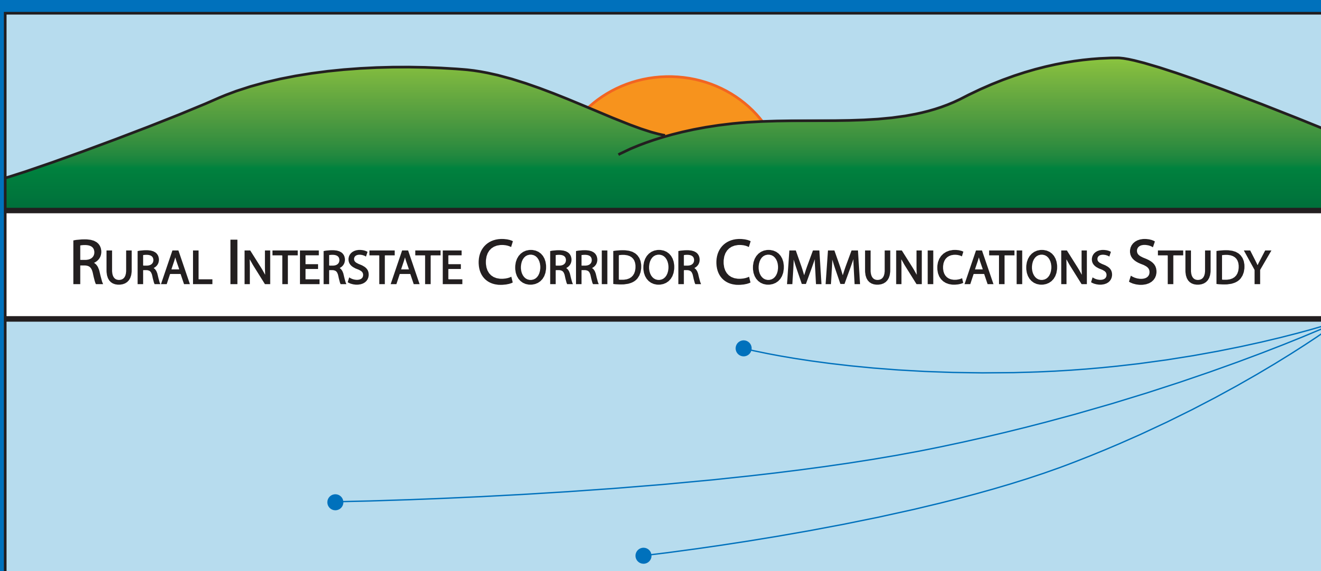
Rural Interstate Corridor Communications Study

Report to Congress



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Abstract

The United States Department of Transportation, working with the U.S. Department of Commerce and with State and local agencies, investigated the prospects for deploying high-speed telecommunications (HST) in three largely rural interstate highway corridors:

- Interstate Route 90 through South Dakota, northern Iowa, southern Minnesota, and central and western Wisconsin;
- Interstate Route 20 through northern Louisiana, Mississippi, and Alabama; and
- Interstate Route 91 through Vermont, New Hampshire, and Massachusetts.

Analysis of the corridors was accomplished using geographic information systems (GIS) technology to organize data on demographic, socioeconomic, and other characteristics. State and local stakeholders were consulted regarding telecommunications initiatives, opportunities, and policies in the corridors. Potential benefits of broadband access were assessed using available information on the impacts of high-speed telecommunications access, along with an assessment of the telecommunications needs of residents and business, educational, health industry, and governmental entities in the corridors.

Some level of high-speed telecommunications infrastructure exists in all of the corridors, but the availability of new wireless and/or fiber optic capacity in the interstate highway rights-of-way could have significant benefits for the transportation agencies responsible for operating and maintaining these rights-of-way. In addition, the presence of HST in these corridors could make broadband access more available to rural communities where broadband is either currently unavailable or prohibitively expensive.

A number of significant barriers exist to expanding HST for underserved rural areas. Regulatory and policy differences often exist between adjacent States, stemming either from statutory limitations on governmental involvement in the provision of services, or policies that limit the ability of transportation agencies to enter into public-private partnerships. Different approaches to the use of agency assets or rights-of-way also present hurdles.

Questions also exist about the level of interest on the part of private sector in ventures that would provide additional HST capacity. The consensus opinion is that sufficient backbone capacity already exists in or near portions of each corridor in the form of fiber optic cable installed in the late 1990s and the first years of this century. In addition, advances in telecommunications technology continue to expand the ability of system operators to carry more volume on existing fiber optic cables. Even if sufficient interest were present regarding the extension of the telecommunication backbone, the problem of constructing facilities to link rural communities to the backbone still exists – the so-called “middle-mile” (infrastructure from the backbone to local distribution points) and “last-mile” (service to end users) challenges.

It is possible, however, that the combined benefits of additional HST capacity to public agencies and local communities, as well as private providers, would be sufficient to justify additional investment in HST capacity – capacity that any individual private provider might not be willing to provide on their own. Therefore, the State Departments of Transportation (DOT) are cooperating with the U.S. Department of Transportation to develop a conceptual design for deployment of fiber optic or wireless systems along the designated rights-of-way. Conceptual design of these potential alignments will contribute to a better understanding of the applicability and transferability of study findings to other transportation corridors.

Executive Summary

SAFETEA-LU

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), the authorizing legislation for the Nation's surface transportation program, included a provision under Section 5507 for a Rural Interstate Corridor Communications Study. Under this section, "The Secretary, in cooperation with the Secretary of Commerce, State departments of transportation, and other appropriate State, regional, and local officials, shall conduct a study on the feasibility of installing fiber optic cabling and wireless communication infrastructure along multistate interstate system route corridors for improved communications services to rural communities along such corridors." The Department of Transportation was directed to identify the "impediments" to installing such an infrastructure and "to connecting such infrastructure to the rural communities along such corridors." The Department was also directed to identify the potential benefits of such an infrastructure for economic development, deployment of intelligent transportation systems technologies and applications, homeland security precaution and response, and education and health systems in rural communities. This feasibility report also provides an analysis of legal and institutional issues, design considerations, and safety and operational issues associated with installation, as well as the degree to which the findings of such a study could be extended and applied to other rural interstate system route corridors in other States.

