Evaluation of Information Technology to Support Distance Sharing and Learning Between and Among Federal Region VII State Transportation Agencies, Region FHWA Offices, and Major Transportation Research Universities

Final Report

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CTRE's mission is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, and reliability, while improving the learning environment of students, faculty, and staff in transportation-related fields.

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INTRODUCTION

Distance sharing and learning is the use of communication technology to enable and improve the exchange of knowledge and information among persons at widely separate locations. Examples of distance sharing and learning include videoconferences, seminars, and courses; Internet World Wide Web (WWW) conferences and threaded discussion groups; and electronic communication and data transfer capabilities such as e-mail and file transfer protocol (FTP). The goal of this project was to investigate the possible benefits of improved distance sharing among major transportation stakeholders in Region VII, identify current and future applications of and needs for distance sharing technology, and develop recommendations for meeting these distance sharing needs.

The project will result in a report identifying the benefits of distance sharing, needs for improved distance sharing capabilities among major transportation stakeholders in the region, and recommendations for meeting these needs under use, cost, and performance expectations identified by the stakeholders. These recommendations will be brought to the attention of state transportation agency directors for consideration and implementation in the region.

BACKGROUND

Distance learning and distance sharing are concepts that can dramatically change the way transportation personnel are trained and the way transportation business is conducted. Distance learning uses telecommunications technology, usually videoconferencing of some sort, to teach or train groups of people who are at different physical locations. An example might be a training course on advanced geographic information system use taught at Iowa State University but taken by students in a classroom in Kansas. Distance information sharing allows several different organizations to use the same information electronically, thus improving coordination of large projects and enabling collaboration among agencies located at different sites. For instance, design staff at the Kansas and Missouri Departments of Transportation might simultaneously review and mark up the plans for a new bridge over the Missouri River via an Internet conference from their own offices. Distance information sharing is usually accomplished using internetworking technology.

This paper will examine the tangible and intangible benefits of expanding the use of telecommunications and information technologies such as videoconferencing and internetworking to improve sharing of intellectual resources and information among major transportation system stakeholders in Federal Highway Administration (FHWA) Region VII. Region VII is a large, four-state region that includes Iowa, Kansas, Missouri, and Nebraska. Major regional stakeholders include the federal government, primarily FHWA; state transportation agencies; and major transportation research units at the universities in the region. The paper will describe existing information technology resources and infrastructure in the region that could be used to implement distance information sharing and distance learning and will explore alternatives for expanding and improving the network. Finally, it will make recommendations leading to an action plan for implementation.

Project Purpose

The distance sharing and learning project for FHWA Region VII was initiated to:

- Examine the benefits of distance sharing of intellectual resources and information among major transportation stakeholders in the region;

- Determine the current state of information technology being used to support distance conferencing, learning, and collaboration;
- Catalogue and prioritize current and future uses and needs for distance learning and sharing information technologies;
- Identify the technology available to meet current and future needs and its interoperability, quality, and costs;
- Develop recommended actions for meeting the distance sharing needs and performance expectations of major transportation stakeholders.

Advisory Committee

An advisory committee made up of representatives from all four states in Region VII (Iowa, Kansas, Missouri, and Nebraska) guided the research for this project and participated actively in the development of the proposed strategic plan and recommendations. The members were also chosen to represent state DOT and university perspectives. They were:

- David Cook, Iowa Department of Transportation
- Dr. Brett Gunnick, University of Missouri-Columbia
- Dr. Patrick McCoy, University of Nebraska-Lincoln
- Richard McReynolds, Kansas Department of Transportation
- Dr. Eugene Russell, Kansas State University
- Ken Sieckmeyer, Nebraska Department of Roads
- Dr. Jerome Westphal, University of Missouri-Rolla

Definitions

Distance learning and education are simple and related concepts:

- *Distance learning* is the delivery of educational and professional instruction that does not constrain the learner and instructor to be physically present at the same location.

- *Distance sharing* can be defined as the transfer of information and/or collaboration among organizations and individuals that is not constrained to occur in real-time or to a physical exchange of documents or materials.

There are two types of distance interaction possible, synchronous and asynchronous. Each of these is defined below.

- *Synchronous interaction* involves the simultaneous participation of all students and instructors and occurs in real-time. Synchronous communications media include interactive videoconferencing, computer conferencing and chat, and audioconferencing via voice communications.

- *Asynchronous interaction* has participation times and locations chosen by the end-user; learning materials are available on-demand or in advance. Such media include videotaped courses, compact disk-interactive (CD-I) and digital video disk (DVD) courses, WWW-based courses, e-mail, and threaded discussion forums. These media provide high levels of convenience and any time “24/7” service, but at lower levels of direct interaction.

Distance learning and sharing can be fostered by a number of technologies not just videoconferencing, which is often thought of initially. As the table below shows, different technologies can and do enable distance learning and sharing:

TABLE 1 Distance Learning and Sharing Technologies

Technologies	EXAMPLES	Relative Use and Cost Levels
Audio-Based Technologies	Audio teleconferencing	Lowest Cost/ Most-Used Now
Internet and WWW-Based Technologies	Electronic mail lists, newsgroups, WWW conferencing, synchronous chat/conferencing	Moderate Cost and Moderately-Used Now
Video-Based Technologies	Videoconferencing, compressed video, full-motion video, satellite uplink/downlink	Highest Cost/ Least-Used Now

Conceptual Examples

Probably the most publicized national example of a proposed distance learning network is the consortium known as the Western Governors' University (WGU). WGU is a partnership of 18 states, 11 private corporations, and several overseas universities. Ultimately, the goal of WGU is to offer thousands on on-line courses from hundreds of different sources (universities, colleges, and private companies) to students in any location. The intended audiences are traditional college students plus working students. Degree programs are being developed. The projected enrollment for the 1998/1999 academic year is only about 3,000 students. WGU plans to enroll over 100,000 students eventually, but is developing more slowly than initially planned. WGU has not gained universal support in the 18 partner states; there is in fact some resistance to the concept, especially on university campuses in the region. Of the Region VII states only Nebraska is involved in WGU at present. (CIO Web Business, September 1, 1998)

The Internet address (URL) for the Western Governors' University web site is:
http://www.wgu.edu/wgu/index.html

Other examples include Michigan State University, which offers a large number of off-campus courses, the University of Phoenix, which is essentially a "virtual university," and Iowa State University, which offers over 65 courses and six master's degree programs off-campus using videoconferencing, videotapes, and the Internet.

An excellent example of a transportation-related distance sharing effort is the Virginia Transportation Research Council's VTRC World Wide Web site, which places documentation for all of that organization's projects on-line. The Internet address (URL) for this site is:
http://www.vdot.state.va.us/vtrc/main/index_main.htm

BENEFITS OF DISTANCE LEARNING AND SHARING

Distance learning and sharing has both tangible and intangible benefits. According to the advisory committee, some of the major benefits in Region VII would be as follows:

- Reduction of duplication of effort across the region. According to the advisory committee, there is considerable regional duplication of effort in both the transportation research and education efforts in the four-state region at present. There are duplicate course offerings and research projects that could be shared through various distance learning technologies.
- Ability to reach broader audiences for both research and education and training. Distance learning and sharing can involve more people or inform more people using the same resources or a relatively modest incremental cost. For this to happen, the technologies used have to be easy to use, convenient, and of fairly high and consistent quality.
- Ability to provide broader course offerings could occur through cooperation and networking; some courses could be offered through distance learning technology that could not otherwise be offered at all. Demand could be aggregated, especially for specialized courses and workshops.
- Travel time and cost savings; these could be realized for researchers, research clients, students, instructors, and customers of clients. Reduced travel might also generate monetary savings, energy conservation, and environmental benefits.
- Increased flexibility in education and training.
- Better service to customers. For instance, the transportation community (for example consultants) in Region VII could more easily audit courses and keep their skills and knowledge up to date.
- New categories of benefits. The application of communications technology usually creates new opportunities and benefits that can only be speculated about. For example, new conversations or idea exchanges might occur and new networks might develop.
- Exchanges with other states, universities, or even foreign organizations through "virtual scanning tours." This type of activity tends to generate a substantial number of new ideas and new ways of doing business.
- The potential to create "one-stop shopping" for customers.

