Video-conferencing

This White Paper was compiled by Donald West, Public Information Officer for the National Mediation Board, using information gleaned from the public Internet, vendors, and other public sources.

Video Conferencing: Basic Definitions

Video-conferencing is two way video and sound between two or more locations using video, audio and high speed digital communication connections. Corporations, government and universities have developed a growing network of private video-conferencing facilities. The use of high quality video-conferencing permits wider contact and rapid response to customer requirements, potentially training, arbitration hearings, and mediation or facilitation sessions. In short, the use of live, television-quality video-conferencing offers many new possibilities for communication between parties who are geographically dispersed.

Conference or seminar broadcasting via video-conferencing is well established, but collaborative work processes are still emerging: most notably with Microsoft's NetMeeting. PC-based video-conferencing over the public Internet is relatively unused, but coming on strong. Video-conferencing technology and associated product prices are changing constantly.

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Advantages of Video-conferencing

In these times of limited travel budgets and the pressing need to get more done in less time, video-conferencing offers the benefits of face-to-face meetings arranged on short notice and at very low cost compared with the long travel times and high travel costs involved in a typical business trip. The use of video-conferencing can not only reduce travel expenses and free up travel time for more productive purposes, but also relieve would be travelers of 9-11 and SARS associated stresses. It can also provide greater access for subject matter experts to large and dispersed audiences. Cost of staff and materials for training can also be reduced. Except for satellite based video-conferencing, video-conferencing is not impacted by bad weather as travel tends to be, especially in winter months. The collaboration of dispersed work groups, distance learning and telecommuting can also be enhanced though video-conferencing.

How Does Video-conferencing Work?

Since the image is digital, the resolution or clarity of the image is determined by how many digital bits or pixels are used to represent the image. A moving image is accomplished by transmitting a sequence of digital frames or still images (i.e., snapshots). These images are received, decoded and displayed at the receiving end. Both ends of the conference simultaneously receive and transmit streams of digital voice and images.

The key component in the image transmission and reception process is the **CODEC**. This is short for coder/decoder and is the device that converts the image to a compressed digital signal for transmission and decodes the received image for display. Displays are usually standard NTSC television receivers or LCD panels or video projectors for large screen applications.

To approach television quality images the system must transmit and receive individual pictures or frames at a rate of at least 30 per second. At any slower frame rate the image would jump and blur when trying to capture motion. To achieve the necessary 30 frames per second with good image quality, end to end digital network bandwidth in the range of 400k bps (ISDN) to 800k bps (IP) is required: k bps stands for thousands of bits per second; m bps would be millions of bits per second.

A video-conference presentation can be enhanced by the addition of video from a VCR, DVD player or computer hard drive.

About Image Quality

Video-conferencing requires compression of the information in order to facilitate the use of protocol and signal bandwidth/speed. Also, the video frame rate (the number of times the screen is redrawn in one second) must be altered in order to further compress the data and reduce the size of the file. The more bandwidth available, the lower the compression ratio and the higher the image quality. The compression ratios and frame rates break down as follows:

Bandwidth	Compression Ratio	Frame Rate
128k bps*	700:1	15 fps**
384k bps*	230:1	30 fps**

* bits per second
* frames (or snapshots) per second

15 frames per second is half of what is used in television broadcast and video. 30 fps is very close to the frame rate used in video. Because video-conferencing is digital instead of analog video, the image is not exactly TV quality, but it is close. A bandwidth of 384k bps at 30 frames per second yields what is considered business-quality video-conferencing.

Video versus Web Conferencing

Video-conferencing requires the two way transmission of digital voice and video signals over some type of communications network with compatible sending, receiving and display equipment at each end. The internet was not designed for the transmission of digital voice or video; therefore, the public internet does not work well for two way, TV quality voice and video.

Because of the limitations, costs and complexity of using IP networks (Internet protocol) for video-conferencing, a modified one-way form of internet based video communications has evolved, which is known as Web-conferencing. Web-conferencing uses private or public internet facilities to download audio, computer generated presentations and small video images to a large number of PCs or meeting rooms. The return communication from the many participants is either by instant messaging or telephone voice connection. Consequently, web-conferencing is used primarily for training and information dissemination to large, geographically dispersed audiences.

Associated services and products include Hosted Services and Collaboration Tools. WebEx, Centra, Viewpoint, VRVS, Placeware and Raindance offer hosted services, while IBT, Microsoft and Spectel offer collaboration software. Web-conferencing is not, however, addressed within the scope of this white paper.

