

**Learning on Demand
for All Ohio Citizens:
*Building Ohio's Video Intranet***

**A Vision and Preliminary Roadmap
from the Ohio Video Intranet Planning Team
Fourth Draft, October 10,1999**

Learning on Demand for All Ohio Citizens

Building Ohio's Video Intranet

Executive Summary

Ohio has come a long way toward achieving the dream of access to education for all of its citizens. Because of Ohio's success in building community colleges and extending universities through systems of branch campuses, fewer citizens face geographical barriers to their educational attainment.

As we enter the 21st century—and face the reality of a knowledge-based economy—the dream of access becomes a dream of providing high-quality educational experiences to any learner, any time, anywhere. However, as we pursue this dream of “learning on demand,” expanding our infrastructure of campuses and buildings ceases to be the principal means by which we are increasing access. Instead, we are building a new knowledge infrastructure, not of bricks and steel, but of computers and networks.

Success in linking all of Ohio's schools, campuses, and libraries to the Internet is on the horizon. But as we anticipate the realization of this ambitious goal, Ohio faces its next challenge—creating a statewide capacity for high-quality video conferencing and video on demand.

Ohio's schools, colleges, and universities have resolved to be leaders in building the Ohio Video Intranet (OVI)—a statewide digital video network that will enable any citizen to obtain quick, easy, and inexpensive access to high-quality video information and two-way video conferencing capabilities.

This paper presents the OVI vision and preliminary recommendations for achieving this goal.

The OVI Vision

Inspired by the dream of providing “learning on demand” to all citizens, Ohio colleges and universities have made great progress in using technology to increase access to distance learning and to share knowledge. The Ohio Video Intranet is the next logical step.

The ability for all learners to obtain quick, easy, and inexpensive access to high-quality digital video information and two-way video conferencing capabilities over the Internet is the promise of the OVI.

The Recommendations

Before learning on demand becomes a possibility for all Ohioans, citizens must gain additional access to bandwidth. This barrier will be surmounted by a combination of market forces that will provide greater bandwidth to homes, state investment in high-speed networks to connect educational institutions, and public/private partnerships to ensure equitable access to the Internet. However, the first step toward learning on demand is building the Ohio Video Intranet, an infrastructure that will enable Ohio's

colleges and universities to deliver video content. Building the OVI begins with adopting common guidelines across all Ohio campuses.

Those guidelines, which are the focus of the OVI Planning Team's recommendations, center on the adoption of the H.323 video conferencing standard and the use of the MPEG-2 format for encoding video content delivered over the Internet.

To support adoption of these common guidelines, institutions should:

- Begin examining campus networks to assess their ability to support widespread individual use of video. Plan to use switched rather than shared network bandwidth.
- Focus on interim video conferencing strategies that meet immediate organizational goals and best allow connections to organizations with which they are developing joint programs to use video.
- Keep in mind, when selecting interim strategies, the need to upgrade to H.323 in the medium term, approximately 3 years. Any decision to invest in video conferencing equipment should take into account the need to upgrade to H.323 or the impact of having to use a gateway to communicate to H.323 users.
- Encode video materials that require high quality and long-term use in MPEG-2 format.
- Adopt whatever low bandwidth video streaming solution best meets the need of the intended audience but consider the vendor's plans for MPEG-4 support.

To support development of the OVI, state higher education technology organizations should:

- Sponsor state action to alleviate bandwidth costs and to provide lower cost high-speed network access (DS-3 or greater).
- Select and promote the use of a preferred video streaming server product(s) to deliver MPEG-2 and MPEG-4 encoded video. Select the product(s) based on their support for multiple server platforms, adherence to standards, and similar criteria.
- Sponsor a testbed implementation of a preferred server product to enable campuses to study implementation of the server and assess its ability to interoperate with other products including encoding and decoding devices and clients from other vendors.
- Develop a plan for a system for statewide video storage and delivery that maximizes the availability of video on demand to small as well as large institutions and also minimizes its impact on state networks.
- Obtain appropriate gateways for institutions.
- Sponsor research concerning the best way to develop and deploy wide area H.323 video networks with particular emphasis on implementing multicast video conferencing. Work with institutions to share research results and experiences for the benefit of other institutions.
- Join with interested institutions to produce a multi-institutional H.323 video testbed that can be used to give other institutions information about bandwidth requirements for H.323 as well as H.323 compliant video conferencing equipment.