In the opinion of the committee and the project research team, the main benefits of distance learning and sharing in Region VII would not be cost and time savings, but rather the ability to offer more and better service to customers, whether in research or education and training. Another key benefit is enabling interactions that would not normally take place due to time and cost constraints. However, early experience in FHWA Region VII and Region VIII suggests that there are indeed real cost savings.

EXISTING USES OF DISTANCE LEARNING AND SHARING IN REGION VII

A number of distance learning and sharing activities are currently underway in the FHWA Region VII states of Iowa, Kansas, Missouri, and Nebraska. For example, the following activities are already underway in the Region in some or all of the states:

- Distance courses on videotape or compact disc-interactive (CD-I);
- Courses by offered videoconference;
- Workshops and seminars by videoconference and satellite downlink;
- Collaborative meetings over the Internet;
- Topic-organized electronic mail lists.

There is also a model distance learning and sharing network in place already in nearby FHWA Region VIII that can be used as a model of sorts. The Upper Great Plains Transportation Institute at North Dakota State University has developed and operates a multi-state compressed

videoconferencing network called TEL8 (named after FHWA's Region VIII). It includes 10 videoconferencing sites in six states, including Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming. The DOTs in each of these six states plus Colorado State University, North Dakota State University, Utah State University, and the University of Wyoming are included in the network. TEL8 was originally developed as a satellite-based system and became operational in 1995, but has recently been transitioned to a system based on land communications lines. It is now land-based using T1 lines leased from AT&T, its own video bridge, and 384 kilobits per second (Kbps) compressed video. Each site on the network is similar, with two monitors and two cameras plus required videoconferencing CODEC equipment. (TEL8 Annual Report, 1997)

TEL8 was originally developed as a way to offer inter-university courses to professional audiences, primarily graduate courses in transportation. The intent was to have each of the four universities offer two graduate courses per year over the network, or eight courses total each academic year. The number of students per course has been about 15 to 20 spread over several sites.

Other examples of uses of TEL8 have included:

- Graduate courses and seminar series on such topics as transportation regulation and soils.
- Dissemination of university research and other technology transfer activities.
- National Highway Institute (NHI) and other short courses and workshops.
- An experiment in bringing selected sessions from the annual meeting of the Transportation Research Board in Washington DC back to state DOT staff in Region VIII via the network.
- Monthly peer information exchange sessions involving about 15 to 20 staff from each state DOT.
- Other technology transfer (T^2) activities.
- Electronic meetings regarding projects that might involve local governments, state DOTs, and federal agencies.
- Multi-state board meetings for groups such as the TEL8 Board of Directors.

During calendar year 1997, TEL8 hosted some 724 conferences for a total of over 1,091 hours. When the compared with a standard work year of 2,080 hours, it becomes apparent that the TEL8 network is very heavily used. TEL 8 videoconferences fall into either long broadcast sessions (over five hours each) and shorter (one to two hour) sessions. The majority of hours are used for the shorter sessions, implying that almost 90 percent of system use is for meetings and short workshops.

TEL8 estimates their costs <u>per site</u> to be:

- $15,000–$22,000 network operations and administration, including a program director.
- $43,000–$53,000 capital investment, including telecommunications bridge costs.

With about 1,091 session hours on the system, operating costs are about $200 per hour.

To help identify potential areas for regional cooperation in distance sharing and learning, participating state DOT and university representatives were asked to identify current activities, capabilities, and directions in distance learning and sharing. Information gleaned from the responses to this inquiry is reported below and organized by state. The survey used to gather this information may be found in Appendix 1 of this report.

Iowa

Of the four states in Region VII, Iowa has made the largest state government investment in telecommunications and information infrastructure that can support distance learning and collaboration.

Iowa Communications Network

The Iowa Communications Network (ICN) is a state-owned and managed fiber optics network that can be used by authorized users to transmit voice, fax, data, and video communications. Construction of the ICN began in 1991 and it has been expanded each year since. There are currently over 550 videoconferencing sites connected to the network and over 825 sites are being forecast by the end of state fiscal year 2000, according to the ICN's WWW site (http://www.icn.state.ia.us). The basic design of the ICN has DS3 lines on the backbone and into at least one point of presence in each county and T1 lines to most individual sites.

Although the ICN was developed to support distance learning via full-motion video, compressed video systems can be interconnected via equipment at the ICN's central hub at the STARC Armory in Johnston. For instance, the Iowa DOT has developed a seven site PictureTel-based compressed video network which uses the ICN for transport. These sites usually operate on their own, but can be connected to other ICN sites to make a larger network.

The ICN has grown so rapidly in terms of use for videoconferencing that a major upgrade of the system is needed to meet forecast year 2000 traffic. A plan is in place to upgrade the network to an ATM backbone incorporating the MPEG II video transmission standard. In addition, some network redundancy would be added to increase network reliability. This would be accomplished mainly by moving from a star to a multiple loop network topology. The changeover to MPEG-2 would allow the ICN to interoperate with private videoconferencing networks (AT&T, MCI, and Sprint) that are also adopting the same protocol for video. Network scheduling (now centralized) will also be decentralized to users' desktops as a result of the upgrade. Funding for these upgrades is now being sought.

Iowa DOT

The Iowa DOT has established the largest internal videoconferencing network in FHWA Region VII. Iowa DOT's network has eight sites, including one in the Transportation Commission Room in the DOT's Ames headquarters, one at the Des Moines headquarters of the Motor Vehicle Division, and six at the DOT's Transportation Centers located throughout the state. More sites are under consideration. The Iowa DOT network is a compressed video network and uses T-1 lines purchased from private telecommunications providers to link to the Iowa Communications Network's backbone.

From January 1 through October 30, 1998, the Iowa DOT compressed video network hosted some 113 different videoconferences for 216 hours of air time. The average conference lasts a little under two hours and connects about four of the eight sites. The Commission Room site was initially involved in almost all of the conferences; however a growing number of conferences involve only "field" sites, for example adjacent Transportation Centers meeting about large projects that cross their boundaries. Several of the Centers are aggressively using videoconferencing to substitute for "live" meetings. There is considerable additional capacity available in the network; perhaps 15 to 20 percent of the possible sessions are being held now. However, video sessions are now being scheduled as much as six months in advance.

The Iowa DOT's network has hosted a wide-ranging variety of meetings and workshops, including:

- Remote presentations by cities and other delegations to the Transportation Commission.
- Highway project right-of-way, design, and construction meetings.
- Information technology (IT) team meetings and IT steering committee meetings.
- Bidders' conferences.
- Meetings with consultants regarding plans, studies, and research.
- University transportation seminars and other training, sometimes downlinked via satellite.
- Total quality management (TQM) meetings and leadership training.
- Meetings regarding personnel sharing among Transportation Centers.
- Geographic information systems (GIS) coordination meetings.
- Meetings about regional or metropolitan transportation plans.
- Job interviews with candidates located in other states.

Not surprisingly, the two Iowa DOT Divisions with the largest numbers of field staff (Maintenance and Project Development) embraced videoconferencing first, but all the DOT's divisions are users of the system.

Although it is also possible for the compressed Iowa DOT network to bridge to the full-motion Iowa Communications Network with its hundreds of sites around Iowa, in practice this is only done for about 15 percent of all the sessions. These have usually involved the Iowa DOT linking several sites to educational programs arranged by Iowa State University. The Iowa DOT is increasingly linking with private videoconferencing network and room providers, for instance AT&T, MCI, Sprint, and Kinkos, to extend their reach outside of Iowa. An example use of this sort of arrangement has been job interviews with candidates located outside of Iowa. In this way, travel expenses can be avoided.

