Internet Videoconferencing: Coming to Your Campus Soon!

High-quality, full-screen, full-motion Internet videoconferencing is now within reach for most colleges and universities

by **Robert S. Dixon**

Colleges and universities typically have a unique resource that is not always recognized as such, that is, their significant Internet bandwidth, which allows members of their campus communities to do things that cannot yet typically be done by businesses and private individuals. One such Internet function that has become practical for widespread use is videoconferencing.

Many people have used the older, more traditional method of videoconferencing, which uses ISDN or leased telephone lines at high hourly rates and requires special room setups and advanced scheduling. Internet videoconferencing has none of these characteristics. It is much more like using the telephone, with the added feature of being able to see the person you are talking to, so there are not only technological, but also sociological differences (see Table 1). It is possible to communicate between traditional and Internet videoconferencing systems via gateways that exist just for this purpose, as described below.

One of the first reactions some people have, when hearing about ubiquitous videoconferencing in their office or laboratory, is fear of the loss of privacy, but this is not really a concern if you think of this technology as being similar to the telephone. You do not fear that your voice will be heard somewhere else if the telephone receiver is on its cradle; similarly your image will not be seen from afar unless you turn on your camera and start up your video system.

It is important to distinguish between Internet videoconferencing and Internet video broadcasting. Conferencing is a two-way process, like using the telephone. Terms such as "call up" and "answer" apply. Broadcasting is a one-way process, like watching television. Terms such as "tune in," "enter URL," "streaming," and "Webcasting" apply. This article addresses only videoconferencing.

In the most basic approach to making a videoconference call, you type in the IP (Internet protocol) address of the person's PC you wish to call, and the call is completed with no further action needed. The systems provide a local dialing directory into which you can enter commonly called numbers, giving them names such as "Bob" or "Dean's Office," which frees you from having to remember the IP addresses. The systems also emulate telephone sounds, such as dial tone, ringing, and busy signals; these sounds are fake and are not to be misunderstood as evidence that any telephone is involved. Systems of gatekeepers (described below) make national and international calling easy.[1]

End-User Equipment Needed

A good network connection is a crucial requirement for videoconferencing. Dial-in connections do not work although cable modems and DSL connections often do. An ordinary Internet connection generally works fine (provided that your campus connection to the Internet is not near saturation), but a high-performance network connection (such as to Abilene or VBNS+) works especially well.[2] In a college or university setting, switched full-duplex Ethernet is commonly available and is the recommended choice for the local connection to your PC.

The typical speed used for videoconferencing is nominally 384 kbps (kilobits per second), which has an actual bandwidth requirement of about 450 kbps. For demanding applications such as telemedicine, a nominal speed of 768 kbps is used, which has an actual bandwidth of about 900 kbps. These speeds do not represent extraordinary requirements for the typical college or university network environment.

Videoconferencing equipment is available in two general configurations, PC-based and standalone.

PC-BASED SYSTEMS

PC-based systems require a modern PC, at least 300 MHz (450 preferable), depending on what the specific videoconferencing equipment manufacturer requires. They are available only for Windows PCs today, so there are unfortunately no Macintosh or Unix systems that can provide high-quality videoconferencing (although Smith Micro has just introduced a low-level Mac product). PC-based systems are suitable for use on your desk, with one to three people sitting in front of them. They are not suitable for use in a classroom or conference room unless they are augmented with better cameras and microphones as discussed below. It is assumed that your PC already has loudspeakers.

PC-based systems are further subdivided into those that have internal and those that have external hardware video compression cards. A hardware video compression card (not to be confused with the much less capable video capture card) is necessary because no current PC is fast enough to do the real-time processing required for high-quality videoconferencing. The compression card has its own CPU, which is dedicated solely to video processing, so it offloads that task from the standard CPU in your PC. Compression cards generally come with a small camera, microphone, and software as a complete kit. Software-only systems are also available, such as Microsoft Netmeeting and White Pine CU-SeeMe, but they do not provide the level of performance of hardware-based systems and are generally not recommended.