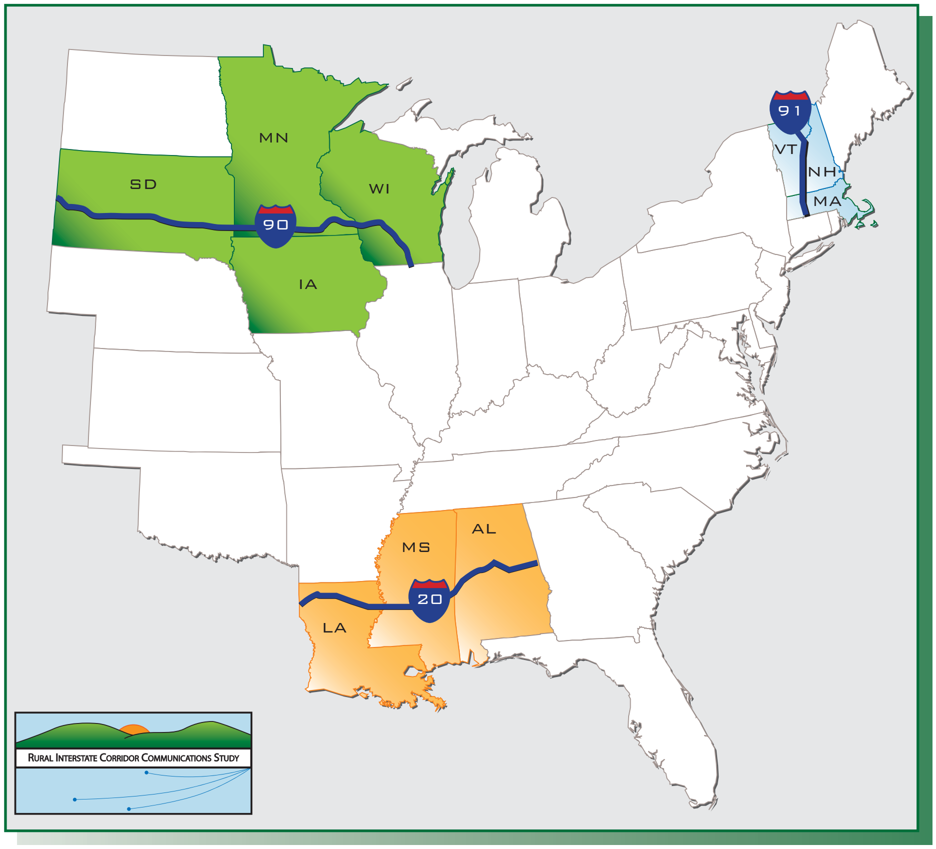
Introduction

The provision of high-speed telecommunications (HST), also known as broadband, can demonstrably improve the economic prospects for businesses and individuals, while also providing a variety of collateral benefits for health care, education, transportation, and public safety. There is extensive literature documenting the potential for improvements in economic development and quality of life that can be derived from increased broadband access, including both projections based on adoption of similar technologies, and econometric studies of actual impacts of broadband deployment.

In 2005, Congress directed the Secretary of Transportation to investigate, in cooperation with the U.S. Department of Commerce, the potential for using interstate highway corridor rights-of-way in mostly rural areas to expand the availability of HST in those areas. The use of interstate highway rights-of-way not only offers a continuous, controlled environment for the construction of telecommunications infrastructure, it also provides a potential benefit to the States that control the rights-of-way to obtain communications capabilities to support existing or planned advanced transportation management technologies in these corridors.

In support of this investigation, the Federal Highway Administration (FHWA), in cooperation with the National Telecommunications and Information Administration (NTIA), is working with State and local agencies to explore the potential for the installation of fiber optic and wireless facilities in three designated corridors passing through or adjacent to 10 States. These corridors are:

- Interstate Route 90 through South Dakota, northern Iowa, southern Minnesota, and central and western Wisconsin;
- Interstate Route 20 through Louisiana, Mississippi, and Alabama; and
- Interstate Route 91 through Vermont, New Hampshire, and Massachusetts.



Study Corridors

This report presents the findings of the investigation and a discussion of the potential benefits and costs associated with the introduction of a high-speed telecommunications backbone facility in each corridor. The report is not a detailed policy, legal, engineering, or cost-benefit analysis. Instead, its intent is to provide a general assessment of the feasibility and desirability of HST deployment along interstate highway corridors, considering factors such as Federal and State policies and regulations, HST needs, demand characteristics, potential public benefits, technology and engineering considerations, and institutional models for deployment.

The fundamental concept under examination is the use of the interstate highway rights-of–way to construct a high-capacity backbone system, which would carry large amounts of data over long distances. At the same time, a sufficient number of access points would be designed into the system both to serve the needs of the transportation agency operating and maintaining the highway rights-of-way, and to potentially provide broadband service to rural communities adjacent to the rights-of-way. While private sector backbone infrastructure exists near many portions of

the study corridors, and some individual States have undertaken HST deployment initiatives, this study is unique in that it examines the potential of multistate coalitions to deploy HST backbone along major transportation corridors, creating additional benefits that might not be realized solely through the initiatives of individual States and private sector providers.