I. The Promise of Video Technology

A new vision of learning is emerging—a vision that is ambitious but achievable, a logical next step in our advance toward a digital, knowledge-based economy, toward classrooms without walls, toward a global village.

It is a vision that focuses on learners—their needs, their practical realities, their unique interests.

It is a vision that begins with the development of a statewide digital network for providing Ohio citizens with the ability to obtain quick, easy, and inexpensive access to high-quality video information and two-way video conferencing capabilities.

It is the vision of the Ohio Video Intranet.

The Vision Evolves

In less than ten years, dramatic changes in how we learn have occurred because of computing and communications technology:

- For many students—from elementary school through college—the Word Wide Web has become an extension of the textbook. For many adults, it has become a way to gain fast access to vital information about health, work, or cultural interests.
- For some citizens, cable and satellite television have meant new sources of knowledge about nature, history, and the arts--and have removed the barriers that block access to knowledge by serving as a vehicle for earning a GED or pursuing continuing education.
- For many companies, television- and computer-based training have meant cost-effective improvements in the skills of their workers.
- And, for many college and university students, distance learning networks have ensured access to courses, research projects, and expertise that are located hundreds—even thousands—of miles away.

These technological learning tools—and the new possibilities they brought us—have changed our perspective of what learning can be.

- Once, most learning was confined to a classroom. Today, we can envision a world where learning is possible anywhere, anytime—where learning is seamlessly integrated into people's everyday lives.
- Once, learning was seen primarily as preparation for adulthood. Today, we can envision a world where everyone considers learning a lifelong process--where barriers to continued learning are insignificant.
- Once, learning was considered important only if it involved the formal transmission of knowledge from teacher or expert to student or novice. Today, we can envision a world where all are engaged in the active, self-directed pursuit of knowledge from a variety of sources--where each person creates a unique history of learning experiences.

In short, the power of technology has opened our imaginations to the promise of *learning on demand*.

In the next decade, as high-speed Internet access and digital television become more common, Ohio's colleges and universities can make learning on demand a reality.

Why Advanced Video Capabilities?

A major purpose for all educational technology is to build upon or enhance the learning opportunities that are available in the learner's environment. Although much can be gained from text and still images, a significant amount of what is learned results from face-to-face interaction with experts and visual observation of the entities, places, or phenomena being investigated.

New Sources of Knowledge

Video enables learners to tap into many additional sources of knowledge. Only high-quality video capabilities will enable Ohio learners to:

- Be active participants in courses that originate from distant sites.
- View demonstrations, applications of knowledge, and live events at distant sites and interact with the experts who are present at those sites.
- Learn independently or study course materials by viewing, capturing, and manipulating video clips, animated graphics, and visual simulations from a variety of sources.

Richer, More Relevant Pathways to Learning

Video conferencing and video on demand services not only expand the sources of available knowledge, they also help teachers provide richer learning experiences. High quality video capabilities, combined with effective teaching, would enable students to:

- Become immersed in realistic simulations of real world tasks.
- Exhibit their own performances to experts at other locations.
- Use and develop visual intelligence in addition to the verbal and mathematical intelligences emphasized in most learning environments.
- Collaborate more effectively with students at other schools.
- Enhance their media literacy and comprehension of visual information.
- Gain exposure to skills that will be highly valued in the job market.

Whether a learner is located in an elementary school classroom, a college computer lab, an office, a college dormitory, or a residence, these advantages provided by video—as well as the flexibility and control video allows—can mean greater success.

A LOOK AHEAD

When fifth grader *Erica Martin's dad asks her what happened at school, she has plenty to say.