Internal compression cards plug inside your PC just like modem or Ethernet cards. They generally provide higher performance and greater flexibility (such as additional audio/video inputs and outputs for use with accessories such as VCRs, document cameras, and so forth) than external cards. The included small camera sits on top of your monitor, and the microphone is built into the camera. This approach applies only to desktop PCs because there are no laptop PCMCIA compression cards available.

External compression cards are contained entirely within a small camera or other small box, and they plug into the USB port on your PC. This makes them very easy to install and use, and they are the only available solution for laptop PCs. The microphone is built into the camera. This approach is the latest technology

Table 1:
Two Types of Videoconferencing

Traditional	Internet
Use in special room; rare	Use anywhere; ubiquitous
Uses ISDN telephone lines	Uses Internet
High installation cost	Low installation cost
High usage cost	No usage cost
Usage at plateau	Usage growing rapidly
Scheduled in advance	Impromptu
Professional operator	Do-it-yourself
Centralized control	Decentralized control
H.320 standard	H.323 standard

Some Common Commercial Videoconferencing Products

Equipment	Approximate Cost
PC-based, internal compression card	
VCON Escort 25, plus needed Polycom Soundpoint PC speaker/mike	$900
Zydacron Z340	$1,100
PC-based, external compression card	
Polycom ViaVideo (small and simple)	$500
VCON ViGO (standard model, accepts external video)	$600
VCON ViGO (professional model, includes speaker and higher speed)	$900
Standalone Systems	
Polycom 128 (basic model, provides most needed features)	$4,000
Polycom FX (high-end model, adds video streamer, built-in MCU, very high speed)	$10,000
Multipoint Control Unit	
RADVision MCU-323 (9 users at 384K, includes built-in gatekeeper)	$17,000
Accord (100 users, traditional and Internet conferencing)	several hundred $K
Video Interface Unit	
RADVision VIU	$4,000
Gateway	
RADVision GW – 323 (includes built-in gatekeeper)	$8,000

For more information about these products, see http://www.vcon.com, http://www.zydacron.com, http://www.polycom.com, and http://www.radvision.com.

and is only now becoming available on the market. External compression card systems are generally less expensive than internal compression card systems. These are the systems of choice for those who just want something simple and inexpensive in their office. A note of caution: Do not to confuse these USB systems with the simple USB cameras that have been widely available for some time; the latter cannot provide high-quality video.

STANDALONE SYSTEMS

Standalone systems require no PC at all. They are self-contained systems with high-performance cameras and microphones attached to them. The cameras can be steered and zoomed as needed with a hand-held remote control. The microphone is often on a long cord so it can be placed in the middle of a conference table. Some of these systems provide automatic tracking so that the camera always points toward the person who is speaking. They have built-in Web servers so they can be controlled from any Web browser anywhere. Some of them have built-in telnet servers for remote monitoring and a built-in telephone that allows audio-only participation in a videoconference.

Standalone systems provide the highest performance and flexibility of all systems. They are probably overkill for use in an office, but they are perfect for classroom and conference room use. They are also generally the easiest to use of all systems, and they cost more than PC-based systems, not accounting for the cost of the PC. They require a TV monitor or projector to display the video, and best quality is obtained with a high-quality monitor that accepts S-video input. They have extensive audio and video inputs and outputs for auxiliary equipment.

AUXILIARY EQUIPMENT

Almost all of the above systems, of any type, can be augmented with additional audio and video equipment. It is not unusual to replace the small camera that comes with a PC-based system with a larger camera that provides remote-controlled steering and zooming and perhaps tracking. Other video equipment such as a VCR or document camera can be added. Wireless lapel microphones, or wireless pass-around audience microphones, can also be added. More detailed information may be found in *The Videoconferencing Cookbook*, now in its updated version 2.0.[3]

Server Equipment

In addition to the end-user equipment described above, you may need to use one or more of the three kinds of server

Figure 1: Internet Point-to-Point Videoconferencing

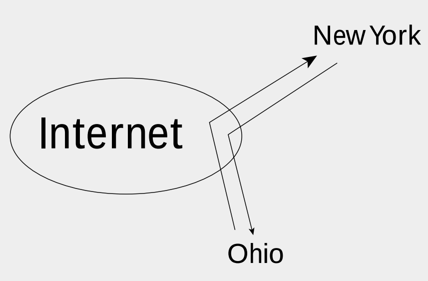
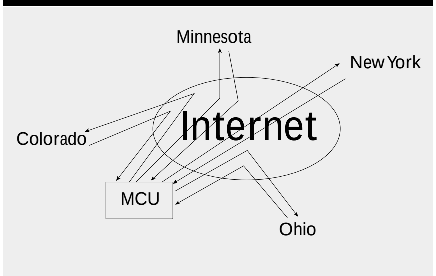