For state fiscal year 1997, the Iowa DOT estimated that its use of videoconferencing resulted in cost savings of $14,000 and productivity gains of over $4,000 for its own staff that avoided travel. A much higher level of savings was realized by Iowa DOT customers and vendors (e.g. local governments and consultants) who participated in videoconferencing events held by the DOT. Figures for fiscal year 1998 should be substantially higher in that the use of the network has steadily increased. Interaction among the regional Transportation Centers has also increased as a result of the availability of videoconferencing as a substitute for travel and "live" meetings. The Iowa DOT has consistently estimated its incremental operating costs to be 9 cents per minute per site. For a typical four-site, two-hour meeting this translates to under $50. This is a level of cost that is rather easy to justify given offsetting staff time and travel savings.

The Iowa DOT is making more use of the Internet over time. An information processing steering committee sets the policy direction for the agency. The Iowa Communications Network also serves as the main Internet service provider (ISP) for state agencies, universities, and other authorized ICN users in Iowa, including the Iowa DOT. The Iowa DOT has two classes of e-mail users at present. Only those e-mail accounts with Iowa Hub connections (a service provided by the ICN which translates e-mail and attachments) are able to send and receive e-mail with attachments. Many others can send and receive e-mail (text-only) via the Iowa DOT's IBM Office Vision system. Some procurement and contracting activities now occur via the Internet.

Iowa State University

Iowa State University has been ranked as one of the top 10 most "wired" public universities in the United States and has extensive distributed computing network facilities. Considerable activity is underway at ISU to provide courses, seminars, and workshops via the Internet. ISU has access to both the ICN (at over 10 sites around campus) and compressed room videoconferencing (currently one site) and transmits a transportation seminar course via video conferencing to two other Iowa universities and the Iowa DOT, once per week during the spring semester. ISU offers a number of training courses that utilize the Internet for such activities as distributing course materials, facilitating working groups, and submitting coursework. The university has licensed two server packages to facilitate on-line class development—TopClass and WebCT.

Center for Transportation Research and Education

ISU's Center for Transportation Research and Education (CTRE) is using videoconferencing, satellite uplink/downlink, the World Wide Web, and mailed videotapes and CD-I disks to deliver courses and seminars to spatially distributed audiences. CTRE is in the process of relocating to a new facility that will include enhanced networking, videoconferencing, and satellite uplink/downlink capabilities.

Kansas

The state of Kansas has a Regents' network for videoconferencing with several sites and satellite uplink-downlink capabilities. It has been used to present the National Highway Institute's (NHI) bridge design course at five sites simultaneously.

Videoconferencing network

Kansas also has an ISDN- and personal computing-based desktop videoconferencing network that offers highly compressed video at 18 sites; a maximum of nine sites can be used at a time due to bandwidth restrictions. Kansas State University (KSU) has taught 1- to 2-day short courses over this network, but the system quality is limited by slow graphics transfer speeds. Kansas State's Computer Science Department uses PC-based desktop videoconferencing extensively to deliver courses. There are compatible sites at Pittsburgh State University and Wichita State University.

Kansas State University

KSU makes extensive use of mailed videotaped courses at present. It is possible to get a master's degree from KSU now entirely by videotape. KSU has already shared some transportation courses with the University of Nebraska-Lincoln; it is possible for students to gain credit at their own university even though the instructor is from the other university.

Kansas DOT

The Kansas DOT (KDOT) still holds most of its meetings face-to-face and by audioconference, but has used satellite down-links to access Transportation Research Board and NHI events. KDOT staff feels that distance learning and sharing is not convenient enough or of a high enough quality to supplant face-to-face meetings and courses yet. It makes extensive use of videotapes for training, but sees videoconferencing as a less likely option.

KDOT is using the Internet (via Novell Groupwise) extensively for text-based e-mail communications in 39 different locations around the state. It is very well integrated with the FHWA system. Communication of attachments has been a troublesome issue. There is some use of Internet Listserv, and electronic bidding on highway projects will likely develop using the Information Network of Kansas (INK) as a vehicle. KDOT has established a three-level

information technology committee to oversee development and there is great support from the top of the agency for technology applications. KDOT has established an Intranet committee and a PC-based desktop video pilot project.

Missouri

Interest in videoconferencing is high in Missouri. In 1995, the Missouri Office of Administration (MOA) established a three-site videoconferencing network—the Missouri Video Network—for state government agencies. Several state and private universities in Missouri developed their own sites at about the same time. In 1996, these sites were all connected together through a project begun by MOA, creating a 12-site, statewide network. The standard technology for these rooms is a VTEL Corporation videoconferencing system. These are room-sized systems providing at least 15 frames per second video (high quality compressed video) with T1 or partial T1 connections. Having this large a network with a common standard has proven very beneficial. Other sites can by connected to the network via ISDN lines, although this provides a lower quality video (less than 15 frames per second), with noticeable compression. An example of the use of videoconferencing has been quality assurance training for the Superpave program.

MORENet

MORENet is Missouri's public internetworking system. It relies on 56 Kbps, 384 Kbps, and T1 lines leased from various telecommunications carriers and serves public schools, public libraries, community information networks, and state government agencies, including the Missouri DOT.

Universities

The University of Missouri-Columbia (UMC), University of Missouri-Rolla (UMR) and Missouri DOT have developed an important institutional arrangement called MOTRC which covers a number of areas, including research, extension, and continuing education. Further, the University of Missouri at Kansas City (UMKC) and UMC have developed a continuing engineering education program to deliver curriculum into the large Kansas City metropolitan market. The University of Missouri at Kansas City has a room compressed video site. Plans are to add a distance learning component to broaden course offerings.

The capability exists for the universities in Missouri to use the state's videoconferencing network, although the current capacity and number of sites are limited. Some experimentation has occurred with ISDN-based videoconferencing (including electronic "smart whiteboards") and Internet-based courses. UMC now has four ISDN-based classrooms, including two new PictureTel sites. In spring 1998, this system was used for only one class, but in fall 1998 it will be used to carry 12 classes. The system can connect up to 20 sites. The cost of the desktop services has generally run about $30 per hour per site, mainly connection fees for telecommunications. Satellite uplink and downlink courses and seminars are becoming common in Missouri.

UMC

UMC has licensed First Class Software to provide courses over the WWW. This allows students and instructors to incorporate and use such features as e-mail, chat, and electronic submission of work in courses. Some civil engineering courses are being offered over the Internet now. As in the other four states, the proximity of the UMC, MDOT, and FHWA offices promotes face-to-face meetings. E-mail is used extensively statewide by all organizations, but attachment and downloading problems are fairly commonplace.

Nebraska

The Nebraska Division of Communications (DOC) has created a 15-site compressed videoconferencing network with sites located around the state. They can be connected with eight additional private sites around Nebraska via the Nebraska Video Conferencing Network. Both the state network and the Nebraska private network can also be interconnected to hundreds of video sites throughout Nebraska and the US and overseas via the Sprint Meeting Channel and the AT&T Switched Video Network.

Internet access

The Division of Communications also provides Internet access via its DOC Internet Transport Service. These are available to state agencies. Among the services that can be provided are frame relay, permanent virtual circuits, and dial-up (PPP) connections. The state's Internet gateway/access provider is Aliant Communications, which is based in Lincoln, Nebraska. Aliant connects to national and international Internet backbone providers.

Nebraska Department of Roads

The Nebraska Department of Roads (DOR) appears to be somewhat behind its peers in terms of the use of Internet-based information technologies. It has placed some plans for roadway projects in digital format (CAD) on CompuServe, much as Iowa DOT has done. The University of Nebraska-Lincoln (UNL), the DOR, and the FHWA regional office are all located near each other in Lincoln, which leads to much face-to-face interaction. UNL provides a number of short courses for DOR which are on technical subjects and usually run two to three days long. These could be provided to remote locations via videoconferencing.

Other Regional Information

Network managers for electronic government

Iowa, Kansas, and Nebraska are all using a similar non-profit network manager concept to quickly develop interactive government services on-line. Iowa Interactive, Information Network of Kansas (INK), and Nebraska On-Line are separate non-profit companies but are all affiliated with each other and have some common ownership. Iowa is the latest state to adopt this approach, and Iowa Interactive, Inc. has started up operations in Des Moines as part of the IowAccess project. The network managers in the three states could potentially be partners in developing distance learning and sharing applications for transportation organizations in the four states, for example serving as hosts for various Internet-based applications. Missouri's WWW development is being done in-house by state agencies.

