

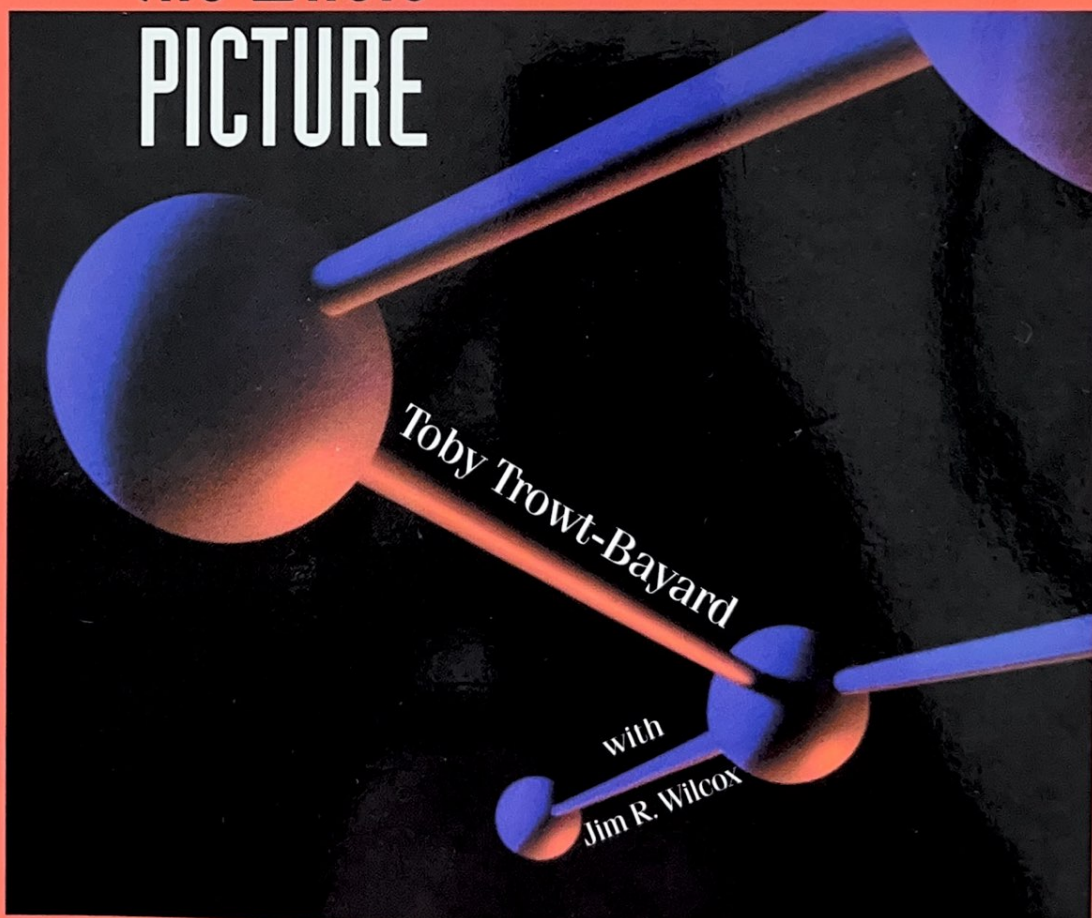
Video conferencing

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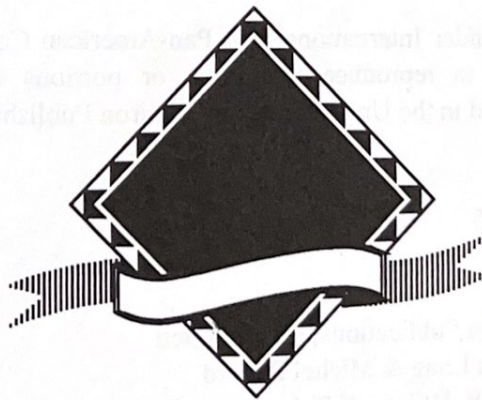
and Interactive Multimedia

the whole
PICTURE



VIDEOCONFERENCING & INTERACTIVE MULTIMEDIA: THE WHOLE PICTURE

By
Toby Trowt-Bayard
with
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Illustrations by
Laura Long
and
Michel L. Bayard

Videoconferencing & Interactive Multimedia: The Whole Picture

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AN INTRODUCTION TO VIDEOCONFERENCING

Vision is the art of seeing things invisible.