Public vs. Private Internets

Video-conferencing requires a bandwidth of 768k bps to handle overhead associated with packet-based technology of the Internet. Due to fluctuations in demand for bandwidth on public Internet, it's very difficult to ensure an end-to-end bandwidth of 768. Private networks are not subject to these limitations, but since private networks operate within the firewalls of an organization, they may not be available to external participants.

About Audio

Some low level applications may communicate in only one direction at a time; that's called **Half Duplex** (e.g., a walkie-talkie). Simultaneous communication in either direction is called **Full Duplex** (like a telephone). Broadcasting with no response at all is called **Simplex** (a radio or TV broadcast for example). It's important to know the difference when buying video-conferencing systems.

Divergent Systems

Video-conferencing systems come in two incompatible flavors: ISDN-based and IP-based. Some systems come equipped to handle either protocol, but if not, its important to know that you can not connect an ISDN-only-based system to an IP network or an IP-only-based system to an ISDN network. This is not to be confused with connecting ISDN and IP networks, which can be connected via a specialized Gateway (AT&T or Sprint for example).

Standards

Video-conferencing is subject to standard methods and protocols, defined by the ITU-T (International Telecommunications Union - Telecommunications) and IMTC (International Multimedia Teleconferencing Consortium). Standards enable equipment and systems made by different manufacturers to interoperate. There are many standards applicable to communication, audio, video, and control units.

Most modern video-conferencing systems, especially Standalones, use the proven H.320, ISDN-based standard, but some are also equipped for adaptation to work using the IP-based H.323. *Although video-conferencing over the Internet is still in it's development stages regarding quality of service, it's advisable to choose an ISDN-based system that can switch to IP for when IP and associated networks mature.*

Approaches to Video-conferencing

Purchase
Purchase, install, operate and maintain own video-conferencing system.

Room Rental
Rent physical video-conferencing rooms fully equipped with resident call management, and troubleshooting.

Virtual Rooms
Instead of renting video-conferencing rooms, online conferencing is available. This requires having a compatible PC and Internet connection and downloading virtual-room software.

Managed Services
Contract for the setup and operation of privately owned video-conferencing system.

[This paper only addresses the nuts and bolts of video-conferencing, not particularly the issues of operations and service.]

Basic System Components

A Codec is the central processing unit of standalone-type of video-conferencing system. A Codec compresses and decompresses data that flows through the device.

System peripherals include cameras, microphones, speakers, displays, and data input devices such as computers, scanners and document cameras.

Depending on the type of system chosen, server products and applications might include multipoint equipment, gateways, scheduling software, system administration software, etc. Video-conferencing also requires a communication network.

System Types and Cost

Communication carriers (lines) notwithstanding, there are four types of Video-conferencing systems: PC-based Desktops (point-to-point or Personal), Videophones (point-to-point; low-level Standalone), Compact (multipoint; a mid-level Standalone) and Group System (multipoint or high-end Standalone). Most video-conferencing systems are plug-and-play, but some high-end systems require trained technicians.

The cost of video-conferencing is as broad as there are technological options from desktop applications to large conference settings, from two connecting locations to multiple sites, from modem dialup to Satellite communication, from poor to television quality reception, from one way to two communication, and from basic presentations to complex ones with whiteboards, graphics and DVD/VCR display.

In short, the more you want, the more you pay. In general however, PC Desktop systems and Videophones will fall in a range around $500 or less, Compacts $5,000 or less, and Group Systems will run a very broad range from $5,000 - $75,000.

Polycom, and Tandberg control 90% of standalone video-conferencing market. Infrastructure is not yet ready for widespread integration of voice, data, and video; however, web-based communication is expected to put PC-based video-conferencing at the forefront by 2006.

PC-based System

Video-conferencing using a PC-based solution may be the least expensive method, but also probably the least in quality and reliability. This approach is designed for point-to-point (one user to one user) video-conferencing, although some systems will accommodate multiple users. PC-based systems may come with collaborative software applications that enable you to share work with the person with whom you are conferencing.

