AT&T's vision for visual communications encompasses an array of technologies, components, communications networks, products, and services to meet the needs of customers at home and at business locations. With these products and services, customers can stay close to their family members; interact with other customers, suppliers, and coworkers; and conveniently learn the latest concepts and technologies in a field.

The additional digital data provides auxiliary information and control.

The video communications decade is further made possible by new, economical modems (modulator-demodulator) that can use the 3.3-kHz (kilohertz) analog bandwidth of an ordinary twisted-wire pair to send 19.2 kb/s (kilobits per second) of data. With these modems, digital connections can be established at various bit rates through the analog network. Alternatively, inherently digital connections can be established at the rates in the currently deployed ISDN hierarchy; i.e., from 64 kb/s to 1.5 Mb/s (megabits per second). (ISDN stands for Integrated Services Digital Network, a CCITT-defined digital network. CCITT is the International Telegraph and

Telephone Consultative Committee, which is based in Geneva, Switzerland.) Finally, for television channels, economical modems have been designed that use the 6-MHz (megahertz) analog bandwidth of the television channel to send about 20 Mb/s of data. These modems for television channels open options for the final digital access to homes and offices to be at radio frequencies that are broadcast over the air or carried on coaxial or optical-fiber cables.

Yet, simple digitization of a typical video signal—i.e., a color television signal—results in a rate requirement that exceeds 100 Mb/s. Such a rate is far too high for the signal to be carried over the modems or digital connections already mentioned. Over the last

Panel 1. Abbreviations, Acronyms, and Terms

BRI — ISDN basic rate interface
CD-ROM based video — video stored in a compressed digital representation on a compact disk (CD) and accessed interactively
CCITT — International Telegraph and Telephone Consultative Committee (based in Geneva, Switzerland)
HDTV — high-definition television
ISDN — Integrated Services Digital Network, a CCITT-defined digital network
ISO — International Organization for Standardization (based in Geneva, Switzerland)
MPEG — Motion Picture Experts Group; also the standard established by the ISO for CD-ROM based video
NTSC — National Television Systems Committee
pay per view — an enabling and payment service for viewing a particular television program
P×64 — a set of standards established by the CCITT for video telephony and conferencing
SIGOIS — Special Interest Group on Office Information Systems
VCTV — viewer-controlled cable television
X.25 — the CCITT's packet-switching protocol at the link and packet layers

decade, compression algorithms have been developed—many at AT&T Bell Laboratories—that reduce the required rate by exploiting both the *statistical redundancy* among parts of the television picture and sound signals and the *subjective redundancy* that is inherent in human vision and hearing. Rates are reduced to the range of 9.6 kb/s to 17 Mb/s for motion images and 6.8 kb/s to 64 kb/s for sound, depending on the quality desired. These rates can be carried over the various switched and broadcast connections.

Because compatibility among different applications and manufacturers is extremely desirable and often is essential, the international standards organizations have standardized several compression algorithms in recent years. AT&T has been active in these standards activities. The compression algorithms balance the frame rate and spatial resolution of the images and the naturalness and intelligibility of the sound with the available connection bit rate. Standards that have been agreed on

include the CCITT's P×64 set for video telephony and conferencing and the ISO's MPEG set for CD-ROM based video. (ISO is the International Organization for Standardization, based in Geneva, Switzerland; and MPEG is the Motion Picture Experts Group. The video information is stored as a digital representation on a compact disk, i.e., the CD-ROM, that can be accessed interactively.) These standards make it possible to provide video communications services that operate between platforms from disparate vendors in an international venue. In this issue, the paper by Aravind et al. describes¹ these standards.

AT&T has played a leading role in setting standards and building platforms that implement them. AT&T's video codec (i.e., coder-decoder) chip set provides the core technology for image and sound communications in video telephones, using the P×64 family of standards; and in personal computers, using the MPEG standard. In this issue, the paper by Ackland et al. describes² this chip set, which was announced by AT&T Microelectronics in April 1992.

Services and Products

The core platform of technology, standards, and components makes possible a wide variety of video communications services that range from basic video telephony to more advanced services, such as videoconferencing, video entertainment, and distance learning.

Basic Video-telephony Service. The fundamental video communications service is *video telephony*, which provides synchronized image and voice connections between two parties.

AT&T has long been involved with video telephony. Prototype systems were developed as long ago as the 1920s. This was followed by the development of AT&T Picturephone terminals and service in the 1960s, and AT&T's VideoPhone 2500, which was announced in early 1992. The latter is the first product to connect to the telephone network via an ordinary telephone wire pair.

The VideoPhone 2500 (which Early, Kuzma, and Dorsey describe³ in their paper) employs a 19.2-kb/s modem. This video telephone uses:

- Protocols that are based on X.25, the CCITT's packet-switching protocol at the link and packet layers,
- A proprietary video-compression algorithm to represent the video at 9.6 kb/s, and
- A proprietary audio-compression algorithm to represent the audio at 6.8 kb/s.