She can tell him about social studies, where multimedia computers enable her class to learn about Africa by hearing its music and watching its dances. She can tell about science class, where a WebCam set up in the city zoo is allowing the class to observe and chart the eating and sleeping patterns of a lion and her newborn cub. Or, she can talk about the questions she asked when a two-way video conference enabled her to talk with the author of the book she is reading.

When her older brother Jason becomes totally confused with his algebra homework, the problem is solvable. He can log onto the Internet to watch video clips of his teacher explaining the new concept they are learning and solving sample problems. Or he can set up a video conference with a tutor from the mathematics department at the nearby University of Dayton.

Erica and Jason are students of the future. Their experiences can belong to all Ohio students.

**All learner names are fictitious.*

Why Invest in OVI?

The future of Ohio and of its citizens is being shaped by two realities:

- Economic growth will be fueled largely by innovation, ideas, and solutions—the products of the human mind.
- The complex problems, opportunities, and challenges faced by society—as well as by the average citizen—can only be addressed through knowledge, understanding, and know how.

Therefore, the wisest investment Ohio can make is an investment in building the capacity of all citizens to learn.

Moving Toward Learning on Demand

A commitment to learning on demand means that all who generate, manage, and disseminate knowledge—schools, colleges, universities, businesses, research centers, media, libraries, cultural institutions, and others—will strive to achieve two major goals:

- Making it possible for all constituents to access the learning opportunities they need—without leaving their everyday environments.
- Instructing and interacting with constituents in ways that will result in high levels of understanding and skill development.

To date, Ohio's investments in educational technology have meant steady progress toward those goals:

- Most of Ohio's colleges and universities have built state-of-the-art campus networks to aid distance learning, research, and other educational activities. They continue to develop high-quality distance learning courses and expand electronic access to knowledge.
- The Ohio Board of Regents' Technology Challenge and Technology Initiatives funds have aided the efforts of campuses to use technology.
- The Ohio Learning Network, a new consortium of Ohio's colleges and universities, is working to combine the best of the state's educational infrastructure, people, programs, and technology to help meet Ohio's educational needs.

A LOOK AHEAD

Despite family obligations and his busy schedule at the small Cleveland manufacturing company where he works, machinist Pete Lopez dreams of becoming an engineer. The video conferencing equipment at work has already made it possible for him to attend several courses from Cuyahoga Community College during the lunch hour. And, he is completing a multimedia self-study course in physics offered by the University of Cincinnati.

Pete knows that his supervisor, Mike Davis, will support his efforts. Mike, who is completing his doctorate, also has been relying on video conferencing. In fact, Mike, who attends Cleveland State University, is always talking about his experiences with "virtual education." He has completed specialized courses at the University of Toledo and Ohio State University, observed live experiments at a Department of Energy facility in California, attended lectures given by German engineers, and collaborated with a group of students at MIT—all without leaving the CSU campus.

Pete and Mike are employees of the future. Ohio can provide similar learning opportunities to all of its workers.

- OhioLINK (a consortium of the libraries at Ohio’s universities and colleges) has vastly improved learners’ access to knowledge by providing access to information and educational resources.
- The Ohio Supercomputer Center (OSC) has made it possible for faculty and students at Ohio’s campuses to conduct cutting-edge research in medicine, business, economics, engineering, chemistry, mathematics, physics, and other disciplines.
- OARnet (the Ohio Academic Research Network), one of the leading regional networks in the world, now provides Internet access and technical assistance to most of Ohio's colleges, universities, and state government agencies and is among the national leaders in helping to develop new higher speed educational networks.
- The Ohio Educational Telecommunications Network has fostered the growth and development of public telecommunications in Ohio, enabling all Ohio citizens to access educational programming.
- Programs such as SchoolNet, SchoolNet Plus, and the Ohio Telecommunity have provided numerous opportunities for school districts to acquire voice, video, and data connections and computers, classroom technologies, and assistance in building the technology skills of teachers.