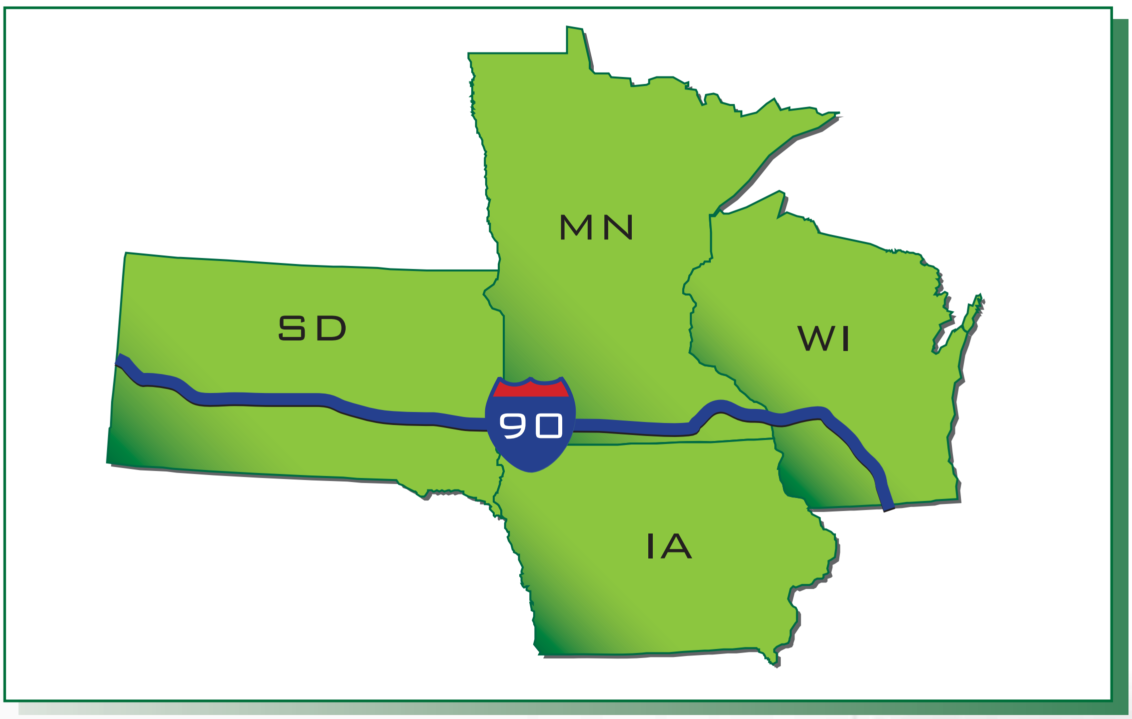
This study is "technology neutral," considering fiber optic, wireless, or conceivably a hybrid system that incorporates elements of each technology. The preferred technology in each corridor will be selected on the basis of both engineering considerations and market factors and may vary by corridor. Regardless of the mode recommended for the backbone system, other technologies could be selected to provide the connections from the backbone access points to the local providers and to the ultimate users of broadband service. Determining recommended methods of providing connections from the backbone to end users, however, is beyond the scope of this study.

In addition, the study is also "competitively neutral" in that States encourage fair and effective competition in the delivery of goods and services associated with high-speed telecommunications and private sector participation in the traditionally public sector project environment.

In the course of the investigation, the study team has identified an appropriate study area for each corridor; collected information about current and forecast social, economic, and demographic patterns in the study areas; and investigated regional initiatives that could benefit from the increased availability of high-speed telecommunications.

To determine the feasibility of deploying such telecommunications facilities, the study team worked closely with the States to examine the physical characteristics, existing facilities, and policies and regulations affecting each corridor. This analysis was undertaken to identify possible barriers to implementation, including physical, environmental, and institutional barriers.

❖ **I-90 Corridor –** Interstate Highway 90 (I-90) is the northernmost east-to-west, coast-to-coast interstate highway in the United States, extending from Seattle, Washington to Boston, Massachusetts. This study focuses on the 843-mile portion of I-90 that passes through South Dakota, southern Minnesota, and central and western Wisconsin. The study corridor, which encompasses a 25-mile buffer on each side of the interstate highway, also includes portions of northern Iowa. The total population of the I-90 Corridor is almost two million, of which 33 percent is found in urbanized areas. The non-urban population of the corridor includes 259,000 people in South Dakota, 369,000 in Minnesota, 79,000 in Iowa, and 627,000 in Wisconsin.



I-90 CORRIDOR

I-20 Corridor

I-91 Corridor

- **I-20 Corridor** – Interstate Highway 20 (I-20) extends 1,535 miles across the southeastern United States, from western Texas to Interstate 95 in South Carolina. This study is concerned with the 542 miles of I-20 that passes through Louisiana, Mississippi, and Alabama. The total population of the corridor is 2,909,000, of which 46 percent is found in urbanized areas. The non-urban population includes 665,000 people in Alabama, 471,000 people in Mississippi, and 418,000 people in Louisiana.

- **I-91 Corridor** – Interstate Highway 91 (I-91) extends from New Haven, Connecticut at Interstate 95 to Derby Line in Vermont at the Canadian border. I-91 runs north and south through the States of Connecticut, Massachusetts, and Vermont. The focus of this study is on the 242-mile portion of the corridor that spans the length of Massachusetts and Vermont. Portions of western New Hampshire also are included in the 25-mile buffer defining the corridor study area. The total population of the I-91 Corridor in 2000 was 1,082,000, of which 59 percent were found in urbanized areas. The non-urban population includes 255,000 people in Massachusetts, 175,000 in New Hampshire, and 210,000 in Vermont.

To determine the feasibility and desirability of the deployment of HST infrastructure in these corridors, the team examined the range of potential benefits, the likely costs involved in construction of the facilities, and the potential to defray the cost of implementation through the involvement of public and private sector partners. The study team is considering various HST implementation models, including public agency initiatives as well as public-private partnerships, for deploying HST infrastructure along each corridor and creating a broader network serving the needs of public agencies, communities, and other end users. Creation of such a network would depend on separate funding decisions involving each State and their respective private sector partners.

The role of the private sector is a significant issue for a number of reasons. First, the deployment of a high-speed telecommunications system could be accomplished by a State Departments of Transportation to serve its own needs. Alternatively, a State government could deploy such a system to serve the needs of a number of agencies across departmental lines. However, the involvement of a private sector partner could potentially defray the cost of constructing and maintaining the system. In addition, the involvement of private sector providers is essential to reaching residential and commercial users in the communities adjacent to the interstate highway rights-of-way.

The successful creation of a public-private partnership involves delivering a benefit to each member of the partnership. In this instance, the public sector benefits through the creation of a multistate network that serves the telecommunications needs of the State DOT (and possibly other State agencies) at a lower cost, while the private sector benefits from access to a continuous, controlled right-of-way that spans multiple State and local jurisdictions, on consistent terms.