Jonathan Swift

WHAT IS VIDEOCONFERENCING?

What is videoconferencing? Although it is common to hear videoconferencing referred to as a “technology,” it is not a technology. Rather, it is a collection of technologies that form the foundation for a wide variety of applications. The term videoconferencing refers to these applications and, to a lesser degree, the technologies that support them.

One can trace the term videoconferencing to two Latin words--videre which means, “I see,” and conferre that means, “to bring together.” Videoconferencing unites meeting participants such that they can share visual information. It overcomes distance as a barrier to collaborative work.

The combination of the words videre and audio (which, in turn, stems from the Latin audire: “to hear”) gives us the word video. One can define video as a system that records and transmits visual information by conveying that information using electrical signals. Although the term video, in its strictest sense, refers only to images, common vernacular reflects the assumption that audio is synchronized with these images.

For the purposes of this book we will define videoconferencing as an exchange of *digitized* video images and sounds between conference participants at two or more separate sites. The transferred images may be pictures of the participants themselves, but they may also include video clips or other material such as still pictures of objects or information that is stored on a computer (e.g., graphics, data files, applications). Likewise, the sounds that are conveyed between sites in a videoconference could be discussions between meeting participants in different sites, but they could also be any other form of digitized audio that is, in some manner, synchronized with the video. Video and audio generally share the same

communication path in our definition of a videoconference, but they can also be transmitted separately.

One can apply videoconferencing to coalesce separate gatherings of individuals into a single multi-site meeting. They can also link two people through dissimilar personal computers, videophones, or other intelligent devices.

Both group-system-based and personal videoconferences can take place as point-to-point or multipoint events. Point-to-point, as the name implies, links participants in only two sites. Multipoint arrangements join more than two sites. The device that links three or more locations in a single conference is called a multipoint control unit (MCU).

Group-system multipoint conferencing has historically been more common than personal multipoint conferencing, but significant changes are occurring in this area. The local area networks that link workstations, servers, and other intelligent devices within a limited geographic area also permit connections to the corporate wide area network and points outside. Organizations are upgrading their LANs to support the bandwidth-intensive demands of videoconferencing. When the networking infrastructure is in place, individuals in disparate sites will participate in a wide variety of multipoint videoconferences. The powerful applications that will result from this capability are both diverse and exciting; indeed, they will eventually transform historic notions of teamwork.

One of the stimulants to the videoconferencing market has been the adoption of widely accepted interoperability standards. Until recently, construction of a videoconference always required all participants to use the same manufacturer's equipment, and to connect by a compatible network. Standards are easing these restrictions, and soon they will eliminate them. Arranging a videoconference will be much like sending a fax: all one has to know is the address.

The era of any-to-any videoconferencing has dawned, but there is much more to come. Standards have provided the boost that videoconferencing and interactive multimedia long needed, and market growth is the result. Just as the value of telephone service grew as organizations and individuals subscribed to it, the value of videoconferencing will grow as organizations and individuals install end points.

As these end points continue to proliferate, the day will come when adding a visual component to a distance communication is an ever-present option. This ability (to enjoin a shared visual experience that spans distance) will change the sociodemographics of the workplace by, at last, enabling telecommuting.

Cultural shifts take time but, as we have seen with the almost overnight acceptance of the Internet and its hypertext-linked subset, the World Wide Web (WWW), these shifts eventually reach critical mass. In the late 1990s, interest in personal computing tools and applications is practically a national obsession. Moreover, as new applications appear on our desktops and our mobile computing devices, they become successively less intimidating. Aided by the graphical user interface (GUI)

2

An Introduction to Videoconferencing

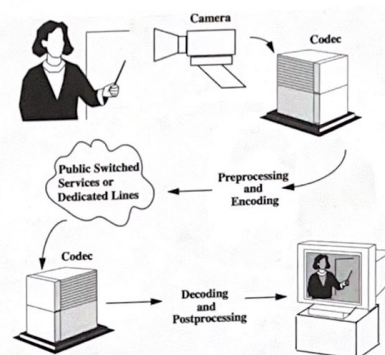


Figure 1-1. How Videoconferencing Systems Work.

and on-line help utilities, we gain expertise with increasing confidence and speed. In this fertile environment, we see videoconferencing becoming a basic tool, just one of many communications options that are as easy to use as they are powerful.