These computing and networking initiatives have expanded access to knowledge and created learning experiences with much greater impact than would have been possible with only traditional methods. But educational technology in Ohio cannot reach its full potential until one more element has been put in place:

Learners must be able to obtain quick, easy, and inexpensive access to high-quality digital video information and two-way video conferencing capabilities.

Providing this access is the purpose of the OVI.

A LOOK AHEAD

Jenny Rogers has just received her last welfare check and is preparing to start her new job as a Licensed Practical Nurse. A single mother in a disadvantaged rural community, Jenny worked for two years to make a better life—first earning her GED and then completing a year of study at Rio Grande Community College. Jenny had always had difficulties in mathematics. In addition, attending classes was not always possible. Sometimes she was without a car. And she didn’t like leaving her two small children with sitters for long periods of time. But access to a computer at her local library enabled her to complete some of her GED and college classes via distance learning, to obtain tutoring in mathematics on Saturday afternoons, and to review video clips of the procedures taught in class each day—as many times as needed.

Jenny is a citizen of the future. What if the world could be expanded for all Ohio citizens?

II. Fulfilling the Promise: A Statewide Video Infrastructure

Ohio's video infrastructure must be capable of supporting two types of video services:

- Two-way video conferencing services—the ability to provide high-quality interactive audio and video communications between instructors and students at a variety of locations.
- Video on demand services—the ability to access high-quality video information whether by playing a video file stored in a remote computer or receiving live video from a broadcast event.

These services already exist in today's environment.

The Current Environment

Many of Ohio's college and university campuses use video conferencing technology to provide interactive distance learning courses to the students they enroll.

- Campuses have facilities or classrooms that are set up for exchanging live audio and video information. Such video conferencing rooms may be equipped with large screen analog televisions, high resolution cameras, and high quality microphones that capture images and sounds from different parts of the room, as well as computers for compressing digital signals so that more information can be sent at lower speeds.
- Campuses are beginning to employ desktop videoconferencing. Typically, each student faces a networked desktop computer with two-way video conferencing capabilities. Instructors have control of these computers and can interact with students individually or as a group.
- Campuses offer courses over the World-Wide Web, allowing students to access course materials and assignments from a Web site and interact with faculty and classmates through a combination of online forums, e-mail, and voice mail. In addition, a vast amount of knowledge gained from research is shared over the Web, from papers to computer data to music to images from telescopes and microscopes.

Each of these distance learning applications shows tremendous promise. But they have not yet realized the vision of learning on demand.

Needed Advances for Realizing Learning on Demand

Before learning on demand becomes a reality, two advances must be made:

- Colleges and universities, as well as other knowledge providers, must expand available content.
- K-12 schools, offices, libraries, homes, and other locations in the field must acquire more high-speed bandwidth.

Ohio's colleges and universities already have developed a wide selection of well-designed distance learning courses and services for learners to access. However, courses delivered via two-way video conferencing are not widely accessible. Since most off-campus sites do not have video conferencing equipment, most courses are offered only at a small number of alternative locations, such as a university's regional branch campuses. Few partnerships exist for sharing courses across institutions or for delivering courses to high schools or businesses. In short, most learners today cannot access a video conference-based course from their homes or offices, nor are they guaranteed that a course will be offered at a location that is accessible to them.

Web-based courses are more widely accessible. However, like most of the other knowledge resources students access online—the typical Web-based course is designed with only text and

still images. Few make use of audio and full-motion video. This means that most courses offered on the Web do not provide the dynamic learning experience that would be possible with video elements.

For learning on demand to become a reality, campuses must provide video-based distance learning courses to a variety of alternative locations, and they must incorporate more high-quality, full-motion video into their Web-based courses and services. The reason such action has not yet been taken relates to the other needed advance—the availability of sufficient high-speed bandwidth to learners in schools, offices, homes, and other off-campus locations.

While many campuses are connected to dedicated networks with the high-speed bandwidth needed for transmitting video, most K-12 classrooms, offices, and homes are connected to the Internet via lines that transmit at lower speeds. Few sites have access to digital television, and most citizens who are able to send and receive video via computer must be content with video that is displayed in a very small window and updated less frequently than the approximately 30 new frames per second needed to accommodate smooth motion.