Figure 2: Internet Multipoint Videoconferencing



equipment commonly used in H.323 Internet videoconferencing. If you are only making a point-to-point call, as shown in Figure 1, then you may not need to use any server equipment. But if you wish to have a videoconference involving more than two stations at once (called multipoint), then server equipment is required. A server called a multipoint control unit (MCU) must be used. All stations call into the MCU, and it sends back to each station the video it has selected, as shown in Figure 2.

The most common video selection rule used by an MCU is that the station with the loudest audio will send its video to all other stations. The audio from all stations is normally sent to all other stations all the time. This provides quite satisfactory interactive conversation among all the stations. Another selection rule sometimes used is the designation of one station as the “speaker,” resulting in that station’s video always being seen by all other stations. This is more suited for a lecture situation.

If you wish to include traditional ISDN telephony-based stations in an Internet videoconference, there are two methods to choose from, each with its own kind of server. A video interface unit (VIU) may be added to an existing traditional videoconferencing room to enable it to function as an Internet videoconferencing station. Alternatively, traditional video stations can use their ISDN lines to communicate with a gateway server, which will bridge them onto the Internet and make connections to Internet video stations.

If you use any of these servers, you must also use a kind of server called a gatekeeper. All H.323 videoconferencing equipment—end-user stations, MCUs, and gateways—automatically self-register with their designated gatekeeper (or this may be done manually if desired). The gatekeeper directs all the stations and servers as to how to provide any requested service (for example, a multipoint conference). It may optionally apply security and access rules as to who is allowed to do what. All the stations and servers registered with a given gatekeeper make up what is called a zone. A zone is typically a university campus. Multiple gatekeepers may be set up to be “neighbors” of one another, and this simplifies making calls from one zone to another.

All of these H.323 Internet videoconferencing components are illustrated in Figure 3. There are three very important observations to note.

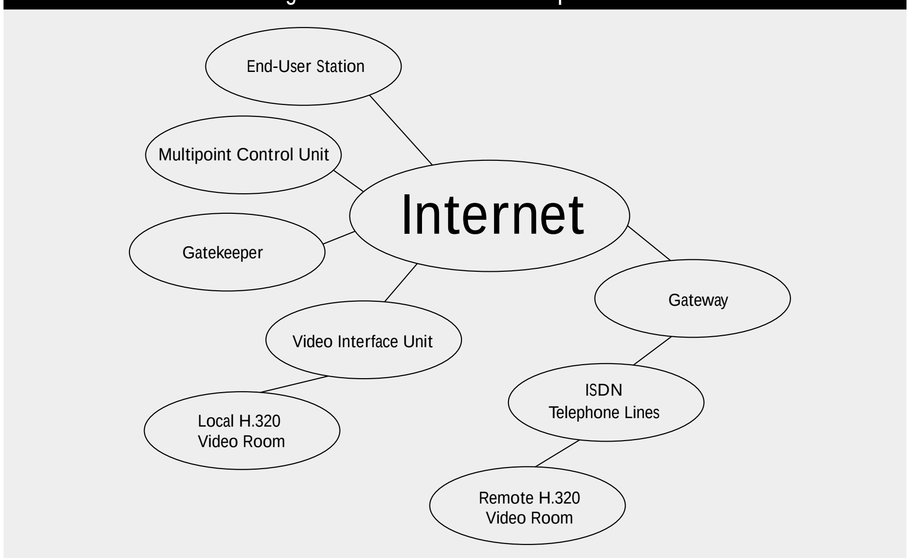
1. All of the equipment components are connected only to the Internet, and not to each other.
2. All of the server equipment may be located anywhere in the world. It need not be physically near any of the end stations. For example, in the multipoint diagram (Figure 2), note that the MCU is not located at any of the four end points.
3. Even though the gatekeeper controls all the other equipment, none of the video or audio flows through it. This is very important since otherwise it would be a bottleneck.