Videoconferencing was not always an accessible, low-cost option for anyone who owned a computer or workstation with a reasonably powerful processor. Until 1990, videoconferencing was a tool for the business-elite. Moreover, until early 1994, when Intel introduced their ProShare family of personal conferencing products for Windows™ PCs, videoconferencing was almost non-existent on the desktop. The history of videoconferencing, how it progressed from a tightly-engineered, customized boardroom implementation that cost as much as \$1 million per site to be a low-end "freebie" bundled in with a PC's operating system is an interesting tale.

Market advancement has been less a continuous progression of enhancements than a random string of breakthroughs. It has been more revolutionary than evolutionary.

THE HISTORY OF VIDEOCONFERENCING

Bell Labs produced the first few demonstrations of videoconferencing in the U.S. In the 1920s, scientists demonstrated a very crude videoconferencing application between Washington DC and New York City. Others were engaging in experiments in Europe in the 1930s, where television technologies and systems were more mature than in the U.S. World War II intervened and, for almost two decades nothing further was done with videoconferencing. In the late-1940s, Bell Labs commenced to revisit videoconferencing by embarking on a series of research

3



Figure 1-2. Picturephone (AT&T)

projects. After researching for a decade and a half, the Labs, in 1964, rolled out the Picturephone. It was the world's first digital, interactive video-enabled telephone. Launched at the World's Fair in Flushing Meadow, New York, it weighed 26 pounds and sat on a nickel-plated pedestal with a base that measured about 10 inches in diameter.

Picturephone compressed a video signal; it squeezed it down so it could be carried over the digital equivalent of 100 telephone lines. They transmitted the audio signal separately. Images were a bit blurry (displayed using less than one-half the resolution of a North American television picture) and the screen was notably small (5.25 inches wide by 4.75 inches high). Nevertheless, it was a well-designed and engineered system.

Picturephone was a personal conferencing tool. In the 1970s, attention shifted to a different implementation of audiovisual conferencing technologies that could be used by a group. Nippon Electric Corporation (NEC) became the first company in the world to produce a group-oriented videoconferencing system. British Telecom (BT), another pioneer, introduced their own version of a videoconferencing system shortly thereafter. BT persuaded the telephone companies that various European countries owned to conduct country-to-country trials of videoconferencing using facilities that they opened to the public. The efforts to render these first videoconferencing public rooms operational paved the way for the videoconferencing interoperability standards that exist today.

Early videoconferencing systems used television technology in its raw, analog form. Progress was delayed in the area of digital transmission because networks could not provide the requisite bandwidth. It was not until low-cost, large-scale solid state

4

memory became available in the early 1980s that videoconferencing advances began in earnest. The key was to store picture information during the processing sequence. Once very large scale integration (VLSI) technology appeared, it was harnessed; with amazing results. One early videoconferencing project was commissioned by the US Defense Advanced Research Projects Agency (DARPA). DARPA wanted an inexpensive, small profile system. The resulting product, Widcom, used VLSI to consolidate large numbers of circuits on a single chip. The approach reduced the required bandwidth for image transmission to the digital equivalent of a telephone line. Consequently, it transmitting a single image took quite some time, a while to transmit a single image and Widcom, which was introduced in 1983, faded into obscurity for lack of a commercial application.

In the late 1970s and early 1980s, the installation of a corporate videoconferencing network required a true leap of faith. At the time, the substitution paradigm (pay for videoconferencing with travel dollar savings) was used to make a business case for the strategic application. The cost of a videoconferencing system was \$250,000—and that bought only the codec.

The codec is the heart of a videoconferencing system. A codec adapts audiovisual signals to the requirements of the digital networks that transport them. As the term implies, compression/decompression and coding/decoding are a codec's four most important jobs. A codec must first turn analog signals into a continuous stream of zeros and ones (coding or digitizing), and then select only the bits necessary to send meaningful audio and video information (compression).