This Executive Summary is part of a *Report to Congress* that presents the study's preliminary findings. The findings provide the Secretary of Transportation's current perspective on the feasibility of deploying high-speed telecommunications in the three study corridors. Subsequent to publication of this report, the Department of Transportation will prepare a *Report to States* which provides more detailed information on the conceptual alignments in each corridor, as well as the results of an investigation into the legal and regulatory considerations involved in the ultimate deployment of such a telecommunications capability. The intent of the *Report to States* is to provide enough information to those States not already engaged in deployment planning, to determine the benefits and risks of such a project, and to provide additional resources to those already involved in such projects. The *Report to States* will concurrently be sent to Congress.

Preliminary alignments for deployment are currently under development in cooperation with the State DOTs. In some instances, the States already have begun their own explorations of the potential for deployment of wireless or wireline facilities in the corridors. In these instances, the study team is looking for ways to provide value to the current engineering efforts. In locations where little work has been done to identify options for HST deployment in the corridors, the study team will cooperatively develop concepts for deployment and preliminary documentation of a possible alignment of a communications backbone.

Defining the Corridors

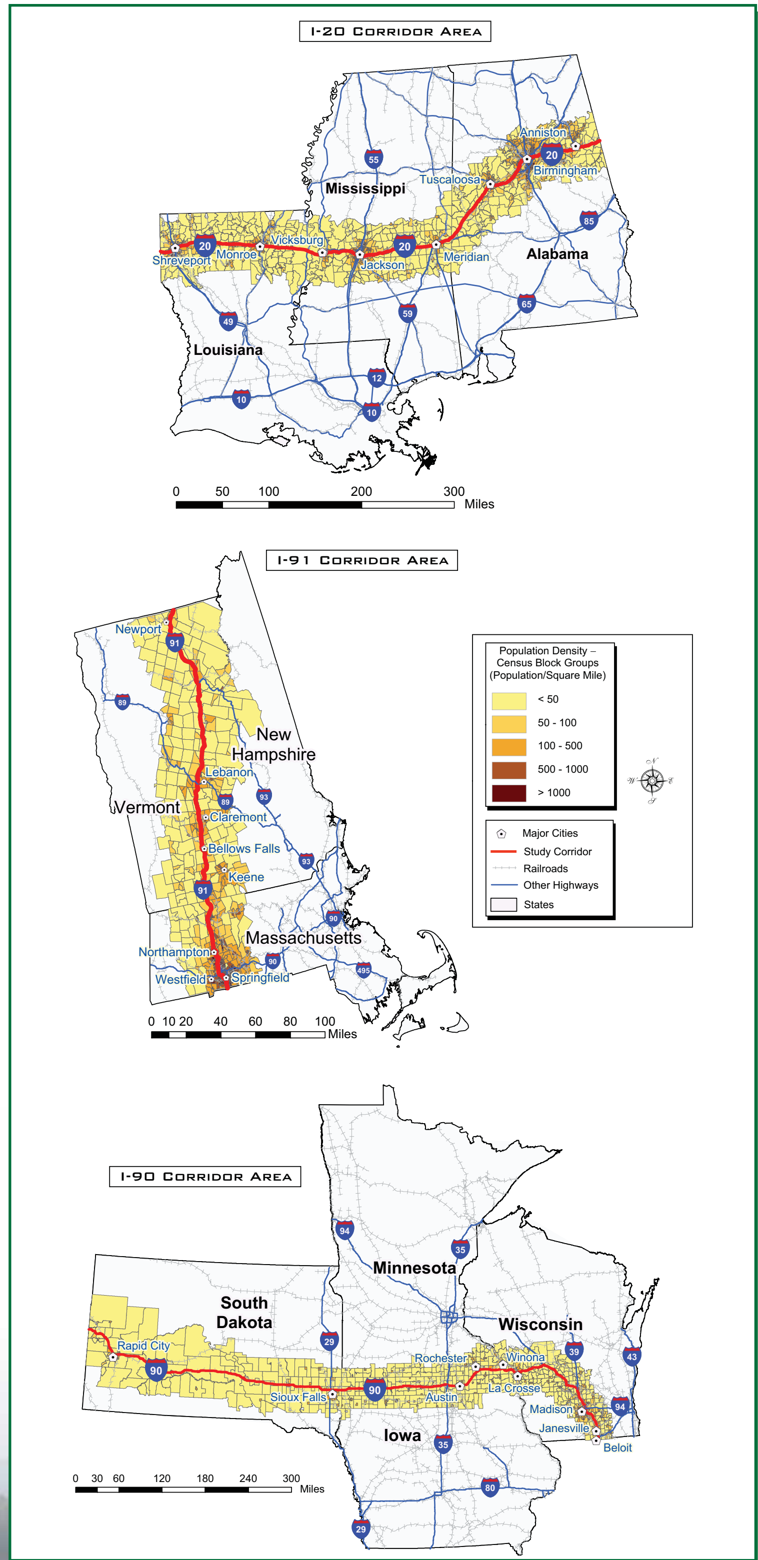
The three rural interstate highway corridors were initially assessed using a regional focus, with stakeholders from the multiple States in each corridor included in the corridor definition process. Corridor boundaries were established using a 25-mile buffer zone on each side of the interstate highway routes, with the boundaries of