Government Technology digital states rankings

Region VII states are leaders when it comes to adopting new digital technologies. All four states in the region had above-average ranks in the latest edition (September 1998) of *Government Technology* magazine's "Digital States" rankings. Iowa and Nebraska ranked just above average while Missouri and Kansas rank well above average. Missouri was the third-ranked state in the entire nation, behind only Washington State and Wisconsin. All four Region VII states ranked in the top 10 in the "digital democracy" category, which involves using the Internet to make government processes more open to citizens. Missouri was one of the top 10 states in terms of business regulation via the Internet and using the Internet for law enforcement and the courts. Kansas and Nebraska were highly ranked in terms of their use of the Internet for higher education.

INFRASTRUCTURE NEEDS ANALYSIS

The regional transport infrastructure required to implement distance learning and sharing is largely in place already in Region VII. All of the universities in the region have high-speed Internet access. The same is true of the Federal Highway Administration offices. All of the state transportation agencies in Region VII with one exception, the Nebraska Department of Roads, also have considerable internetworking capabilities. Videoconferencing is common throughout the region and the number of available sites is growing. This means that the main need in the region is some sort of "host" that performs distance learning and sharing coordination and which may develop some content and programming.

Some connecting infrastructure may need to be developed to support distance learning and sharing in Region VII. If so, it would tend to be infrastructure needed for "last mile" connections to wire local sites, for instance at individual universities or state DOT's. For instance, additional videoconferencing sites may be needed locally, additional personal computers may need to be added, and some local area networks (LANs) may need to be internetworked.

Interoperability Issues

State agencies and universities in the four states can easily communicate among themselves in terms of data interchange, WWW access, electronic mail, on-line discussion groups, and low-quality desktop video provided standard internetworking protocols (TCP/IP) are used. There are problems now with e-mailing file attachments, especially among agencies using older technologies or proprietary systems. This problem can be addressed through the adoption of newer, more open systems for e-mail.

Higher quality videoconferencing arrangements involving systems in multiple states are more complex. However, most of the states have settled on videoconferencing systems that could be interoperated at a standard that provides high-quality compressed video. There are essentially three levels of quality of videoconferencing being used in Region VII at present. (Bezar, 1995, provides much more detail on the types of videoconferencing available). Each one of these is discussed below.

- *Broadcast-quality video.* The Iowa Communications Network (ICN) is by far the most extensive of the videoconferencing networks in the four states, with some 557 classrooms as of April 1998. Unlike other systems in the region, the ICN uses a 45 MB backbone network and a full T-1 line (1544 Kbps) for each video circuit plus another for audio and control. This allows for true full-motion video (at more than 30 frames per second, which is the standard for broadcast television) all of the time as well as the ability to broadcast still images in great detail, for example magnifications of pictures or maps. The video displays are generally large television monitors; a small number of rooms also have very large projection screens.

- *Room or group videoconferencing.* Most agencies in the four-state region use more conventional compressed videoconferencing. For example, the Iowa DOT's PictureTel system, which links its central office and several remote sites, uses three primary rate ISDN (PRI) lines to transmit at a rate of 384 Kbps. This provides at least 15 frames per second and the illusion of full-motion video most of the time, although sometimes extremely rapid movements can show up noticeably as video artifacts. This sort of system is the prevailing standard in much of the nation and the world and is very common in private videoconferencing networks. The video displays are large television monitors or on wall screens via video projectors.

- *Desktop videoconferencing.* The other type of videoconferencing system in use in the region is the Federal Telephone System 2000 (FTS 2000) system, which is available for use by the Federal Highway Administration offices. This system operates over one ISDN BRI circuit (128 kbps) and transmits at a rate below 15 frames per second. This is noticeably less than full-motion video, but is acceptable for conferencing in which there is little movement, such as meetings (with mainly "talking heads"). The video displays are often large computer monitors, which makes these systems most appropriate for individuals or small groups sitting around relatively small conference tables.

All three of these systems are interoperable to some extent since they all embrace the ITU H.320 family of standards for videoconferencing. It is generally not a problem to hold a videoconferencing session mixing the 384 Kbps room video systems and the 128 Kbps desktop systems, although the quality would drop to the lowest common denominator. In practice, however, it is more difficult to interoperate the broadcast-quality ICN system with the room and desktop systems. A typical problem when this is attempted is a loss of the audio signal. However, this type of session can be accomplished through the use of one of two video bridges at the Iowa Communications Network's network hub in Johnston, Iowa. The ICN is making some improvements that will make the system more interoperable with compressed video networks. Iowa's proposed upgrade of the ICN to the MPEG II standard and to an asynchronous transfer mode (ATM) network should make multi-state videoconferencing involving the ICN more common. Agencies that need to videoconference extensively outside Iowa or internationally, such as the Iowa Department of Economic Development, now build systems that accommodate both the ICN and room compressed video. The up-front incremental cost of having both systems is relatively small—less than $5,000 for a room—in that much of the camera and monitor equipment can be used by both systems. Additional costs will be incurred on an ongoing basis.

This said, the most logical approach to developing a videoconferencing system across the four-state region is to adopt the 384 Kbps compressed video room videoconferencing approach as a desirable standard. The 384 Kbps standard is already being used in a variety of places in all four states and is the de-facto standard in both the public and private sectors. The exceptions to this trend in Region VII are essentially the Iowa Communications Network (which operates at a much higher quality standard) and the Federal Highway Administration (which operates at a lower standard through FTS 2000). The interoperability problem should be minimal in that both the Iowa DOT and Iowa State University (on campus and through CTRE) already can or will in the future be able to conduct and join compressed video conferences. (However, at times difficulties have been encountered in maintaining the audio portion of interoperated conferences).

BARRIERS AND GAPS ANALYSIS

A number of issues affecting the feasibility and usefulness of distance sharing efforts were identified by the advisory committee. These include:

- Varying needs for distance sharing. The need for distance sharing/learning application may vary widely among states and organizations. These variations could make gaining consensus and commitment on collaborative development and use of distance sharing more difficult.
- Competition among universities, organizations, and individuals. Providing distance sharing/learning activities to individuals, DOTs and other organizations represents revenue

opportunities for universities and researchers. Competition for these opportunities could hamper cooperation on distance sharing/learning within the region.

- Difficulty obtaining administrative and legislative support. A lack of knowledge and understanding of distance learning/sharing technologies and paradigms could make obtaining strategic and financial support from administration and legislators difficult. Universities and state DOTs will need to educate their administrators and public officials on the technologies, applications, costs, and benefits of distance learning/sharing activities. At some (but certainly not all) universities, the continuing education organizations may view expanded outreach programs by academic departments as an intrusion on their turf.
- Need for some face-to-face networking. The need to develop professional contacts limits the use of distance sharing. Attendance at professional conferences and meetings enables networking while distance sharing tends to reduce personal interaction.
- Loss of communications effectiveness. According to communications researchers, only about 45 percent of the value of communication comes from listening and audio. About seven percent comes from words and 38 percent from the way the voice is used. The other 55 percent of communications comes from things like gesture, posture, facial expression and body language. (Mehrabian, 1972) Visual clues are lost when communications media like audioconferencing are used. Videoconferencing helps restore some lost audio clues, but is in some ways an inferior mode compared with face-to face communications. There are real questions about whether the same level of quality of education can ever be offered electronically. For this reason, distance learning and sharing will tend to augment rather than replace face-to-face meetings, classes, or conferences.
- Issues of curriculum control and quality assurance, faculty control of curriculum, tuition rates, and credits in the case of distance learning.
- Issues of copyright, pricing, and ethics that are created when intellectual property is placed in electronic formats, especially on the Internet.
- Lack of communication/cooperation. A basic lack of communication and cooperation among universities and DOTs and within these organizations could stymie efforts to plan and implement distance sharing/learning and lead to duplication of efforts, infrastructure, and activities.
- Budget constraints. Although distance sharing/learning may be more cost effective for some activities or enable needed activities that have gone unfulfilled, financing the infrastructure and support for these activities may be difficult. Cost tends to be a very important consideration and barrier. Up-front costs (for example installing videoconferencing rooms or telecommunications lines) can run into the tens of thousands of dollars. Likewise, continuing costs for telecommunications services and satellite time can also be steep. Such costs appear to vary considerably from location to location in Region VII, apparently due to the existence of subsidies for distance education in some states.
- Lack of adequate local facilities and infrastructure. States/organizations may lack adequate local facilities to conduct distance learning/sharing activities. For example, videoconferencing facilities may not be conveniently available to the DOT in a state, thus limiting the applications of distance learning/sharing for that organization.
- Inadequate data transmission bandwidth. Some facilities may be limited in their ability to support certain bandwidth-intensive activities such as large file transfers, e-mail attachments, and especially videoconferencing. Organizations with only low-bandwidth connections to the Internet, for example analog (T-0) or even single ISDN line connections, may be unable to participate effectively in all aspects of a distance learning and sharing network.