PC-based systems typically have several drawbacks however. Residential users tend to use narrowband telephone communication lines and 56k modems, hardly adequate for video-conferencing: 128k is considered a minimum for "adequate" quality and 384k for TV-like quality. Limited data compression and low-end peripherals such as microphones and cameras also impact the quality of this type of system. When using the public Internet, the quality of the audio and video will be dependent on how fast the Internet connections are, and network congestion on the Internet can also contribute to choppy audio and video.

A Sample PC-based System: SeeNx Instant Video Communications Bundle (home or office)

This bundle includes SeeNx, premier video communication software, Logitech QuickCam® Pro 4000 digital camera and EyeNx NX100 computer headset with microphone. The Logitech QuickCam® Pro 4000 camera will capture full motion video at up to 30 frames per second. The NX100 computer headset features a noise-canceling microphone and high-performance speakers for video conferencing with quality sound input and output. This point-to-point video-conferencing package costs about **$170 per PC**.

Microsoft's NetMeeting software, on the other hand, is free since it is included in Windows XP. The user, however, must obtain and install on a PC a camera and audio devices. Other samples of video-conferencing software include: iSpQ VideoChat, CUseeMe, and Fly Conferencing Suite

Video Phone

These systems are low-level Standalones; they include all the hardware and software components in a self-contained unit, which requires a user supplied TV set or display monitor. Installation is easy (plug & play) and the unit is usually portable to locations with appropriate communication connections. Only an ordinary TV set and an ISDN basic rate line or LAN connection are needed to start video-conferencing. Videophone may be a good solution for residential users with a 128k or higher ISDN, DSL, or cable Internet connection. That said, it should be noted that a good Internet connection minimizes, but does not eliminate, limitations regarding the use of the public Internet as noted elsewhere in this paper.

A Sample Videophone: D-Link

D-Link makes point-to-point, personal video conferencing over the Internet easy and cheap via Videophone. It is a standalone device; you do not need a computer. Connect a standard telephone and a television, plug in a standard Ethernet network cable connected to the Internet, and you are ready to conduct real-time video-conferencing up to a full 30 frames per second. Wizards make setup easy. The remote control (included) allows the user to easily answer an incoming videophone call or initiate a new one. The built-in caller ID provides privacy protection. Not counting the Internet connection, this system is available for roughly **$250. O**ne vendor has a $50 rebate, making the system only $200. Getting through a firewall may be a problem as video-conferencing uses some ports not permitted through firewalls.

Compact System

These systems are mid-level Standalones; they include all the hardware and software components in a self-contained unit, which requires a user supplied TV set or display monitor. Installation is easy (plug & play) and the unit is usually portable to locations with appropriate communication connections. Only an ordinary TV set and an ISDN basic rate line or LAN connection are needed to start video-conferencing. Modern compact systems can be enhanced with a variety of peripherals such as document stands and white-boarding devices.

A Sample Compact System

A sample Compact configuration from Sony includes using a 3-line (384) ISDN line at $200 for installation and roughly $90 per month. The ISDN service would come in to a Network Terminator costing about **$400** and connect to a compact, TV-top system costing **$4,000** not including a TV or display unit, installation or technical support. For an extra **$1,200 - $2,100**, multipoint capability can be added to this system. Optionally, a desktop or notebook PC can be connected to this type of video-conferencing system to exchange data, graphics and the like.

Group System

These high-end Standalone systems share much of the same features as their less expensive counterparts. They differ largely in speed and the ability to provide users with the highest quality audio and video available. They are designed to provide "TV Quality" smooth seamless video and audio and allow all parties involved to see and to hear each other. Group systems are usually implemented in conference rooms and lecture halls. They tend to be self contained units in a cart.

The equipment consists of:

- a large display
- a conference room style microphone,
- speakers,
- a wide-angle video camera,
- a video Codec,
- and equipment to interface with three or more ISDN BRI lines or a PRI line.

These systems can be expensive, often between $5,000 and $75,000 depending on the size of the system. The ISDN lines will cost between $120 to $240 per month plus the local and long distance charges of 30-90 cents per minute for each video call.

A Sample Group System

A sample high-end Standalone configuration from Rodata, which markets Polycom systems, includes using a 3-line (384) ISDN line at $200 for installation and roughly $90 per month. The ISDN service would come in to a Network Terminator costing about $500 and connect to a standalone, 1-monitor system costing around **$12,000**, not including installation and technical support. Optionally, a desktop or notebook PC can be connected to this type of video-conferencing system to exchange data, graphics and the like.