One begins to appreciate the job performed by a codec when one considers that an uncompressed digitized telephone signal requires a network transmission speed of about 90 million bits per second (Mbps) or more. Even after discarding the vertical and horizontal synchronization information required by analog television signals, an uncompressed digitized television signal still requires 45 Mbps or more. Contrast this with the capabilities of the Integrated Services Digital Network (ISDN) bearer or B channel that offers a transmission speed of 64 Kbps (in which K is kilo, or thousand). Even when two B channels are combined, as they are with ISDN's Basic Rate Interface (BRI), the resulting 128 Kbps of capacity comes no where near to satisfying the uncompressed signal's bandwidth requirements. In short, if one wants to transmit full-motion video plus audio from home (having captured that signal using some type of standard camera and microphone) one must discard 99.99% of the information to get it to fit over the line. Even when one uses ISDN's Primary Rate Interface (23 B channels) for transmission, the compression burden is enormous.

Today we can squeeze a reasonable quality videoconference over two ISDN B channels. We can squeeze a somewhat degraded version of the same signal over a plain old telephone service (POTS) line, the type of line that connects the vast majority of residential and business telephone users to the telephone network. In 1978, the same degree of picture resolution and motion handling required 6 Mbps of

5

bandwidth. Along with the \$250,000 codec we mentioned earlier, a company, in the late 1970s and early 1980s had to buy cameras, microphones, and speakers and prepare the conference facility to offer acceptable acoustics and lighting. In short, early adopters of videoconferencing built broadcasting studios at a cost of \$500,000–\$1,000,000 or more. A coast-to-coast line that connected corporate videoconferencing facilities rented annually for about \$35,000.

Unless organizations conducted videoconferences all day, every day, the videoconferencing projects of yesterday were not often economically feasible. Implementation depended on senior management's belief in the strategic value of the technology. A few forward-thinking companies were up to the challenge. Early adopters of videoconferencing include Aetna Life and Casualty, Atlantic Richfield, Boeing, Citibank, Chrysler, DEC, Eastman Kodak, Federal Express, Ford, Hewlett-Packard, J.C. Penney, Merrill Lynch, MONY, Proctor and Gamble, and Texas Instruments. Only 187 of the Fortune 500 companies listed in 1970 still existed in 1993; all the videoconferencing early adopters on this list were among the survivors.

Nearly all these early adopters used group-oriented, room-based videoconferencing systems that were manufactured by Compression Labs, Incorporated (CLI) of San Jose, California. CLI was founded in December 1976; it was initially dedicated to developing facsimile and video compression technologies. A CLI founder, Dr. Wen-hsiung Chen, will go down in history as one of the great pioneers of video compression. In 1963, Dr. Chen emigrated from Taiwan to the U.S. where he pursued his Ph.D. in mathematics. While at the University of Southern California, he discovered a compression technique that became a fundamental part of CLI's first commercial system: the low bit-rate (compared to previous methods) VTS 1.5. The first VTS 1.5 reached the market in September 1982. It required the equivalent of 24 telephone lines for signal transmission, and provided very good picture quality, considering the bandwidth. T-1 carrier, the basis of the North American digital hierarchy, is composed of 24 channels, each of which is the equivalent of a telephone line. CLI's system allowed companies to move from satellite-based videoconferencing to terrestrial transmission—the "T" in T-1 means terrestrial. Consequently, the transmission costs associated with videoconferencing plummeted.

In 1984, CLI began to face competition from a Massachusetts company called PictureTel. PictureTel (Danvers, Massachusetts) was founded by a team of Massachusetts Institute of Technology (MIT) engineering students and their professor. The group had invested a great deal of time researching low-bandwidth digital video signal processing. After a lot of trial and error, they developed a way to reduce the bandwidth requirement for transmitting an acceptable-quality videoconference to an amazing 224 Kbps—the equivalent of four phone lines. Overnight, group-system videoconferencing became economical at low data rates.



Figure 1-3. Custom Boardroom System (courtesy of AT&T).

PictureTel's product was the first software-based videoconferencing system to become commercially available. It became the cornerstone of a planned migration strategy that led from a build-your-own product to an integrated system in which all the necessary components were packaged in a single chassis. CLI responded with a similar product, and the race began. The two firms began grappling for control of an exploding market in a competition that still exists today. While the two were busy working magic in their laboratories, a third company, VTEL (formerly VideoTelecom Corporation) challenged the competition. Founded in 1985, VTEL was the first company to offer a videoconferencing product that ran on a DOS-based PC. For the first time, customers could upgrade their videoconferencing systems by simply downloading new sets of manufacturer-provided floppy disks. In 1980, only a few companies knew how to code and compress a video signal to affordable bandwidths. Manufacturers produced codecs at a rate of 100 per year.