- Issues related to distribution of revenues and costs of distance learning/sharing activities among cooperating organizations.
- Issues related to responsibility and costs for the operation and maintenance of any required infrastructure or services.
- Close physical proximity of FHWA state offices and the four state DOTs in Ames, Jefferson City, Lincoln, and Topeka minimizes the need for distance sharing between them. This fact is being made even more important with the movement of FHWA away from reliance of its regional offices (such as Region VII's in Kansas City) and toward its division offices, which are located in the four states.

It should be noted that very few of these barriers are really technological. Most are institutional and have to do with policies and procedures, budget priorities, and traditional ways of doing business.

The one organization-specific barrier identified in the course of this study pertains to the Nebraska Department of Roads (NDOR). Unlike the majority of its agency peers nationwide, NDOR has in the past made little use of the Internet for communications and provision of information and services to its customers. As an example, NDOR was one of only four state transportation agencies in the nation that did not have a presence on the World Wide Web during 1998. (The other three states without web sites were Mississippi, New Hampshire, and New Mexico). However, NDOR has recently made a large commitment to use the Internet more extensively and has hired a webmaster to develop on-line content.

FUTURE TRENDS THAT WILL HELP BRIDGE GAPS

All planning in the field of information technology must keep in mind the rapid changes that are presently occurring in technologies and how they are used. The three most powerful trends are closely interrelated and will lead to a situation in which distance learning and sharing are not only commonplace, but the norm. These trends are:

The Analog to Digital Transition

A great transition is underway in the world from analog (waveform-based) communications modes to digital (bit-based) modes. Some of these transitions in technology are shown in the table below. What this migration from analog to digital implies is a world in which many modes of communication converge. This in effect means that all the lines between media will become blurred and moving information from one medium to another will become relatively seamless. Analog media will all be supplanted by digital media over time.

TABLE 2 Analog to Digital Transition

From:		To:
Analog television sets	→	High-definition television (HDTV)
Analog cable television (CATV)	→	Digital cable television
VHS video cassette recorder (VCR)	→	Digital video disk player or drive (DVD)
Analog data modem	→	Digital "modems" (ISDN, ADSL, cable modems)
Analog cellular telephone	→	Personal communications services (PCS)
Audio cassette	→	CD-ROM

Moore's Law

Developed by Gordon Moore, one of the founders of the Intel Corporation, Moore's Law expresses the fact that computing power is advancing so rapidly that the capabilities of personal computers basically double every 18 months. The standard personal computer configuration from 1996 (perhaps an Intel Pentium chip with a 166 megahertz clock speed and a 2.5 gigabit hard disk drive) has been replaced in only two years by one that is three times faster, has more than twice the storage, and costs hundreds of dollars less. Experts in the computing field forecast that Moore's law will continue in effect for at least one more decade, which means that computing capabilities will double about 6 or 7 more times during that period. At that point, totally new technologies for computing may be entering the marketplace.

Costs for videoconferencing are also continually dropping as is the price/performance ratio. Costs for high bandwidth lines are falling, at least for large customers. For example, monthly costs for an AT&T T-1 access line can be as low as $250–$300 in a highly competitive market, although a figure of $500–$700 would be common across the country. Costs for videoconferencing equipment—at least on a price/performance basis—are also falling. (*Network World*, November 16, 1998)

Wired World

Although digital convergence and Moore's Law are powerful forces, it can be argued that the most powerful trend in information technology over the past few years has been the rise of internetworking—networking computers together and then networking the networks together. This trend is culminating in a figurative explosion of telecommunications bandwidth that will tend to drive down costs even as availability and quality increases. As was noted in the recent US Department of Commerce report, "The Emerging Digital Economy," a host of companies are competing furiously to add more telecommunications bandwidth worldwide. These companies include:

- *Telecommunications Providers.* Manufacturers and software companies have been developing new technologies to allow higher-bandwidth communications across the existing copper network infrastructure, including DSL technologies, compression, packet switching, and faster electronic switches. Communications carriers around the world are building fiber optic networks; technological advancements include optical amplification and new photonic switches to make these high-speed networks more powerful and more efficient.

- *Satellite Constellations.* Satellite, telecommunications, electronics and aerospace companies plan to spend close to $27 billion to build a global broadband network in the sky between 1998-2002 and reach most of the two billion people that live in areas around the world where phone service is unavailable or unreliable. Examples include Iridium and Teledesic; these

networks will be household names within five years. Some of these satellite networks will be data- and Internet-oriented while others will be voice call-oriented.

- *Cable Providers.* Coaxial cables already pass more than 90 percent of U.S. households, piping in TV programming at speeds much faster than telephone copper carries voice traffic. Four years ago, many cable companies began to prepare the cable network for two-way Internet traffic, investing in fiber optic cable and set-top boxes to decipher voice, video and data sent in digital form. These services will become common in the next four years.

- *Wireless Communications Providers.* Over time, wireless networks will be integrated with the Internet. Investments in satellites and repeater stations are now being made at a rapid rate to accomplish this. Cellular phones, pagers and hand-held computers will be able to transmit and receive voice, data and Internet traffic, particularly as digital cellular systems (such as personal communications systems or PCS) gradually replace older, analog cellular networks.

- *Electric Utilities.* A number of utility companies around the country are beginning to lay thousands of miles of new fiber cable for Internet access at speeds 10 times faster than today's high-speed phone connections. The original purpose of this was to read meters and control peak electric loads, however these networks will also be able to provide voice, data, and cable television services. (An example in Iowa is the Cedar Falls Municipal Utilities.) Some experimentation is also taking place in Europe and the US with providing telecommunications directly over electric transmission lines and into homes and businesses.

Essentially what is happening is that the futures of telecommunications and computing are becoming intertwined. Further, the future of telecommunications is increasingly becoming the Internet and IP. By the year 2002, packet switching (the system upon which the Internet is built) will supplant the traditional mode upon which telecommunications has been based—circuit switching. Packet switches are now more efficient than circuit switches and the gap is quickly widening. (*USA Today*, October 8, 1998)

The upshot of these trends is a world where digital media converge, high-speed computing is inexpensive, and virtually all organizations are networked and can communicate cheaply in a variety of ways (voice, data, e-mail, WWW, fax, video, etc.). Forrester Research, a technology forecasting firm, estimates that perhaps one-quarter of Americans will have broadband access to the Internet by 2002; Forrester sees cable television companies dominating the home broadband market and telecommunications companies dominating the business market.