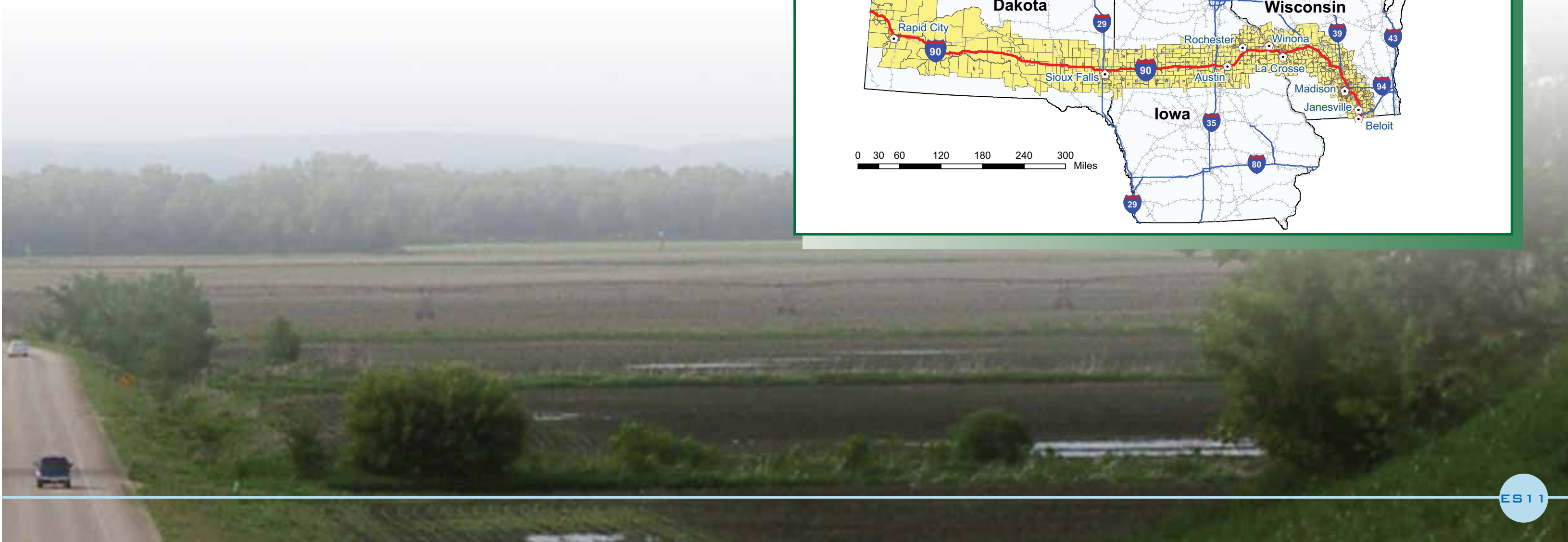
the analysis area based on census block group boundaries. This buffer zone represents the approximate area that would most stand to benefit from access to HST backbone along the interstate highway alignments.

Information was collected from a variety of sources to create profiles of each corridor. The corridor profiles provide background information, including descriptive information, tables, and maps, on conditions along each of the corridors that may affect telecommunications needs and benefits. The profiles discuss factors, including demographics of the corridor population, economic base of the corridor communities, education resources, health resources, and existing transportation and telecommunications infrastructure. The data on these factors were incorporated into a geographic information systems database to facilitate spatial analysis and mapping.

Once the corridor profiles were created, the potential demand for bandwidth in each corridor was assessed, based on consideration of the telecommunications needs of different types of users. This assessment of bandwidth needs considered the needs of State Departments of Transportation and

Corridor Areas with Population Density





other key public sector users as well as businesses, residents, health care providers, and educational institutions. The needs assessment considered forecasts of population growth through 2030 but did not assume fundamental changes in the way that HST technology is used compared to current and near-future applications.

The background research for this report also included a review of the potential benefits of improved access to HST for rural communities in general, and to the corridor study areas in particular. Existing literature on the benefits of rural Internet and HST access was reviewed. Interviews were conducted with people knowledgeable about each corridor, including planners, economic development officials, health care and educational service providers, and people involved with local HST deployment initiatives, to provide a perspective on HST needs in each corridor. This information was used to develop an assessment of the potential benefits of HST infrastructure deployment to the communities and institutions that could be served.

> “A national study of the economic impact of broadband Internet access in communities “supports the view that broadband access does enhance economic growth and performance, and that the assumed economic impacts of broadband are real and measurable.””

Benefits of Broadband to Rural Communities

This study is undertaken in the context of a revolution in telecommunications technology and in the impact of this technology on both individuals and businesses in the United States and across the world. For the past decade, since the passage of the Telecommunications Act of 1996, telecommunications companies have been extending the reach of information and communications technology in ways that have transformed the way Americans live, work, and play. The availability of ubiquitous, inexpensive telephone service, both wireline and wireless, has affected millions of lives and opened up new business opportunities. Access to the Internet from the office, home, and on the move has had an enormous impact on society, as the ready availability of information and the capacity to send and receive e-mail and instant messages have proliferated.

"Always on" broadband telecommunications has enabled the transmission of huge amounts of data almost instantaneously, with profound impacts on sectors from finance to entertainment. Expanded deployment of HST in rural areas has the potential to provide significant benefits in a number of areas, including economic development, health care, education, transportation, and safety and security.

The benefits to rural communities of expanded HST access and use are potentially quite significant. A national study of the economic impact of broadband Internet access in communities "supports the view that broadband access does enhance economic growth and performance, and that the assumed economic impacts of broadband are real and measurable." These benefits include an increase of 1 to 1.4 percent in growth rate between 1998 and 2002, in comparison to a control group; a relative increase in the number of business establishments of 0.5 to 1.2 percent over the same period; substantially higher housing rents (a proxy for property values); and a small but statistically significant increase in the share of establishments in information technology-intensive sectors.[1]

Despite its potential benefits, widespread availability of high-speed telecommunications service is a relatively new phenomenon, particularly in rural communities. Although some commercial services were introduced in the late 1990s, market penetration overall, and particularly penetration into rural communities, has only recently started to accelerate. While the Federal Communications Commission (FCC) reports that "more than 99 percent of the Nation's population lives in the 99 percent of ZIP codes where a provider reports having at least one high-speed service provider,"[2] in

many ZIP codes, the actual proportion of people with access to high-speed service is quite low. The penetration of high-speed telecommunications has been uneven, and there is evidence that a "digital divide" exists not only across socioeconomic, but geographic and demographic boundaries as well. A 2006 survey by the General Accountability Office (GAO) found that nationwide only 17 percent of households in rural areas were broadband subscribers, compared to 29 percent of households in urban areas.[3]

The Federal Government has played an active role in supporting the deployment of HST, including to rural areas. In enacting the Telecommunications Act of 1996, Congress sought to increase competitiveness in the provision of telecommunications service. Congress also reinforced its commitment to providing universal telecommunications service to the public, including underserved rural and lower-income communities. The goals of Universal Service, as mandated by the Telecommunications Act of 1996, are:

- To promote the availability of quality services at just, reasonable, and affordable rates;
- To increase access to advanced telecommunications services throughout the Nation; and
- To advance the availability of such services to all consumers, including those in low-income, rural, insular, and high-cost areas at rates that are reasonably comparable to those charged in urban areas.