Today, a codec just as powerful as a good 1980 model (which required a refrigerator-sized cabinet) can be implemented in software only. These software-based codecs are being packaged as enhancements to high-end personal computers. They are also based on standards, and thereby pave the way for any-to-any communications, regardless of the platform on which they run.

FROM THE BOARDROOM TO THE DESKTOP

As we stated, videoconferencing applications began with Picturephone, a personal conferencing product, and moved on to group-oriented systems. The migration was driven by economies of scale. The tremendous cost of early codecs and, that of the bandwidth required to move a compressed audiovisual signal, had to be amortized

Compressed Video Technology

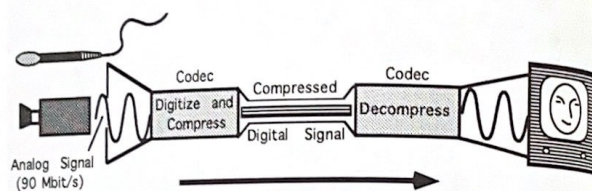


Figure 1-4. Compressed Video Technology (Michel Bayard).

across a group. The economics have changed but the market is still lagging.

The legacy of boardroom videoconferencing lingers. Because early installations were so costly, the first applications of videoconferencing often reflected their boardroom environment. Housed in custom-designed and engineered studios, videoconferences were formal events that were often exclusively attended by senior managers and executives. These conference attendees were often so senior that another person, someone not really part of the meeting, was present to operate the equipment. To recover productive time that was lost to travel, executives and other highly valuable and scarce human resources were leveraged through videoconferencing. They generally did not, however, inconvenience themselves with the technical complexities that such systems presented.

This paradigm is changing, albeit more slowly than many would like. The ease-of-use challenges posed by videoconferencing are being addressed. Powerful processors make quick work of compression. The cost of the codec and other peripherals (cameras, microphones, and speakers) is plummeting. Digital bandwidth is generally abundant, and the cost of that bandwidth has dropped significantly. Competition, as a result of a newly deregulated telecommunications market, will drive transmission costs even lower and increase the number of carriers that offer digital service. Fast processors, cheap bandwidth, simplicity in system operation all suggest a market that is poised to skyrocket. Moreover, one must consider the real market driver, consumer demand for useful tools that allow people to lead just-in-time lives in an era in which they have scant time to react.

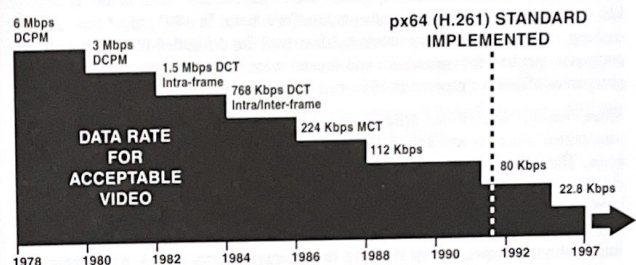


Figure 1-5. Business-Quality Video: Declining Bandwidth Required (Laura Long).

In this very competitive, highly-dispersed global economy, every competitor struggles to capture market share. Markets fragment and shift, and niches repeatedly emerge for firms that act quickly before the opportunity is lost. We are all scarce human resources in today's environment. Our productivity is key to the survival of the enterprise for which we work. Furthermore, because there is so much to know and so much to do, we are forced to specialize. As the challenges intensify, each person's focus becomes smaller. Teamwork and collaboration, whether on a personal level or an enterprise level, are mandatory.

Visual communications enhance collaborative activities. However, not every work environment is the same; each has adapted to its special needs. That is why another form of collaboration, that which leads to interoperability standards, is key to the survival and prosperity of videoconferencing. In December 1990, an international telecommunications standards organization, part of the United Nations, voted to accept a videoconferencing interoperability standard. This standard allowed codecs that were manufactured by CLI, PictureTel, VTEL and many others to negotiate technically compatible sessions over variable bandwidth channels. The standards-making process did not end in 1990, rather, it began. Today audiovisual standards exist for every application. They share many common attributes. All are designed for digital networks, and all share the goal of a reduction in the amount of information that must be transmitted. While the 1990 standard was aimed at group-system video, those ratified in 1996 were more inclusive; they clearly reflected that PC-based personal conferencing is the next frontier.