PC-centric systems

The combination of a video-conferencing Standalone with a standard PC creates a truly "Intelligent meeting system" for a primary conference room. Adding certain elements to a robust PC and dedicating that PC to a conference room, will create voice and videoconferences that are versatile. This type of solution is for advanced users or where a full time moderator is present to run the equipment. These systems solve the video-conferencing challenges of sharing information.

[This classification of system type is used frequently in sources used to compile this white paper, but it is not discussed further here, since virtually every video-conferencing solution today either includes or accommodates optional PC capabilities.]

Control and Integration Devices

Behind the scenes are key components of a video-conferencing system. They include gateways and servers, bridges or routers, and Multipoint Control Units (MCUs). These systems are needed for bandwidth management, connecting multiple users, a variety of video-conferencing solutions, and communication carriers. Scheduling and management software is also needed for system control, contact information storage, and connection reservations.

Recording and Playback

Recording and Playback, also known as “video on demand”, is an add-on to streaming solutions. This means the proceedings of a videoconference or other programming can be captured and stored on a hard disk. This would require a high capacity disk, since video files can be quite large, reaching several hundred megabytes, depending on the length of the program, the compression ratio, scan refresh rate, and window size, among other factors. Software allows non-conference users to access and play stored videoconferences, using the media streaming application; these users need only a browser or media client such as Real or Windows Media Player.

Minimum PC Specifications

The state of the art for PCs and Video-conferencing is rapidly advancing. Minimum specs for one application may not suffice for another application. Always refer to the "required specifications" of any product being considered as to processor type (eg., Pentium 4), processor speed (mhz), memory (RAM), hard drive space, CD or DVD, and operating system (e.g., Windows 98). It should also be noted that minimum specifications usually relate to a minimum level of video-conferencing performance and quality. In other words, the better the PC the better the conferencing.

System Selection Issues

When selecting a video-conferencing system, the following is a list of things to look for or ask about:

- Can the conference sessions be recorded for later playback?
- Can the video-conferencing system work with other brands of systems from PC-based Desktops to Compacts and Standalones?
- Is the system forward compatible with the emerging Internet Protocol (IP) products and other future technologies?
- Is the video-conferencing system capable of multipoint conferences, i.e. linking several locations simultaneously, or is extra hardware and software needed?
- Can the system integrate peripherals such as slide shows, graphics, computer presentations, CD and DVD content?
- Can non-compatible systems such as ISDN and IP-based systems be accommodated in the same session?
- How good is user and technical documentation?
- What kind of training is available?
- Is end-user and technical assistance available?
- Are system maintenance plans available?
- Does the video-conferencing system come from a manufacturer with a solid track record?

Emerging Innovations

The most recent innovations in video-conferencing technology involve making the overall experience more realistic. Video codecs and software algorithms deliver higher sustained frame rates, sharper images, and smoother motion. Cameras can now emulate the human eye, through auto-focusing, auto-aperture, and automatic locating of the speaker. High-resolution displays which include CRT displays, plasma flat panels, and large LCD screens, serve to improve the natural feel of video-conferencing. Higher quality audio allows full-duplex transmission, stereo sound, and better sampling rates. Full-duplex also reduces latency, for better lip-synchronization. Microphones with incredible pickup ranges and sensitivities allow better focus on the speaker, and updated circuitry provides echo cancellation and background noise suppression for better overall sound quality.

Graphical Intuitive User Interfaces promote better ease of use. Product support items such as installation wizards and quick-start guides, facilitate systems working right out of the box and making calls in minutes. Most systems include hand-held remotes, and web-based remote management for on-line system administration, troubleshooting, and configuration. Dialing directories allow greater simplicity of navigation.

Video-conferencing equipment is also far less pricey than it once was. A quality group system can now be found for under $10K. These lower prices and enhanced user friendliness make video-conferencing a practical substitute for travel.

Major Providers of Video-conferencing Systems

Polycom

Polycom is the world's leading provider of group and desktop video communications systems, audio-conferencing systems and network infrastructure solutions. Polycom's proven, interoperable communication solutions are renowned for high quality, affordability and ease of use.

Tandberg

Headquartered in Oslo, Norway, TANDBERG is a leading global provider of video-conferencing systems and solutions. The company offers sales, support and services in more than 50 countries worldwide. A high performance product line offers a full range of solutions from basic to high-end products. Tandberg’s video-conferencing products are generally regarded as the “Cadillacs” of the industry.