In addition to policy development, the Federal Government has supported telecommunications deployment to underserved areas and other key target users through grant and loan programs. The Rural Development Telecommunications Program, a program of the United States Department of Agriculture, makes available investment

capital for building rural telecommunications infrastructure by rural utilities, municipalities, commercial corporations, limited liability companies, public utility districts, and Indian tribes, as well as by cooperatives, and other nonprofit, limited-dividend, or mutual associations. Subsidies for high-cost users, schools, and libraries are provided through the Universal Service Fund, which is supported by fees collected from carriers and administered through the Universal Service Administrative Company (USAC). According to the latest information on connections to the Internet for primary and secondary schools and libraries in the United States, the "E-Rate" program (the Schools and Libraries program of the Universal Service Fund) and State and local initiatives for providing educational connections have been tremendously successful in providing high-speed access to educational institutions. As part of this study, the investigators have looked at the degree to which a rural interstate corridors telecommunications infrastructure could supplement existing efforts to provide access to high-speed telecommunications for the Nation's **educational institutions and libraries**.

Broadband, high-speed telecommunications also can make a significant contribution to **improvements in rural health care** through **"telemedicine."** Telemedicine encompasses a variety of techniques to bring specialized medical knowledge to remote locations through the sharing of images, health data, and real-time interaction between doctors and patients. This report identifies current and planned telemedicine initiatives in the study areas, and discusses the potential for using advanced telemedicine techniques being explored elsewhere.

State Departments of Transportation have many potential applications for high-speed telecommunications access. As the Nation's transportation system operators deploy more advanced **intelligent transportation systems (ITS)** technology for traffic management and traveler information, the ability to communicate in real-time, or near real-time, becomes more important. Transportation management centers can actively manage freeway and arterial management systems to make the best use of available capacity, but they require up-to-date information from field devices, and the ability to transmit information to dynamic message signs and other media in order to advise the traveling public of potentially hazardous situations.

CCTV Camera

Closed circuit television (CCTV) cameras, used for monitoring traffic conditions and incidents on the roadway, require HST to provide full motion video back to a centralized operations center where operators can dispatch appropriate resources. These cameras are placed primarily in urban areas, but increasingly are being placed in high-incident locations in rural areas. Getting HST to the highway rights-of-way has traditionally been an expensive proposition. If the interstate highway right-of-way is used for the placement of HST, that brings it one-step closer to where a Department of Transportation ultimately needs the service. HST also can be used to transport that video to other service providers such as State emergency management agencies, where it becomes crucial during a local, regional, or statewide emergency or disaster.

In addition to systems that manage traffic or communicate with travelers, transportation agencies are improving the efficiency of their operations through communications with field offices and with their vehicle fleets. Essential functions such as winter maintenance and incident response are enabled by high-speed wireless and wireline communications. Rapid response to constantly changing conditions and events is essential to 21st Century transportation systems management and operations.

Vehicle Infrastructure Integration (VII) is another potential application of HST along rural highway corridors. VII is a recently launched program that will exchange communications between vehicles and the roadside to improve safety and mobility. A specific frequency range (5.9 GHz) has been dedicated to provide the radio communications link between vehicles and the roadside. Deployment of VII could potentially accomplish the following:

- Warning drivers of unsafe conditions or imminent collisions;
- Warning drivers if they are about to run off the road or speed around a curve too fast;
- Informing system operators of real-time congestion, weather conditions, and incidents, thereby supporting traffic operations to reduce congestion and improving response to emergency situations; and
- Providing operators with data on traffic patterns to improve the long-term planning, management, and operations of the transportation system.

HST deployment along highway corridors also would support the U.S. Department of Transportation's Congestion Initiative. The National Strategy to Reduce Congestion on America's Transportation Network, announced by the DOT in May 2006, provides a blueprint for Federal, State, and local officials in their efforts to respond to the growing challenge of congestion. Congestion in U.S. transportation systems has a substantial adverse impact on the United States economy and on quality of life for millions of Americans. While congestion is most heavily concentrated in urban areas, it also occurs in rural areas especially as a result of traffic incidents, special events, weather, work zones, and border crossing delays. ITS technologies that rely on HST systems, such as CCTV and other traffic monitoring devices as well as traveler information and vehicle communications technologies, have the potential to yield congestion relief benefits even in the rural portions of each study corridor.

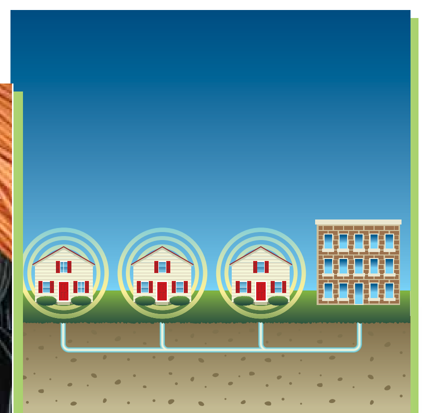
> "Public safety and security officials at all levels of Government can benefit from the ready availability of sophisticated data in more usable forms."

Finally, HST and broadband connectivity can significantly enhance **homeland security preparedness** and response applications.[4,5] Public safety and security officials at all levels of government can benefit from the ready availability of sophisticated data in more usable forms (e.g., geospatial data). Robust communications infrastructure can facilitate the availability of such information directly to service providers and first responders, wherever and whenever they need it. Virtually every aspect of homeland security involves information sharing among local, State, and Federal Government officials, including border security; emergency response capacity; biological, chemical, and radiological threat assessment and monitoring; and physical infrastructure management. Broadband will greatly enhance the capacity to share vast quantities of data across government agencies and all levels of government.