This bandwidth barrier will be overcome by three forces: public private partnerships that help to ensure equitable network access to Ohio's citizens, state investment in high speed networks to connect educational institutions, and market forces that will lower the cost and broaden the availability of high-speed network access in homes and businesses.

Just as the advent of the World-Wide Web in the early 90s helped spark consumer interest in more powerful computers and modems, the possibilities for multimedia are creating a market demand for high-speed bandwidth to homes, dorms, and other locations. Many Internet business users have already subscribed to higher speed ISDN or T-1 lines. New high-speed networking technologies for Internet access, such as cable modems and xDSL, are now becoming more widely available. Interest in digital television is growing and bringing us closer to a true convergence of television and computing.

If recent trends continue, networking advances will occur, costs will get lower, and increasing numbers of citizens will invest in high-speed access to bandwidth. As the amount of available high-quality multimedia content increases, the number of schools, offices, libraries, and households making the necessary investments will increase—and public policies to address the issue of universal high-speed access to the Internet will be proposed.

The First Step: The Ohio Video Infrastructure

The prospect of increases in the bandwidth available to learners, raises an important question:

If Ohio's colleges and universities continue their commitment to providing high-quality multimedia courses, will they be able to deliver those courses to citizens to locations across the state and beyond?

The answer is yes.

In fact, Ohio can position itself as a leader in providing learning on demand by taking an important first step within the next two years. That first step is to develop an appropriate technical infrastructure for transmitting and receiving video—the most bandwidth-intensive element of multimedia—across a wide range of locations and types of equipment.

A planning team, consisting of representatives from the k-12 higher education community and the state's technology leaders, has already defined the most important characteristics of an infrastructure that can support widespread access to two-way video conferencing and video on demand. They call their concept the Ohio Video Intranet (OVI).

The OVI will use the physical infrastructure and standards of the Internet and the World Wide Web, using standards and software that will help to ensure hardware and software compatibility across all sites.

Use of the Internet as the physical channel means the broadest possible access for learners. Any school, office, library, home, or other location will be able to tap into the OVI by investing in a high-speed Internet connection and a computer with video capabilities. These items are available in today's marketplace and likely to become increasingly cost-effective, as well as desirable not only for educational use but also for enhancing business communications, entertainment, the dissemination of news, and other online activities.

Building the OVI

Building the OVI will require commitments from Ohio's educational institutions and technology organizations, as well as from state government.

Ohio colleges, universities, and educational technology organizations should begin examining campus networks to assess their ability to support widespread individual use of video. This particularly entails an assessment of the amount of bandwidth they can provide to the desktop. Since shared network bandwidth may make desktop video delivery difficult, campuses should look for switched network bandwidth.

Campuses can begin supporting the OVI by following OVI guidelines as they upgrade or expand their existing distance learning technologies or acquire new distance learning capabilities. These guidelines are designed to deliver video while ensuring that:

- OVI users will be able to conduct two-way video conferences between locations with different types of equipment and deliver sharp, clear video to classrooms, college dormitories, work sites, libraries, and homes.
- OVI users will not need expensive, specialized equipment. Campuses will be able to upgrade cost-effectively to more advanced video and sound and new quality standards as they become available.
- Users at their desks, in their classrooms, and in their homes will be able to create video connections spontaneously and with ease.

To conform to OVI guidelines, campuses will need to:

- Migrate to the H.323 video conferencing standard.
- Support the delivery of MPEG-2 encoded video.

Migration to the H. 323 Video Conferencing Standard

The Internet Protocol (IP) is the de facto networking standard for computers with Internet access. This means that the infrastructure must deliver video over IP networks and cannot rely on dedicated video bandwidth or specialized networking approaches, such as Asynchronous Transfer Mode (ATM). To support video delivery over IP networks to homes and other locations, to ensure compatibility among campuses, and to provide the fastest possible transmission of video, the Ohio Video Intranet should conform to the H.323 video conferencing standard.