It was inevitable that videoconferencing would arrive at the PC. In 1989, only VTEL was shipping a PC-based product and, at five feet tall and 200 pounds

(including the packaging), it was not invited to sit on many desktops. Three years later, several true desktop systems were introduced but, with prices at \$10,000–15,000, few organizations could afford them. In 1993, more than 20 new desktop products entered the market. Most sold for \$5,000–8,000 (including the computer required for operation), and several were in the \$3,000 range. One of the companies offering a product in 1993 was ShareVision of Milpitas, California.

ShareVision's ShareView product ran on an Apple Macintosh computer and transmitted video, voice, and computer data over ordinary telephone lines—POTS lines. The package, which consisted of a combination video capture board and codec, and a network interface board, also included a color camera, a handset, a headset, and software. At initial introduction, the system sold for \$4,499, but the price later dropped to under \$4,000. ShareView enhanced mere file transfer and image sharing, however, by offering document conferencing. A ShareView user could launch an application and share it with another party even though the second user did not have it running on their system. This feature made ShareVision one of the pioneers in the area of visually assisted collaborative tools. Throughout this book, we will refer to this area as *personal conferencing*. Many competitors have followed where ShareVision led.

In January 1994, almost exactly one year after the introduction of ShareVision, Intel introduced their ProShare family of personal conferencing (desktop) products. One ProShare family member, the Video System 200, allows conferees to see each other in a quarter-screen window on their PC monitor while sharing a computer application. Other members of ProShare forgo the face-to-face altogether, in favor of document conferencing and voice exchange. Intel owns the term document conferencing; in 1993, it bought the rights to use it from VTEL.

Critics of ProShare emphasized, at the time of its introduction, that it required the local telephone company to furnish ISDN BRI services. Such services consist of two B channels that are melded into a 112/128 Kbps aggregate channel. The problem with ISDN was, and still is to some extent, availability. Although almost all telephone companies are moving to offer some form of high-bandwidth digital transmission service to business and residential consumers, not all offer ISDN. Intel can take much the credit for a surge in ISDN deployment by the Regional Bell Operating Companies (RBOCs) and GTE; they worked cooperatively with them to demonstrate that customers are anticipating such networks. ISDN applications are, of course, not limited to videoconferencing. Remote access to enterprise network services and telecommuting (replacing the physical commute with a telecommunications-based alternative) provided many ISDN market opportunities.

Besides complaining that ProShare required network services that were not always available, Intel's competitors criticized them for not embracing the international standard for videoconferencing that the International Telecommunications Union's Telecommunications Standardization Sector (CCITT/ITU-T) ratified in 1990. Without support for standards, ProShare could not interoperate with other systems.

Intel's response was rational: the standard in question, known as H.320, was overkill for the desktop, and too expensive to implement. Intel had managed to keep the ProShare Video System 200 priced at under \$1,500 for most installations; that price has since dropped dramatically. Although H.320 required expensive hardware codecs, ProShare compressed using software only. Intel eventually implemented the mandatory portions of the standard, but their point was well-taken. The desktop videoconferencing market, and personal conferencing, would not happen until the ITU-T ratified a new standard that was aimed at the desktop.

In 1996, the new personal conferencing standard appeared. Known as H.324, it was aimed at videoconferencing over POTS. Even before H.324, another standard, aimed only at graphics conferencing, was ratified by the ITU-T. This standard is formally known as Transmission Protocols for Multimedia Data, but is better known by its ITU-T Recommendation number, T.120. T.120 is an umbrella standard. Under the T.120 umbrella is an applications template, a specification for how multipoint audiographics conferences can be set up and managed, a specification for how binary file transfers are to be accomplished, and a few other technical provisions.

At the same time that the ITU's H.324 standard for videoconferencing over POTS was completed, yet another personal conferencing standard was completed. The H.323 standard defines how videoconferencing systems communicate over local area networks (LANs) to integrate realtime voice, data, and video into networked devices such as PCs, workstations, and video telephones. Other umbrella standards are being developed by the ITU-T. They include H.321, a standard for videoconferencing over fast-packet Asynchronous Transfer Mode (ATM) networks, H.322, a standard for videoconferencing over LANs that can guarantee the low latency (minimal time delays) required for moving frames of video in rapid succession, and other supporting standards. Clearly the ITU, always the most prescient of organizations, sees desktop videoconferencing as a very strong market. Moreover, inspection of many of the standards that fall under the H.321, H.322, H.323, and H.324 umbrellas show a great deal of commonality. This commonality will lead to interoperability between systems that are connected to diverse networks, including LANs, the Internet, telephone lines, and super-fast ATM-based networks.