Preliminary Alignment Approach

Preliminary alignments are currently under consideration for each corridor. Outreach already has been conducted to corridor stakeholders through a variety of means, including corridor- and State-level workshops, a project web site, and web conferences. This outreach has identified factors such as existing HST infrastructure and telecommunications initiatives, State policies regarding utility accommodations and resource-sharing agreements, the level of interest of each State in deploying HST backbone along interstate highways, and potential engineering and design challenges.

To produce the conceptual design for each interstate highway corridor, the study teams will work with State DOTs and other stakeholders. The alignments will be conceptual in nature, not detailed plans. However, the concepts will be developed in sufficient detail to take into consideration potential barriers to implementation such as terrain, environmentally sensitive areas, and geophysical barriers such as rock outcroppings and river crossings. In addition, the alignments will be consistent with State policies for use of the rights-of-way, including utility accommodation policies and the presence of existing utilities and utility corridors. The conceptual alignments will further address considerations such as the backbone technology (i.e., buried fiber versus wireless towers) and selection of access point locations.



The development of preliminary alignments also will address resource-sharing issues, including potential roles for the public and private sectors for construction, ownership, operations, and funding. Potential resource-sharing models include: market driven (all parties pay full market value for resources); quid pro quo (parties exchange goods or services of equal value); and forcing legislation (requirements or incentives for the private sector to take action). The results of the conceptual alignment study will provide useful information to other States that also might be considering the deployment of HST in interstate highway rights-of-way.

Building a telecommunications backbone in interstate highway rights-of-way presents both advantages and disadvantages. Interstate highway routes provide connectivity across multiple States and through both densely and sparsely settled areas. The planners of the interstate highway system created corridors that link major population centers, but also provide access to smaller communities. In fact, the interstate highway routes have had considerable influence on the location of and economic prospects for rural communities.

Fiber optic Cable Installation

While the interstate highways offer the benefit of a continuous, controlled right-of-way, many States have policies limiting or restricting the use of interstate highway corridors for the longitudinal placement of utilities. These policies, while not uniform among the States, are motivated by a desire to avoid any activities within the rights-of-way that have the potential to disrupt operations or open the DOT to any liability concerns. In some States, in efforts to gain control over financially risky information technology and communications projects, State governments have adopted policies that limit the ability of transportation agencies to implement communications systems serving any purpose other than the agency's own communication needs. This is in part due to the need to comply with Federal regulations that prohibit State and local governments from providing communications services that may compete with private providers; it also may be a reaction to some previous instances where partnerships with telecommunications providers have failed to deliver promised benefits.

Even in cases where some kind of partnership with private entities is possible, significant challenges remain. One challenge relates to policies restricting the ability of agencies to recover costs other than administrative expenses for allowing access to the rights-of-way. In other instances, negotiation of access agreements may be constrained by State policies that forbid Departments of Transportation from offering exclusive access, or access to a limited number of providers. Creating a network that crosses State boundaries creates additional complications. The proposed alignment would have to conform to requirements of each jurisdiction, including the possibility of States having different policies or design guidelines.

In the process of developing a preliminary alignment, the study team will consider operational issues associated with installation and maintenance. These issues focus on maintaining the safety of the traveling public during the construction of the wireline facility (trenching for installing conduit, construction of access points and equipment sheds for repeaters and amplifiers) or wireless towers. In addition, access will be needed for routine maintenance, upgrades, and repair of damaged equipment.

Findings and Conclusions

This study has examined the feasibility and potential benefits of installing high-speed telecommunications backbone along interstate highway rights-of-way. The findings of the study do not provide a "one-size-fits-all" recommendation as to whether such deployment should take place, or the specific methods of the deployment. The existing availability of HST infrastructure, including both public and private infrastructure, varies across and even within corridors. Some States already are undertaking initiatives to expand HST deployment. Others have policies discouraging or prohibiting the use of interstate highway right-of-way for utilities including telecommunications. The potential market for HST services and the resulting benefits of deployment also vary across the corridors. Furthermore, specific design and engineering issues have not yet been investigated, or potential costs determined; these will be addressed in the subsequent *Report to States*.

Despite these disparate findings, a number of general conclusions can be drawn from the results of the study to date:

- **Expanded HST deployment in each corridor could potentially lead to significant benefits,** including benefits to State transportation agencies and the traveling public, as well as general benefits to residents of rural communities in each corridor through economic development, improved health care and education opportunities, and enhanced quality of life. Rural areas are lagging in broadband adoption compared to urban areas, and as a result are failing to reap the benefits provided by HST services.

- **No single technology will provide the solution to HST needs** in all rural corridors. Fiber optics, wireless, or a hybrid of the two technologies may be most appropriate depending on the specific conditions and needs within each corridor.

- **The Federal Government must continue to play an active role** if the full benefits of HST deployment are to be realized. A precedent exists for such involvement through the development of policies at both the legislative and executive level, as well as programs such as the Rural Development Utilities Program and Universal Service Access Fund. Federal leadership is especially critical to establish a framework that will promote creative approaches to multistate deployment without imposing unnecessary new requirements. DOT could provide technical assistance and/or incentives for States to enter into multistate agreements and public-private partnerships.

- **The most direct benefits will be to transportation agencies**, for whom public-access HST along the highway corridors will support a set of advanced traffic management applications that will enhance mobility and safety. **Additional benefits to rural communities will be realized only if the HST backbone is deployed in such a way that it spurs additional local public- and/or private-sector investmen**t in providing HST connections to end users. This will require the creation of public-private partnerships so that private sector providers have access to the HST backbone infrastructure. Fortunately, precedent for successful public-private partnerships exists.

- Individual States execute **laws and policies that may limit the deployment** of a corridor-wide communications backbone. Absent Federal law or regulations this condition will in all likelihood continue to persist.

- **Infrastructure deployment can be greatly facilitated by the establishment of uniform design guidelines and standards.** The Department of Transportation and the American Association of State Highway and Transportation Officials (AASHTO) can revisit current policies and guidelines regarding HST implementation to address new issues stemming from advanced communications technology.