Fortunately, the end user need not be concerned about the operation of any of the servers. They will generally be installed and run by the campus computing and networking organization and function transparently to the end user.

Applications of Internet Videoconferencing

The following example applications are some of the uses we have made of this technology at Ohio State University within the past year. More such uses are becoming possible as the technology becomes more accessible and affordable.

Figure 3: H.323 Video Components



Telemedicine. In laparascopic surgery, a small video camera and light are placed in the patient's abdomen through a small incision. The surgery is performed with instruments that are remotely controlled through mechanical linkages. The surgeon does not look at the patient, but rather at a video monitor showing the patient's organs and the instruments. This same video is narrated by the surgeon using a wireless lapel microphone and sent to a classroom where it is viewed by a group of medical students. It would be impossible for so many students to be present in the operating room watching the surgery in person. The same scenario can be used where the surgery is performed in a small rural hospital and the video is sent to a consulting surgeon in a major medical center, who is on hand in case unexpected medical conditions are encountered during the surgery.

Distributed, collaborative college course. Students and faculty at four widely separated universities conducted a joint graduate seminar in the field of communications. A total of 42 students and their four professors at the University of California Santa Barbara, the University of Southern California, Purdue University, and the University of Illinois participated as if they were in the same physical classroom. The Internet videoconference used an MCU at Ohio State University and was controlled technically from Argonne Laboratory in Chicago. The course is described in detail at http://www.spcomm.uiuc.edu/contractor/429_files/frame.htm.

Guest lecturer in a college course. A small college in Pennsylvania wished to have a professor at Ohio State deliver a guest lecture for an English course at the college. It was not practical for the OSU professor to travel there, so the lecture was conducted via videoconferencing. The professor in the Pennsylvania classroom remarked afterwards that his students were so pleased by this lecture that they wanted to remain after the class hour and continue the discussion. This was the first time he had seen such behavior in his students.

Remote thesis defense. An engineering student at Mississippi State University had for one of his thesis advisors a faculty member at OSU. His thesis defense was conducted via Internet videoconferencing with participants at both universities. He passed.

Presentation of a paper at a conference. I was invited to present a paper at the NET2000 conference in Ottawa, Canada, but was unable to travel there in person. Instead, I presented my paper remotely via Internet videoconferencing. There was full interaction with the audience and other speakers.

The high-water marks for Internet videoconferencing systems thus far have been the events known as the Megaconference and Megaconference II.

The Megaconferences

The high-water marks for Internet videoconferencing systems thus far have been the events known as the Megaconference and Megaconference II. The first was held on October 11, 1999, with 60 universities and organizations from throughout the world participating. It was run from the Internet2 members meeting in Seattle, but since it was fully interactive, it occurred simultaneously throughout the world. Each university made a short presentation to the rest of the group, describing their university and what uses they were making of Internet video technology. The event ran for six hours, and the presentations were very creative, involving campus scenes, school songs, dramatic events, and even hula dancers. A panel of judges chose the best presentations, and the winning universities received videoconferencing equipment prizes, which had been donated by many vendors.

On October 31 of this year, Megaconference II was run from the Internet2 members meeting in Atlanta, with 114 universities and organizations participating. Every continent except Africa was represented, including Antarctica. This event represented the world's first Internet-based full-day conference track of refereed papers. The presenters delivered their papers from all over the world, describing their real-world applications of this technology, using the technology itself to do so. Even the conference chairperson was located remotely; the lectern was empty. The audience consisted of those physically present in the conference auditorium, plus those all over the world who joined via H.323 videoconferencing. All audience members and presenters were fully interactively connected with each other. In addition, streaming video technology was used to broadcast the conference track live to all those who could not participate interactively. The abstracts of all papers submitted, including those that could not be accommodated due to time constraints, are available at http://www.mega-net.net/megaconference. That collection of abstracts provides a good cross-section of the practical applications now being made of this technology.