H.323 allows delivery of video over unreliable networks (networks without dedicated bandwidth for video). A number of Ohio sites have tested the use of this approach to video conferencing. These tests have generally been successful and will probably lead to more widespread use of this form of video during the next year.

Current Status: In addition to H.323, two other video conferencing standards are in place in Ohio:

- H.320—a standard for video conferencing over dedicated T-1 lines. Ohio has one H.320 video network connected to T1 lines provided through the State of Ohio Multiagency Communications System (SOMACS) and several H.320 video networks that are not connected to SOMACS, including a number of regional university networks.
- H.321/H.310 –the standards for video conferencing over ATM. H.321 is being used as part of the SchoolNet Interactive Video Distance Learning Pilot. H.310 is a standard for transmission of high quality video (MPEG-2) over ATM. ATM-based video-conferencing is being used at a number of universities and colleges.

These other types of video networks can co-exist with H.323 networks. Gateways are available or under development that make it possible to communicate between the different types of networks. This removes the requirement for institutions and for the state in general to standardize immediately on H.320 or H.321 video conferencing while H.323 is under development. However, future migration to an H.323 environment will be worthwhile because relying on gateways in a video conferencing environment with many users makes the process of connecting sites more complex and can limit the number of sites that can connect to each other.

Interim Recommendations: Institutions should focus on interim video conferencing strategies that meet their immediate organizational goals and best enable them to communicate with those few organizations with which they are developing joint programs using video. However, planners should keep in mind when selecting interim strategies, the need to upgrade to H.323 in the medium term, approximately 3 years. And, any decision to invest in video conferencing equipment should take into account the need to upgrade to H.323 or the impact of having to use a gateway to communicate to H.323 users.

Institutions also should plan to increase network bandwidth. However, they will have a great deal of flexibility in the short term because they can convert networks dedicated to H.320 or H.321 to general IP bandwidth supporting any Internet application, including H.323 video conferencing. Bandwidth used for H.320 video can become part of a campus' general bandwidth and be used to help support H.323. ATM T-1 lines used to carry native video over ATM can also be reconfigured to carry video over IP. Alternatively, expenditures currently being made to pay for dedicated video bandwidth could be reallocated to pay for greater bandwidth for the institution's general Internet connection.

The State's Interim Role: The state can support migration to H.323 in a number of ways:

- Joining with interested institutions to produce a multi-institutional H.323 video testbed that can be used to give other institutions information about bandwidth requirements for H.323, as well as H.323 compliant video conferencing equipment.
- Sponsoring efforts to research the best way to develop and deploy wide area H.323 video networks, with particular emphasis on implementing multicast video conferencing.
- Working with institutions to share research results and experiences for the benefit of other institutions.
- Obtaining appropriate central gateways for institutions.

Supporting the MPEG-2 Standard for Video on Demand

To provide individuals with high quality video information on demand whether by playing a video file or transmitting a broadcast event, the OVI must support the MPEG-2 standard.

MPEG-2 is currently the single standard for the encoding of high-quality video files. By this means of encoding, it is possible to retain the most visual information from a video source. Other forms of encoding will capture less of the information. Thus, video in this form can be of the same level of quality as broadcast television (including HDTV)—the de facto standard of video quality. MPEG-2 will permit the delivery of video on demand to individuals at their homes over high-speed network connections at the level of quality to which they are accustomed.

Current Status: While the standard for encoding high-quality video files is clear, specifying the infrastructure for streaming that video to the end user is a more difficult problem. There are a number of competing and not interoperable video server and client products available for streaming MPEG-2 files. Particular vendors' video servers require specific clients. This situation will make it difficult to develop a statewide video on demand infrastructure when videos from a campus using one server/client product can not be viewed by a student at another campus using a different vendor's products.

The complexity of developing a statewide, interoperable video on demand infrastructure is made even more complex by the fact that competing products and technologies also characterize the world of lower quality Internet video on demand. This problem may be solved by the adoption of the MPEG-4 standard for low bandwidth video streaming. However, at the present time, there are a number of competing alternative software products and proprietary video formats used in this situation.