Some experts see the cost of long-distance telecommunications falling to match the cost of local telecommunications, essentially wiping out any effects of distance. In this environment, those individuals and organizations that are not internetworked during the next three to five years risk being left out. It is also a world in which telecommunications bandwidth will become increasingly inexpensive, shrinking the effect of distance. (The Economist, October 6, 1995)

STRATEGIC PLAN

Goals for distance education and distance sharing were identified by the Advisory Committee. These tended to fall into three main priority areas where the committee members felt technology could have the largest beneficial impact. These are:

Administrative Videoconferencing
A number of face-to-face meetings take place in the region (both within individual states and across borders) where distance technologies could be subsitituted. The goals of distance sharing in this topic area might be to:

- Save travel time and expense by decision makers, staff, faculty, and customers.
- Allow interactions and idea sharing that might otherwise not occur.

Transportation Research
Considerable effort in Region VII goes into applied and highly applied transportation research, which is conducted in-house at the four DOTs, at universities, and by private consultants. The goals of distance sharing in this area might be to:

- Reduce duplication of effort in transportation research. This assumes that a pro-active effort could and would take place to consolidate and coordinate efforts and projects.
- Make research results more accessible to both researchers and consumers of research.
- Leverage research dollars.
- Provide for one-stop shopping for research results, works in progress, and expertise.
- Develop a stronger research community by increasing interaction.
- Identify strategic gaps in research that could be filled.
- Generate new lines of research inquiry.
- Share expenses to collect data and procure tools where possible and appropriate.

Transportation Education and Training
Considerable resources are also expended educating and training transportation professionals and technicians in Region VII. Distance learning could help to:

- Reduce duplication of effort in transportation education and training.
- Make education and training more accessible, especially to persons who cannot travel or have constraints on their ability to access training and education on-campus.
- Leverage training and education dollars.
- Provide for one-stop shopping for education and training.
- Develop a stronger education and training community.
- Identify strategic gaps in training and education that should be filled.
- Better generate and deliver new courses and workshops needed by agencies, companies, and individuals to stay current.

These goals and priorities in turn suggested two main projects plus an ongoing initiative to use videoconferencing more extensively for administrative purposes. These three elements could together make up a distance learning and sharing plan for Region VII transportation organizations. The use of videoconferencing for administrative purposes is in effect a matter of “just doing it.” The infrastructure is already largely in place in the region to carry on effective conferences both within single states and across state lines. All that remains is the need to identify topics of highest value to the transportation organizations in Region VII and to arrange and pay the toll charges for the videoconferences.

POTENTIAL PROJECTS

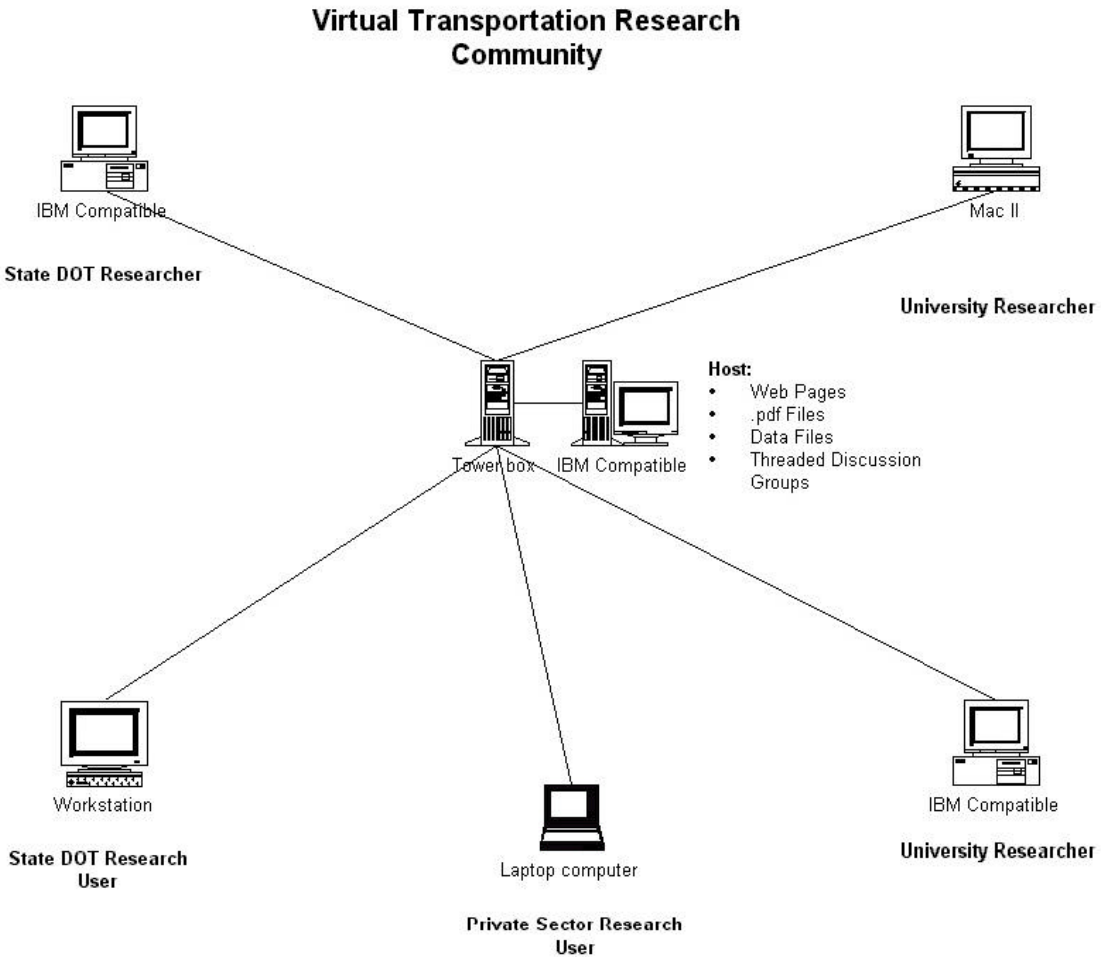
Two other projects could be initiated that would be more far-reaching and also require considerably more planning and expenditure of resources. These projects are a Virtual Transportation Research Community (VTRC) and a Virtual Transportation University (VTU).

Virtual Transportation Research Community (VTRC)

This project would develop an on-line, Internet-based clearinghouse and forums for sharing research results and expertise among the state DOTs, FHWA offices, and universities in the region. This would be similar to the system used in Virginia, but would include four states rather than one. It could also be helpful to regional organizations such as metropolitan planning organizations (MPOs), regional planning commissions, and local governments. The clearinghouse would help reduce duplication of effort by placing information about all research projects being conducted and already conducted on-line and also help generate valuable new lines of inquiry. It is likely that the clearinghouse function of the VTRC would operate as a free service to users.

Requirements:

- A coordinating body to oversee the development of the virtual community;
- A part-time webmaster/systems operator (Sysop) to maintain and develop the web site for the community;
- Communications/Internet access for a WWW server and other Internet servers/sofware;
- A WWW server hardware and software; this could be located outside the firewall at either a state DOT or university;
- An FTP server (allows uploading and downloading of data, documents, and computer programs that are available for public domain use);
- Threaded discussion forum software (allows on-line discussion of research topics and issues);
- Volunteer moderators to manage threaded discussion forums.



Virtual Transportation University (VTU)

This project would consist of a clearinghouse that would allow for sharing of traditional academic and continuing education workshops and courses across state lines. Courses could be aimed at academic, professional, and technical audiences. It would probably be wise to begin with the professional development and continuing education audience and work toward the academic audience, which will raise more difficult institutional issues. The system would be, in effect, a smaller and more specialized version of the Western Governors' University or other "virtual universities."