THE MARKET FOR VIDEOCONFERENCING

At the fall, 1996 Telecon show, the sixteenth in a series of teleconferencing trade shows, it was easy to see where the videoconferencing market is going. In his State of the Industry report, Dr. Norm Gaut, chair of PictureTel Corporation, put it in perspective. According to Dr. Gaut, there are four waves of visual communication: dial-up room conferencing, ISDN-based desktop conferencing, videoconferencing over LANs (including LAN-multicast in which a broadcast signal is received by multiple users all listening on a single "channel"), and videoconferencing over the Internet. We would respectfully expand the fourth wave to include

videoconferencing over public switched networks, of which the Internet is one such type, and POTS service is another. Dr. Gaut elaborated on desktop conferencing impact on the market. He noted that H.323 LAN-based video is being bundled with network operating systems, and that software-only H.324 codecs are being packaged with personal computers, along with video-ready modems, speakers, cameras, and microphones as an integrated videoconferencing-ready package. While this packaging is not solely aimed at videoconferencing, the multimedia PC will be able to do videoconferencing, along with other audiovisual-oriented applications such as Web surfing, CD-ROM playback, and interactive games.

As the PC becomes multimedia-capable the videoconferencing market will explode. Frost and Sullivan (Mountain View, California), one of the foremost authorities on the videoconferencing market, forecasts the 1996 market for videoconferencing at about \$4.74 billion. In 1997, they expect the market to grow to \$7.55 billion and to reach \$20.69 billion by the year 2000. Their report, "US Videoconferencing Systems and Services Markets," published in August 1996, also notes that the videoconferencing market will experience a 42.3% compound growth rate in revenues between the years 1992 and 2002. Frost and Sullivan expects sales of desktop videoconferencing products to accelerate after 1997 when personal conferencing on computer platforms should proliferate.

Another study, conducted by the market research firm Infonetics Research (San Jose, California), provides additional insights into how the videoconferencing market will grow. Infonetics found that by the end of 1997, almost 60% of survey respondents will incorporate desktop videoconferencing on their networks. Implementation will be selective, although one-sixth of Infonetics' respondents planned on pervasive use of desktop videoconferencing in 1997. Most respondents plan to incorporate desktop videoconferencing into existing LANs. They prefer switched LANs (for instance, those based on ATM or Ethernet switching) to shared LANs (traditional 10Base-T Ethernet, for instance) because shared LANs are not naturally equipped to deliver frames of audiovisual information with minimal, predictable delays. Many of the respondents who plan to implement desktop videoconferencing lack knowledge of the important standards that support such installations, (e.g., H.323). Moreover, many had only a passing familiarity with H.320, a much older and more widely implemented videoconferencing standard that was targeted at group-systems. Likewise, T.120, the data exchange standard for sharing desktop applications, creating a virtual "whiteboard" that can be shared by multiple users and file transfers was still largely unknown, although many respondents at least knew that they needed to know more.

The Infonetics Research study provided an exceptionally clear picture in other areas, too. It noted that almost 40% of survey respondents used small-group videoconferencing systems known as *roll-abouts* (because of their packaging, which features wheels to make them mobile). Approximately 72% of respondents who worked for companies with more than 1,000 employees used hybrid boardroom-to-roll-abouts arrangements to link employees in major infrastructure

sites with smaller field office sites. Furthermore, almost 90% cited a need for multipoint control units to link users in three or more sites in a single videoconference.

Other market research studies draw similar conclusions. The firm Personal Technology Research estimates that, in 1996, the group videoconferencing systems market grew from \$700 million to approximately \$1.3 billion. InfoTech Consulting expects the number of group systems shipments in the U.S. to grow by a factor of six—from 19,600 units to 119,800 units—between 1995 and 1999.