Interim Recommendations: Institutions should begin as soon as possible to encode video materials in MPEG-2 format. A different encoding strategy should be chosen only if the video is from a source that does not contain sufficient visual information to warrant MPEG-2 encoding, or the video is only ephemeral. Only ephemeral video materials should be encoded solely in proprietary video formats, e.g. RealVideo.

Institutions also should adopt whatever low bandwidth video streaming solution best meets the need of the intended audience. The selection of a solution should be made with the vendor's plans for MPEG-4 support in mind. It should also be made with an awareness of the strong probability that the institution may need to migrate to a different vendor's products given the immaturity of the market for video software.

The State's Interim Role: The state of Ohio can support a smooth transition to MPEG-2 by taking steps to select and promote the use of a preferred server product(s) for delivering MPEG-2 and MPEG-4 encoded video. Although use of any product will remain voluntary, the server(s) most likely to be widely used will be those that provide the best price and support from experts. Part of this promotional activity should be a testbed implementation of the server product where an implementation of the server can be seen and tests can determine its ability to interoperate with encoding and decoding devices and clients from other vendors. If the product is also selected based on its support for multiple server platforms, adherence to standards, and similar criteria, more campuses will have MPEG servers that are compatible.

The State's Long-Term Role

In addition to providing interim support for campuses implementing the OVI guidelines, the state of Ohio should begin planning for when institutions begin to increase their demands for video.

Although the conversion of H.320 and H.321 lines from dedicated video bandwidth to general Internet use will provide more general use bandwidth for institutions, it is still likely that the development of widespread individual use of video will require higher amounts of bandwidth than normally purchased. This will place an additional financial burden on institutions. Therefore, Ohio should develop a plan for providing low cost high-speed network access (DS-3

or greater) to all campuses. This will prevent the need to ration video use because of the high cost of network capacity.

In addition, Ohio should support development of a system for statewide video storage and delivery that includes central facilities and distributed caches for video storage and streaming. This system will minimize the impact of the increased traffic that video services will cause on state networks and maximize the availability of video on demand to all institutions, including smaller ones. The state also should plan to use distributed video delivery and multicasting to reduce the burden of video delivery.

Summary of Recommendations

As the OVI is being developed, institutions should:

- Begin examining campus networks to assess their ability to support widespread individual use of video. Plan to use switched rather than shared network bandwidth.
- Focus on interim video conferencing strategies that meet immediate organizational goals and best allow connections to organizations with which they are developing joint programs to use video.
- Keep in mind, when selecting interim strategies, the need to upgrade to H.323 in the medium term, approximately 3 years. Any decision to invest in video conferencing equipment should take into account the need to upgrade to H.323 or the impact of having to use a gateway to communicate to H.323 users.
- Encode video materials that require high quality and long-term use in MPEG-2 format.
- Adopt whatever low bandwidth video streaming solution best meets the need of the intended audience but consider the vendor's plans for MPEG-4 support.

To support development of the OVI, state higher education technology organizations should:

- Sponsor state action to alleviate bandwidth costs and to provide lower cost high-speed network access (DS-3 or greater).
- Select and promote the use of a preferred server product(s) to deliver MPEG-2 and MPEG-4 encoded video. Select the product(s) based on their support for multiple server platforms, adherence to standards, and similar criteria.
- Sponsor a testbed implementation of a preferred server product to enable campuses to study implementation of the server and assess its ability to interoperate with other products including encoding and decoding devices and clients from other vendors.
- Develop a plan for a system for statewide video storage and delivery that maximizes the availability of video on demand to small as well as large institutions and also minimizes its impact on state networks.
- Obtain appropriate gateways for campuses.
- Sponsor research concerning the best way to develop and deploy wide area H.323 video networks with particular emphasis on implementing multicast video conferencing. Work with institutions to share research results and experiences for the benefit of other institutions.
- Join with interested institutions to produce a multi-institutional H.323 video testbed that can be used to give other institutions information about bandwidth requirements