Sony

Sony Electronics, a world-wide leader in electronics, brings innovative technology to its video-conferencing products including 6-site multipoint. Sony offers a full line of group and compact video-

conferencing systems as well as auxilliary devices such as projectors, cameras and web-conferencing products.

Vcon
VCON is the leader in IP (Internet Protocol) Video-conferencing. VCON has a complete line of video-conferencing solutions for visual communications, including desktop conferencing systems, group conferencing systems, software-only client solutions and an integrated rich media server. VCON's exclusive Interactive Multicast technology, combining the best of interactive video and streaming video, is available across the VCON product line.

Sprint
Sprint offers IP-based video-conferencing service that ties together all the needed equipment, support, and network transport. Because the service uses IP, it can be accessed by any worker with a high-speed Internet connection to a PC.

VBrick Systems
VBrick network appliances are low cost, high quality video and audio encoders/decoders. VBricks enable the transmission and delivery of DVD-quality video and CD-quality audio signals over standard switched Ethernet, ATM, T1/E1, xDSL, satellite, or microwave networks. VBricks provides true television quality video - while only using minimum network bandwidth.

PicturePhone
PicturePhone Direct is the world's largest supplier of video-conferencing products and accessories. It provides both immediate and long-term video-conferencing solutions. Its extensive array of video-conferencing products and accessories, coupled with a highly trained technical staff, allows it to configure the best combination of products for video-conferencing.

AT&T
AT&T offers a suite of high quality video-conferencing services to meet the diverse needs of collaborative meetings, training sessions and presentations:

- Standard Video Bridging Service offers cost-effective multipoint video bridging
- Video On-Demand Service allows users to self-launch ad-hoc video calls with the click of a mouse
- Video Gateway Service **provides connectivity between disparate networks**, ISDN to IP, or IP to IP with QoS

Zydacron
A SCOTTY Tele-transport Corporation – Zydacron is committed to the philosophy that a videoconference call should be as reliable as an

analog phone call. It has a comprehensive offering of advanced solutions for high quality audio and video with advanced communications and support for H.320 and H.323. Zydracron products increase efficiency through multi-tasking. It offers the combination of video communication and advanced data collaboration.

Communication Carriers

There are numerous modes for connecting geographically dispersed computers, hardware devices or software applications. The speed (bandwidth) of the various modes range from 56k bps(bits per second) for Modem to 9.95g bps for OC-192 (177,714 times the speed of a 56k modem). A single user connecting to a service provider may find a 56K Modem adequate for most uses such as text and graphics; however, good video-conferencing will need a more robust (broadband) mode such as ISDN, DSL, or Cable. Other technologies noted here are geared to high-end applications.

ISDN is the grandfather of broadband connections, but DSL and Cable have captured the market. It should be noted that ISDN is currently available in more locations nationwide than DSL or Cable and may be the only option in some locations. In remote areas however, Satellite service may be a practical option.

How Much speed or Bandwidth is Needed?

384k is considered the minimum bandwidth for good quality video-conferencing (30 snapshots or frames per second). A plain old telephone line (POTS) is 64k. To get to 384k, ISDN, for example, requires 3 BRI lines at 128k each. It takes 2 POTS lines to get to 128k. Therefore ISDN requires six (6) POTS lines. A full T-1 line in comparison will provide roughly four times the bandwidth of ISDN. A full T-3 line is roughly equivalent to 28 T-1 lines.

Carrier Types

Modem	Cable	ISDN	DSL	T-1
T-3	Frame Relay/ATM	IP	Satellite	Wireless

Modem

A dial-up 56 Kbps modem service is a good starting point for Internet access and lower end applications. Each user needs his own modem and phone line to dial-up and be connected to the Internet. The modem ties up the phone line so you will need separate lines to use the phone and a computer at the same time. For multiple users, the cost of phone lines and modems may become less economical than other connecting technologies.

ISDN

Integrated Services Digital Network (ISDN) is the digitization of the telephone network to facilitate the movement of voice, text, graphics, video, music, and other applications over existing telephone wires. ISDN for residential needs is focused on video-conferencing, high-speed file transfer, and home-office telecommuting.