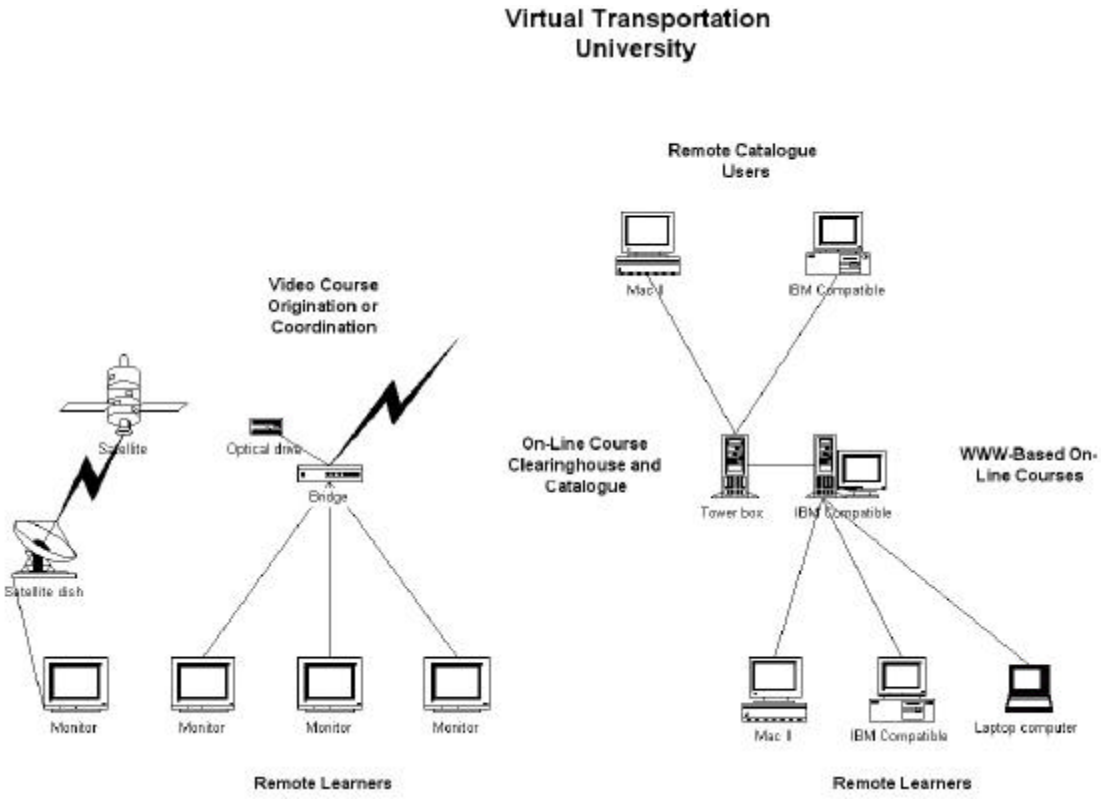
Courses and workshops would be offered via a variety of media, including mailed videotape, mailed CD-ROM, mailed CD-I, mailed DVD, satellite, compressed videoconference, and World Wide Web. The host organization could also arrange or coordinate distance learning courses or act as an originating site for WWW-based courses, satellite courses, and videoconference courses. It is likely that the clearinghouse function of this project would operate as a free service for users; however, as is the case at present, courses and workshops would be charged for as appropriate.

Requirements:

- An oversight board to manage the development of the virtual university, in particular some of the difficult institutional issues that might arise with respect to curriculum, quality assurance, intellectual property, credits, etc.

- A part-time coordinator to develop course-sharing and certification arrangements and develop and maintain a catalogue of available courses
- A part-time Webmaster/Sysop to manage a WWW site for course information (could be split with the requirement for the Virtual Research Community).
- A part-time on-line course developer for "routine" courses and workshops that could be placed on the Internet.
- Communications/Internet access for all participating locations, and high-capacity access for the hub location.
- A WWW site to describe the virtual university and contain course and workshop information.
- WWW course software (that allows entire workshops and courses to be offered on-line).
- An FTP server for uploading and downloading computer files associated with courses and workshops.
- Threaded discussion groups for student/instructor discussions associated with courses and workshops.
- 384 Kbps compressed room videoconferencing capabilities (provided the system runs on the H.320 standard).
- Satellite uplink/downlink capabilities at the virtual university "hub" and downlink at all participating locations.

Some equipment and personnel assets of the Virtual Transportation University could be shared by the Virtual Transportation Research Community if the same organization were the host. This would help reduce costs and help create synergies.



REQUIREMENTS FOR THE HOST ORGANIZATION

A host organization will be needed for both the VTRC and the VTU. Since many of the same requirements exist for both there would be synergies possible if the same host were used for both. The main requirements for a host would be as follows.

- Ability to host staff needed to operate a distance learning and sharing program.
- A high-speed and high capacity WWW server.
- E-mail, Listserv, and threaded discussion group server and software capabilities.
- High speed communications access for Internet servers.
- Licenses for WWW-based course development software.
- A high-capacity FTP server.
- High speed (three ISDN PRI circuits or better) communications access for videoconferencing.
- A compressed videoconferencing room and full complement of equipment for origination and receipt.
- Access to a videoconferencing bridge.
- Satellite uplink and downlink capabilities.
- Facilities and equipment needed to duplicate electronic media, for instance videotapes, CD-ROM disks, and DVD disks.
- The ability to catalogue, manage, and distribute materials in various electronic media. This might include the ability to use Internet-based programs such as “spiders” to identify and catalogue regional transportation resources.

Hosting the VTRC and VTU would require the ability to hire and retain specialized technical staff. It would be possible to contract the functions out to a private contractor. However, it is likely that several organizations in Region VII either have these capabilities now or will have them in the near future. This would include most of the universities and some of the state DOTs. The preferred way to determine a host organization would be to use a request for proposal (RFP) process.

Preliminary Cost Estimate

Typical cost categories for distance learning and sharing include personnel costs, facility costs, capital equipment costs, circuit and other maintenance charges, and dial-up session costs or toll charges. According to the University of Missouri-Columbia, capital costs for a high-quality ISDN-based PictureTel videoconferencing classroom dual monitor setup are about $20,000 per room, including a $7,000 “smart whiteboard” and a $6,000 video projector so the video can be viewed on a large screen in front of a class rather than on a small monitor or computer screen.

According to Iowa State University, equipment, installation, and hookup costs for a totally new room quality compressed videoconferencing would total $51,000 to $61,000. In addition, monthly costs would include three ISDN PRI lines at about $200/month each, toll charges, and bridge costs for connecting multiple sites in a conference.

By contrast, installing a full-motion videoconferencing facility such as one on the Iowa Communications Network could exceed $100,000, including all finishing, equipment, and hookup costs. Once installed, this approach would tend to have lower ongoing costs.

Estimated start-up and first year operating costs at the host organization for the Virtual Transportation Research Community and the Virtual Transportation University would be at least

$200,000; the Virtual University would be by far the more expensive of the two due to the need for more staff and videoconferencing hardware and services. See the table below for the cost estimate.

TABLE 3 Estimated Start-Up Costs

	Virtual Transportation Research Community	Virtual Transportation University	Notes
Personnel			
Webmaster/systems operator (1 FTE split between the two projects)	$22,500	$22,500	Source: Ziff-Davis publishing WWW site
Web course developer/educator (1/2 FTE)	$0	$22,500	Source: Ziff-Davis publishing
Fringe benefits for both positions	$6,750	$13,500	30% of salaries
Shared	$5,000		Compaq Proliant 2500
Shared	$1,200		Compaq
$3,000	$3,000		Hewlett-Packard 8532 NT
Server operating system	$725	Shared	Microsoft Windows NT Server
NT workstation operating system	$300	Shared	Microsoft NT Workstation 4.0
Web/FTP server software	$2,500	Shared	Microsoft Back Office
Threaded discussion software	$0	Shared	Freeware CGI or HTML script
On-line course software	$0	$0	Assumes the use of university licensed software
Miscellaneous software (office and WWW creation)	$1,200	Shared	Microsoft Office software suite, Front Page, etc.
Telecommunications			
Annual Internetworking cost	$7,200	Shared	T-1 @ $600/mo.
Annual video communications cost	Shared	$7,200	T-1 @ $600/mo.

TABLE 2 Estimated Start-Up Costs, continued

	Virtual Transportation Research Community	Virtual Transportation University	Notes
Other hardware			
Videoconferencing hardware	$0	$61,500	Room compressed system
Satellite uplink hardware	$0	$0	Assumes use of existing facility
PC to video scan converter		$2,000	
Other costs			
Telephone, postage, etc.	$2,000	$5,000	
TOTALS	$52,375	$144,400	

Additional costs would be incurred depending on particular services used such as satellite uplink/downlink time, video bridge time, and videoconferencing toll charges. These costs would be significant, but could potentially be charged back to participating agencies or students. There may also be annual maintenance agreements, but these depend on which equipment vendors and telecommunications carriers are used.