This video telephone provides full-motion, color images on a small screen at a relatively slow frame rate along with good-quality audio.

ISDN Video-telephony Service. Video telephony with higher spatial resolution and a greater frame rate can be provided over higher bit-rate connections than are available using ordinary, analog, telephone wire pairs. For example, an ISDN basic-rate-interface (BRI) connection (i.e., 64 kb/s) is an excellent vehicle for video-telephony service. The image representation can be carried at 56 kb/s and the sound representation at 8 kb/s. If the full ISDN BRI connection is used to provide video-telephony service, then the total available bit rate of 128 kb/s in the two bearer channels (i.e., B channels) can be split to carry digital representations of the sound and image. For example, the image signal can be carried at 112 kb/s using the P×64 standard, while the accompanying voice is carried at 16 kb/s, thus providing an output image and output sound at higher quality.

In December 1991, First Lady Barbara Bush used a prototype AT&T ISDN Personal Video Terminal to read a brief Christmas story and talk face to face with children at hospitals in St. Louis, Missouri; Baltimore, Maryland; and Atlanta, Georgia. The children were also able to call Santa at his workshop and request special gifts and toys.

AT&T's activities in this area are described in the paper by Crouch, Hicks, and Jetzt.⁴

Other Video Services. The technology, standards, and platforms developed for video telephony make it possible to provide a wide range of applications to customers. These applications include video and multimedia conferencing, distance learning, real-time video applications (such as video on demand), and multimedia information services.

Various video services can be brought to homes over the wires that the local telephone companies provide, or over the cable that the cable television company provides. For the cable-based services, if information—either video, data, or control—is to be carried in both directions, then both downstream and upstream channels must be active. Such services can also take advantage of new compression algorithms for NTSC signals. (NTSC is the National Television Systems Committee.) These algorithms combine AT&T's work on the compression of HDTV (high-definition television) signals and on the MPEG standard.

Video messaging. A basic video communications service is video messaging. This service includes the recording of video messages in a mailbox, similar to what is done with voice messages in today's voice-mail systems. Also, electronic mail messages can be enhanced to include a video component, so that supplementary still or motion images with voice and sound can be attached to the text messages. Exploratory work is under way in AT&T Bell Laboratories for these capabilities.

Multimedia conferencing. Video conferencing is an area of video communications in which AT&T has long been active. AT&T 5ESS® switches, AT&T SLC® carrier systems, AT&T DDM 2000 multiplexors, and fiber cables are examples of network products that support point-to-point visual communications from very low bit rates to multimegabit rates. But more than point-to-point connections are needed to provide interactive multimedia capabilities (i.e., coordinated text, image, and voice) during a conference.

One important new element for multimedia conferencing is a *multimedia conferencing bridge* that provides connection and synchronization capabilities for multiparty, multimedia communications. The paper by Horn et al. describes⁵ the architecture and features of such a bridge.

Another AT&T project, the research prototype called Rapport,⁶ provides collaborative work capabilities using multimedia conferencing. By using this system, the conference participants can share text, image, and audio information and can work collaboratively on applications, such as drawing graphics or developing a computer program.

Distance learning. Another important application of multimedia conferencing is distance learning. In a distance-learning application, an instructor can teach students who are at remote locations. Students can see and hear the remotely located instructor, as well as the information he or she provides. This information includes photographic images, lecture notes that the instructor writes in real time, and short segments of video material.

The paper by An et al. describes⁷ an AT&T trial of a system that uses ISDN and a prototype multimedia bridge to provide distance-learning capabilities, with California State University at Chico as the center location.

Video on demand. AT&T is active in the customized delivery of real-time video to the home. One important service in this area is video on demand, which

gives customers the opportunity to select a video for viewing at a time they specify. Video-on-demand services may be delivered by cable-service providers and by telephone companies.

The paper by Allen et al. reviews⁸ the significant market drivers for video-on-demand service and describes a joint test of this service in the Denver, Colorado, area by Tele-Communications, Inc., US WEST, and AT&T. This trial will offer two services: Take One™ service, a true video-on-demand service; and Hits At Home™ service, an extended pay-per-view service.

Multimedia information services. Video terminals and the video networking infrastructure will accelerate the introduction of other new services. Customers will be able to access interactively video and related data from different sources. As an example, the research prototype of a document alerting and browsing system, called the AT&T RightPagesSM image-based electronic library service,⁹ demonstrates how various journals and other publications might be accessed in the future. As a further example, home shoppers should be able to browse through video catalogs and use associated data to purchase merchandise.

Conclusion

The wide variety of products and services presented in this issue support AT&T's premise that the 1990s will be the video communications decade. AT&T is dedicated to being a major contributor to the advances that are coming.

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