BRI or PRI

Basic Rate Integrated Services Digital Network **(BRI ISDN)** service allows a single telephone line to carry voice, video, and data simultaneously to give you more efficient and affordable service. BRI has two B channels to carry voice, video, or data and a third channel (the D channel) to carry the call set-up information and low-speed packet data. Features include all-digital service, speeds up to 128k bps per line (384 for 3 BRI lines), flexible capacity on demand, and uses existing wiring.

Primary Rate Integrated Services Digital Network **(PRI ISDN)** is a dial-up service that does not require a modem. It's much faster than modem service. PRI ISDN has 23 B channels plus one 64 Kbps D channel. Each channel has a 64k bps capacity, enabling a total transmission speed of up to 1.5m bps. Additionally, since you can split the line into separate channels, multiple users can talk on the phone and use the computer at the same time. Each user can work at a speed of 64 Kbps.

Dialup or Dedicated

Dial up ISDN service is designed to provide economical Internet access to homes and businesses with high bandwidth needs or local area networks (LAN) that have relatively basic usage requirements. For locations with low to medium usage, users can enjoy the convenience and speed of a dedicated access service at a fraction of the price.

For greater bandwidth needs, both 64K and 128K Dedicated ISDN Access is available. Get the advantages of the Internet without the burden of multiple modems and slow analog phone lines. ISDN is a low-cost way to get high-speed access to the Internet for home or office.

DSL (Digital Subscriber Lines)

DSL is an excellent dedicated access solution. It is affordable and easy-to-install. This dedicated high-speed service rides ordinary phone lines at speeds typically from 128 to 384k bps. Typically, download and upload speeds are not equal, a system that is called Asymmetrical **(ADSL)**; where both speeds are equal, the system is called Symmetrical **(SDSL)**. Very High DSL **(VDSL)** speeds range from 1 - 9m bps. A DSL modem and an Ethernet card are required for installation. A splitter may also be required to separate high frequency data from low frequency voice. Thus data and voice can be

transmitted at the same time. The subscriber must be located within roughly 3.5 miles of a Central Telephone Office; the closer the better the quality of the connection.

Cable
Cable service is generally for home usage rather than for business purposes, because businesses are rarely wired for cable and you cannot connect a network to the Internet with cable. A cable connection is much faster than any type of dial-up connection. Cable speed is typically about 1m bps (18 times faster than a 56k Modem) although it maxes out at 52m bps; however, the connection is shared with others in the community. At 1m bps, the more people using the cable at any one time, the slower the service. This would translate into congestion and delay. Using this type of "shared" connectivity may also incur a security risk: neighbors may be able to access your files. Like DSL download and upload speeds, typically, are not equal (i.e., Asymmetrical) with far more speed dedicated to downloading information than to uploading.

T-1
T-1 **(Full T-1)** is a dedicated, leased connection technology best suited for large networks where 20 or more users are communicating at the same time. T-1 is about 10 times faster than ISDN and has speeds up to about 1.54 Mbps. If you don't have 20 or more users or the level of traffic does not justify the cost of the **Full T-1**, you can lease a portion of a T-1 line **(Fractional T-1)**. This will keep expenses down and still yield a premium service for accessing the Internet and connecting a network to it.

T-3
T-3 is a high-end leased service used by many medium-to-large sized entities. A **Full T-3** line can transmit data at up to 45 Mbps. That's extremely fast! It's the equivalent of 28 T-1 lines. As many as 672 users can use the service simultaneously while working at 64 Kbps. If you don't need the full T-3 line, you can lease a portion of it **(Fractional T-3)**. This will keep expenses down and still give you a premium service.

Frame Relay and ATM
Frame Relay and ATM are essentially communication architectures for broadband networks and service integration. Frame Relay is essentially a dedicated trunk-like service used for low to mid-scale applications. However, some service providers now offer a dialup option as well. ATM (Asynchronous Transfer Mode) is a newer dedicated trunk-like service for much larger applications. Frame Relay runs a bandwidth ranging from 56k to 45m bps compared to ATM which runs a bandwidth ranging from 1.5m to 622m bps. Frame Relay or ATM can provide trunk-like connections for long distances in conjunction with carriers like ISDN serving as end of line tie-ins.

Internet Protocol (IP)

IP-based video-conferencing service ties together all the needed equipment, support, and network transport. Because the service uses IP, it can be accessed by any worker with a high-speed Internet connection to a PC. One of the biggest technical hurdles of IP video-conferencing is that the traffic is often blocked, either by a company's own firewall or by firewalls operating within the network of the service provider a company uses for its IP services. Solutions are emerging to overcome that obstacle by allowing the IP video-conferencing traffic to pass through both sets of firewalls.