TACTICAL PLAN

Open Standards

It is extremely important that any systems implemented for distance learning and sharing in Region VII be open and standards-based. That is, any systems should not be based on any proprietary technologies or software that would tend to limit the size of the distance learning and sharing network. The idea is to build a large matrix of users who can quickly and easily communicate and share information in a large variety of configurations.

- Internetworking—the current protocol for internetworking is called IP (Internet protocol). This valuable networking protocol is now in use in literally hundreds of nations and millions of computers worldwide. Content on and use of the Internet's World Wide Web continues to expand at a rate of something like 20 percent every month, or doubling about every 100 days.
- Video conferencing—it is very likely the H.320 videoconferencing protocol will continue to be the prevailing standard for the sort of videoconferencing envisioned in this plan. H.323 is an International Telecommunications Union (ITU) proposed standard that supports real-time video, audio, and data transmissions over IP-based data networks, whether local or wide-area. H.323 is in some ways an extension of the earlier H.320 standard for ISDN-based videoconferencing, however it is potentially much more powerful for developing networks as could be developed throughout Region VII in that any IP port could also become a video or audioconferencing port. This could bring videoconferencing to many desktops over personal computers or digital cable television and might be appropriate for some applications such as small meetings or instruction. The H.323 marketplace is currently experiencing the same sort of explosive growth as the internetworking marketplace.

- Connectivity—the variety of connectivity options is large and growing for both Internet and videoconferencing. However, some of these connectivity options are simply too slow and "narrow" to support high quality distance learning and sharing applications. ISDN connections are the bare minimum for effective videoconferencing and connections based on three ISDN PRI lines are preferred. For Internet-based applications (at least at the client end) a T-0 line with a 56Kbps modem could suffice for some individual use, but a larger bandwidth connection (for instance ISDN BRI, ASDL, or a cable modem) would be preferred. Some examples of digital signal classifications, connection types, and their bandwidths are shown below.

TABLE 4 Examples of Connectivity

Level	Mbps	Equivalent Voice Channels	Typical Application
T-0/DS0	0.064	1	Voice line/data modem/fax
ISDN/BRI	0.14	2	Dedicated data line
ASDL (low)	0.256	5	Dedicated data line
ASDL (med)	0.768	14	Dedicated data line
ISDN/PRI	1.544	24	Dedicated line/compressed video
T-1/DS1	1.544	24	Dedicated line/compressed video
ASDL (high)	1.544	24	Dedicated data line
T-2/DS2	6.31	113	Wide area network (WAN)
Ethernet	10.00	179	Local area network (LAN)
Cable Modem	10.00	179	Dedicated data line
T-3/DS3	44.736	804	Wide area network (WAN)
Fast Ethernet	100.00	1786	Local area network (LAN)
FDDI	100.00	1786	Wide area network (WAN)
OC3	155.00	2768	Internet Backbone (Regional)
OC12	622.080	11107	Internet Backbone (National)

Source: Network Magazine, October 1998.

FUTURE DIRECTIONS/RECOMMENDATIONS

The Advisory Committee for this project recommends that anything done in Region VII in terms of initiating distance sharing and learning have the following characteristics.

- A small but critical niche. (As the Iowa DOT and others have found, distance interaction tends to start with a small group of users and purposes but later mushrooms.)
- A regional or multi-state benefit.
- Some sense of urgency and a limited time line.
- A clear business rationale.
- A project champion or several champions.

These features would increase the likelihood of success and the ability to expand and replicate the application of distance sharing and learning. Some specific ideas were suggested as "starter applications." These are:

- A Chief Administrative Officer (CAO) videoconference on some topic of importance and urgency to all four of the Region VII state DOTs.
- A videoconference on shared regional training needs and/or one on shared regional research needs.
- A portion of certification training for construction and materials technicians. (Introductory or general training would be the best fit for a distance learning application).
- "Pool fund" meetings for discussion of regionally-important research projects such as those involving crash testing or work zone safety.
- A review of new technologies for technology sharing purposes.
- Aggregating demand for National Highway Institute (NHI) and other courses that would otherwise be under-subscribed.
- Workshops related to highly specialized technical topics such as developing metadata or location referencing systems for geographic information systems (GIS).
- Organization and initial operation of an ITS America regional chapter.
- A class or series of classes on the use of geographic information systems in transportation (GIS-T)

Specific Actions

The Advisory Committee also developed a set of specific actions that could be undertaken to move distance sharing and learning ahead in Region VII. These are:

- Begin using videoconferencing to support MATC activities. (MATC would be responsible for this action.)
- Develop a more refined plan for the Virtual Transportation Research Community and Virtual Transportation University and (if there is sufficient regional support) designate a host and find funding to support development and maintenance. Implement the VTRC first and market it sufficiently. Phase in the VTU over time, beginning with a WWW-based clearinghouse for courses and workshops and culminating in full-fledged sharing of courses at the regional level. (MATC and the four DOTs would work jointly on this through a formal steering committee.)
- Develop detailed standards and performance goals for the VTRC and VTU. (MATC and the four DOTs would lead this through the steering committee.)
- Survey the potential videoconferencing needs of the Region VII DOT CAOs and their key staff to determine potential videoconferencing topics. If a need is identified, initiate such conferences. (The four DOTs would take the lead on this.)
- Have the Region VII transportation academic community meet and discuss formally sharing courses and workshops that would benefit the Region VII transportation community. Develop a handful of pilot videoconferencing workshops and courses in technical areas such as GIS-T that could be offered via distance learning technologies and then be carefully evaluated. (MATC)
- Develop a Region VII training plan for NHI and similar courses where demand could be aggregated via videoconferencing. (DOTs)
- Gather together and document additional Region VII state DOT experiences with videoconferencing in a fashion similar to what is presented in this report for the Iowa DOT and TEL8. (DOTs)

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APPENDIX 1: DRAFT INTERVIEW QUESTIONS FOR MULTI-STATE DISTANCE LEARNING AND COLLABORATION PROJECT

Current Levels of Interaction

- What is the current level of interaction among the universities, DOT, and FHWA in your state? Which interactions might better be accomplished electronically, e.g. through video or via the Internet?

- What is the current level of interaction between transportation organizations in your state and those in the other three states in FHWA Region VII? (Examples: training, project management, maintenance coordination, planning, etc.) Which of these interactions could be handled via video or via the Internet?

Current and Planned Distance Learning and Collaboration Activities

- What are your state's transportation organizations currently doing in terms of distance learning and electronic collaboration within the state?

- What is your state doing now, if anything, with multi-state distance learning and electronic collaboration? What would you most like to do on a multi-state basis?

- Are the universities in your state currently providing or planning to provide telecourses for transportation agency employees? If so, how many will likely pursue coursework? How supportive is the state DOT of this approach?

- Does your state have any such applications and technologies programmed for implementation in the next 1–3 years?

- What are the highest priority applications for the next 1–3 years? What are the highest priority technologies?

- Are there any long-range (5 years or more) plans or goals in place for electronic collaboration and distance learning in your state?

Current and Planned Technology and Infrastructure

- What telecommunications and internetworking infrastructure systems and standards are in place now in your state? For videoconferencing? For internetworking?

- What telecommunications and internetworking infrastructure systems and standards are planned for the next 3–5 years in your state? For videoconferencing? For internetworking?

- Are the systems in place now or being planned "open" (e.g. they will interoperate with other systems meeting appropriate ITU, ISO, or internetworking standards) or proprietary?

Institutional Issues and Problems

- Are you aware of any laws, rules, regulations, or operating procedures that would interfere with development of distance learning or collaboration, especially across state lines?

APPENDIX 2: MOCK-UPS OF WEB PAGES FOR VTRC AND VTU