Lasting Results of the Megaconferences

As a result of these megaconferences, H.323 Internet videoconferencing among universities has increased in quality and quantity. Many new end-user systems have been purchased, some of which are upgrades to previous systems that have proven to be inadequate. The prizes donated by the vendors added more end-user systems at various locations. In addition, a large community of users has been created and made aware of one another, which has fostered many collaborative arrangements. Vendors have become aware of this large user community, and special purchasing arrangements and prices have been made available to participants. Feedback has also been provided to vendors as to problems and features in their products that need attention.

There is now much wider awareness of the capabilities of Internet videoconferencing, among not only megaconference participants but all the faculty and administrators who have since seen and participated in many demonstrations and applications. This technology is now routinely used in many locations for many purposes.

Shortly after the first megaconference was proposed and approved in April of 1999, the "free love" multipoint control unit went on the air at Ohio State University. This MCU provides a continuous videoconference, open to anyone in the world. People drop in as they wish to talk to colleagues, to test their equipment, to ask questions, and to arrange and give demonstrations. Anyone may connect to the unit at any time by using gatekeeper address 128.146.199.52, setting your speed to 384 kbps, and dialing 70*1234 .

What Does the Future Hold?

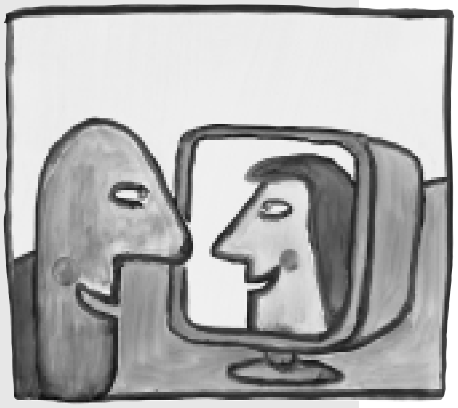
The megaconference experiences are a harbinger of what will eventually be possible at all conferences on all subjects. Now that it is practical to bring in via the Internet remote speakers and audiences who could not otherwise attend a conference, all conference organizers will need to consider this as an augmentation to their event as it will be expected as a routine conference feature. A number of presentations were made in this manner at the EDUCAUSE conference in Nashville, October 10–13, 2000, and this practice will only increase in the future.

In addition to the conference type of application, as the technology becomes more accessible and affordable and greater bandwidth becomes more readily available, the other applications described in this article will also become routine, enabling and supporting more effective and efficient distance learning in higher education. *e*

Videoconferencing Etiquette

Here are a few pointers to make your videoconferences more effective and efficient:

1. Do not cause echo. Echoes are a leading problem in videoconferences. Use a system that has good echo-canceling capabilities. If this is not possible, use a headset or provide external echo-cancellation equipment. Remember, you will not hear the echo that you cause, but everyone else in the conference will.
2. Mute your mike in the software when you are not talking for some length of time. Some systems cause noise that can capture the conference even with the microphone switch turned off.
3. Adjust your color. Set color or saturation to maximum, and then adjust the hue. Back off on the color only if it is too garish. Most clients are too pastel with the default settings.
4. Eliminate background noises near microphones (for example, fans, disks).
5. Provide good lighting on your face. Do not use back lighting.
6. Allow for small time delays. Start talking and keep talking and don't hesitate because you see or hear something unexpected. Small delays are always present. Don't keep asking, "Can you hear me?"
7. Label your site clearly with an attractive sign or with a character generator so other people know where you are.



Source: These tips are adapted from a set of guidelines developed in conjunction with the megaconferences. For the complete guidelines, see http://www.mega-net.net/megaconference/etiquette.htm.

Endnotes:

1. An effort of ViDeNet has standardized this dialing system and everyone is urged to conform to that standard. For more information, see http://www.cavner.org/videnet.
2. For more information about Abilene, VBNS+, and other high-performance networks, visit the Internet2 site at http://www.internet2.edu.
3. *The Videoconferencing Cookbook* is one of several resources developed by the Video Development Initiative (ViDe), a multi-institutional effort established to promote the deployment of digital video in higher education. Another resource is the white paper on video-on-demand, *Digital Video for the Next Millennium.* Both are available at the ViDe Web site (http://www.vide.net).

Robert S. Dixon (bob_dixon@osu.edu) is chief research engineer in the Office of the CIO at Ohio State University and senior systems developer/engineer at the Ohio Academic Resources Network.