Personal Technology Research has forecast the overall videoconferencing market to grow from \$52.5 million in 1994 to more than \$1.8 billion in 1999. Company sources estimate the 1996 data-conferencing market at \$14–28 million, or approximately 10–20% of the personal conferencing market. The firm Multimedia Research Group expects the personal conferencing market to soar from \$250 in 1995 to \$15 billion by the year 2000. Feedback Research Services proclaims that its forecast of \$283 million in the year 2000 for multiple-use telemedicine videoconferencing systems, teleradiology equipment, and telecommunications services is conservative.

Telespan Publishing Corporation president, Eliot M. Gold, proclaims unit sales of add-in boards for videoconferencing grew from less than 5,000 to more than 91,000 per year between the years 1992 and 1995. Estimating 1995 sales at 19,600 room based systems (\$635 million in sales) and 71,900 personal conferencing units (\$110.8 million in sales), the organization Forward Concepts projects that, by the end of the decade, those numbers could grow to approximately 37,000 (\$405 million) and 7.8 million (\$1.6 billion), respectively.

These personal conferencing projections reflect a 1996 installed base of 111 million PCs connected to LANs, and the ratification of the T.120, H.324, and H.323 standards. The Electronics Industries Association assesses that 50% of computer populated homes are connected to the Internet and are equipped for multimedia applications; in 1990, that number was approximately 25%. More than 40% of the companies that responded to an Olsten Corporation survey are providing telecommuting options, and 70% are preparing to do so. Link Resources estimates that the number of telecommuters will rise to about 50 million by the year 2000.

CONCLUSION

The Picturephone, so far ahead of its time that it was deemed a failure, was far more successful than many realized. Its developers recognized that many people desire the ability to initiate a casual videoconference from a desktop or a room in their home. The market today is proving that the pioneers in Bell Labs labored not in vain, but that their timing reflected their vision, not the environment in which they lived.

All successful applications of technology have their pioneers: the scientists, the engineers, and the human factors specialists. Their work would all be for naught if it were not for the early adopters who try their products, companies such as we have mentioned in this chapter.

Eventually, successful applications achieve broad-based acceptance and move into the corporate mainstream. A typical conclusion to the cycle of research and development finds these applications delivered to and embraced by the casual consumer. With market growth comes acceptance, and with acceptance comes greater demand for ease-of-use, new capabilities, and lower cost. At some point, the brilliance of every successful implementation of a technology is overlooked by those who benefit from it.

The state of the videoconferencing industry is somewhere in the middle of the adoption continuum. Although it is a healthy, growing market, its growth potential is, yet, untapped. The remainder of this book is dedicated to fostering in the reader an understanding of videoconferencing applications, the technologies they depend on, and the key decision points one must consider when making a product or service selection. Once mastered, we firmly believe that most readers will be enthusiastic about the benefits of videoconferencing, and will want to gain first-hand experience.

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2

VIDEOCONFERENCING APPLICATIONS

*Nothing in the world is single,
All things by a law divine
In one spirit meet and mingle*

Percy Bysshe Shelley

VIDEOCONFERENCING IN THE REAL WORLD

After a slow start in the 1980s, video communication is gaining broad support. Videoconferencing is an invaluable human resource management tool. It fosters collaboration, increases scheduling flexibility, shortens response times, and provides access to specialists and experts.

Manufacturing companies leverage it for comprehensive quality assurance and real-time process and equipment monitoring. Healthcare providers employ videoconferencing to enhance continuity of care, and legal teams use it to standardize and, therefore, streamline casework. As a result of dramatic declines in network and equipment costs, cultural changes, and standardization, videoconferencing is solving a wide range of business problems. Advances in group system, application sharing, LAN, and even POTS standards have advanced interoperability such that it has traversed the confines of intra-organizational communications.

Public videoconferencing rooms abound. One can find a nearby Kinko's Copy Center videoconferencing room by simply dialing 1-800-254-6567. Press "2," press "4," and enter the zip code to learn the address, phone number, and directions to the site. Once there, one will find a room based videoconferencing system and accommodations that rival those in many corporations' conference rooms. Personal Conferencing is even easier. Manufacturers bundle rudimentary personal conferencing capabilities in the consumer PCs they sell through retail outlets. Consumers can buy more elaborate systems from the same retailers.

Businesses use personal conferencing to save time and money by linking employees, customers, suppliers, and strategic partners. Legislators encourage it by