VPN
Virtual Private Networks (VPN) use public telecommunications infrastructure while maintaining privacy through the use of tunneling protocol and other security procedures. VPNs are used when the distance between to points is too far to justify a fully dedicated link.

Fiber-optic
Fiber-optic has far greater capacity than other signal carriers. It is being installed by major telecommunication companies as a trunk line or backbone for services that will originate and terminate with other signal types.

Satellite
For people living in rural areas, satellite connections may be the best option. A satellite dish connects at a respectable 400 kbps speed range, which is at the lower end of DSL's speed range. Some users complain about "latency issues," that is, the time it takes for an Internet page to get bounced off the satellite and bounced into their dish. The net result: pages can appear slower than with DSL and cable. You're also sharing bandwidth with thousands of other users, so speed can be impaired during peak traffic hours. Wind, rain and snow storms can impact the signal so that speed is reduced considerably or it shuts down completely.

Wireless
This wideband option has a projected speed of 1-100m bps and will handle bigger information tasks like mobile Web browsing, e-mail, and audio and video files. Wireless is in an infant stage of development and therefore limited in coverage to mostly the largest cities of the U.S.

OC
Optical Carrier (OC) specifies the speed of fiber optic networks conforming to the SONET (Synchronous Optical Network) standard. The range of OC currently is from about 52m bps to almost 10g bps. That's roughly 178,000 times faster than a modem. This is for customers who need ultra fast connections for mission-critical communication.

Carrier Comparison Table

Note: Costs noted in this table were picked from the Internet without regard to the location, the vendor or specifics of service offered.

Mode	Signal Carrier	Service Share?	Spd/Band-width	Spd v. Modem	Installation	Cost	Comments
Dialup - 56k Modem	Phone lines	No	56k bps	1X	$25 +	$25 or more + long distance (3-10 cents/minute)	Inadequate for adequate level of video-conferencing
Digital Subscriber Lines (DSL)*	Phone lines	No	128-384k bps	2-7X	$0 - $110	$30-$90 per month	Must be within about 3 miles to a Central Telephone Office
Cable	cable	Yes	512k-52m bps	18X	$100 - 200	$40 - 50	Availability is widespread. Shared connection.
Phone line – ISDN	Phone lines	No	384k-1.5m bps	(3 lines) 7X	$75 - $200	$60 - $250	3 BRI lines (384k) minimum for office video-conferencing
Satellite	airwaves	Yes	400k bps	7X	$200 - 500	$35 - 70	Becoming more accessible and affordable. Shared bandwidth.
Wireless	airwaves	No	1 – 100m bps	357X	$1000**	$600 (1.5m bps)**	Struggling with licensing and funding issues
(IP) Internet Protocol	Internet	Yes-public No-private	768k bps	14X	$0 +	$500 - $1500	Depends on Internet traffic and access bandwidth
T-1	Dedicated line	No	1.5m bps	26X	$525	$1000 - $5000	High speed
T-3	Dedicated line	No	45m bps	803X	$1050	$17,177 - WITS	Very high speed
OC1 OC3 OC12 OC48 OC192	Fiber Optic	No	52m bps 155m bps 622m bps 2.48g bps 9.95g bps	928X 2768X 11107X 44285X 177714X	N.A.	"big bucks"	Ultra high speed

* Very High Digital Subscriber Lines (VDSL) is available in some areas running a bandwidth of 1-9m bps.
** Wireless is in an infant stage of development and therefore limited in coverage to mostly the very large cities of the U.S. To connect DC to Chicago would cost approximately $600 per month plus $500 for installation at each end.

Teleportec: The Cutting Edge or Science fiction?

Teleportec conferencing makes it possible for you to be in two places at once, wherever you are in the world: its systems digitally teleport your image from your location to a meeting, conference or event anywhere in the world. You will appear in the room live, life-size, within an apparent 3-dimensional environment as if you are actually there and have eye-to-eye contact with those present. Natural face-to-face interaction can now take place without traveling across the world, saving your business time and money and enhancing your internal and external communications network. This really is the closest thing to being there; the only thing you can't do is shake hands. This solution, which can be purchased for about $30,000 per location or rented for $400 per hour at select conference-service sites, brings video-conferencing to a new level. See www.teleportec.com.

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