- A substantial national fiber backbone system already exists between major metropolitan areas due to prior private sector investments, and thus **opportunities for resource-sharing agreements for new fiber capacity are limited.** In areas where backbone capacity already exists, the provision of additional backbone services along interstate highways will only benefit communities if access is provided at a cost low enough to induce additional private-sector investment in "last-mile" connections. An optimal strategy will rely on public-private partnerships to make use of existing infrastructure and to promote investment in new infrastructure only where it is needed.

- **States also have a strong potential interest and role in deploying HST in interstate highway corridors.** Congestion and incident management is not just an urban issue. Congestion relief through ITS implementation (e.g., at border crossings) is to some extent contingent on availability of HST. However, State DOTs generally do not have resources readily available for major investments in HST. Supplemental funding will be required to build out communications infrastructure for future public applications in cooperation with the private sector. Especially where existing private-sector backbone capacity is limited, State DOTs would be well advised to recognize and take advantage of the potential value of their property to the private sector by offering consistent rules of access.

- **An HST backbone along an interstate highway corridor provides benefit to all State functions** and to the State as a whole, not just to transportation interests.

- **The private sector is a critically important partner** in any HST deployment initiative, not only for providing last-mile connections and potential financial support, but also for maintaining and operating the system. The way that State DOTs are currently constituted and operated, oriented primarily toward capital construction, presents a challenge for deploying and maintaining telecommunications capabilities. Telecommunication entities with State oversight are better able to manage telecommunications resources and to keep up with the rapidly changing technology.

- Looking toward the future, **Vehicle Infrastructure Integration (VII) could establish the need for a nationwide communications backbone** that uses interstate highway corridors. The U.S. DOT is continuing to work with States and other stakeholders to determine whether such an opportunity exists and what appropriate governance models can be applied.

Executive Summary End Notes

[1] Gillett, S.E., W.H. Lehr, C.A. Osorio, M.A. Sirbu. *Measuring Broadband's Economic Impact*. Final Report, National Technical Assistance, Training, Research, and Evaluation Project #99-07-13829, Economic Development Administration, U.S. Department of Commerce, Washington, D.C. (February 2006).

[2] "High-Speed Services for Internet Access: Status as of June 30, 2006." Industry Analysis and Technology Division, Wireline Competition Bureau, Federal Communication Commission (January 2007).

[3] United States Government Accountability Office. "Broadband Deployment Is Extensive Throughout the United States, but it is Difficult to Assess the Extent of Deployment Gaps in Rural Areas." Report to Congressional Committees, GAO-06-426 (May 2006).

[4] Report on Building Out Broadband, *Findings and Recommendations*. The President's Council of Advisors on Science and Technology (December 2002). http://www.ostp.gov/PCAST/FINAL%20Broadband%20Report%20With%20Letters.pdf.

[5] The Department of Homeland Security (DHS) expects to fund advanced telecommunications backbone for first responders. In January 2007 the FCC issued a notice of proposed rulemaking for the allocation of spectrum in the 700 MHz band for implementation by DHS of a nationwide, broadband, interoperable Public Safety Network. 72 Fed. Reg. 1201 (January 10, 2007).

1. Introduction and Background

This report explores the potential for the use of rural interstate highway corridor rights-of-way for the deployment of fiber optic cabling and/or wireless communication infrastructure, across one or multiple States. The goal of these deployments would be to benefit rural communities. This telecommunications infrastructure, as envisioned in Section 5507 of the Safe, Accountable, Flexible, Efficient Transportation Act: A Legacy for Users (SAFETEA-LU), would comprise one element of the Nation's "telecommunications backbone" system, the "main arteries" of the Nation's advanced telecommunications network.

SAFETEA-LU

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), the authorizing legislation for the Nation's surface transportation program, included a provision under Section 5507 for a Rural Interstate Corridor Communications Study. Under this section, "The Secretary, in cooperation with the Secretary of Commerce, State departments of transportation, and other appropriate State, regional, and local officials, shall conduct a study on the feasibility of installing fiber optic cabling and wireless communication infrastructure along multistate interstate system route corridors for improved communications services to rural communities along such corridors." The Department of Transportation was directed to identify the "impediments" to installing such an infrastructure and "to connecting such infrastructure to the rural communities along such corridors." The Department was also directed to identify the potential benefits of such an infrastructure for economic development, deployment of intelligent transportation systems technologies and applications, homeland security precaution and response, and education and health systems in rural communities. This feasibility report also provides an analysis of legal and institutional issues, design considerations, and safety and operational issues associated with installation, as well as the degree to which the findings of such a study could be extended and applied to other rural interstate system route corridors in other States.

Creation of such a communications infrastructure could potentially have immediate benefits to the transportation agencies that control the interstate highway rights-of-way (ROW) that would be utilized. Furthermore, the introduction of high-speed telecommunications (HST) can demonstrably improve economic prospects for businesses, individuals, and communities, while also providing a variety of collateral benefits for health care, education, and public safety. However, while construction of a backbone facility could ultimately support the provision of advanced telecommunications services to adjacent communities, the delivery of service to customers also is dependent on the availability of regional and local distribution networks as well as local Internet service providers that would connect the backbone infrastructure to the end user.

This *Report to Congress* presents the study's preliminary findings. Subsequent to this report will be a *Report to States*. Table 1 presents the language of Section 5507 along with a cross reference to the location within this report or refers to the follow-on *Report to States* in responding to all issues raised in the legislation. This report provides the Secretary of Transportation's current perspective on the feasibility of deploying high-speed telecommunications in the three study corridors. The *Report to States* will provide the more detailed preliminary backbone alignment and installation issues for potential high-speed telecommunications in the three identified corridors.

Table 1: Legislative Language of Section 5507

Section 5507. Rural Interstate Corridor Communications Study		
Section	**Description**	**Report Location**
(a)	Study – The Secretary, in cooperation with the Secretary of Commerce, State Departments of Transportation, and other appropriate State, regional, and local officials, shall conduct a study on the feasibility of installing fiber optic cabling and wireless communication infrastructure along multistate interstate system route corridors for improved communications services to rural communities along such corridors.	
(b)	Contents of Study – In conducting the study, the Secretary shall identify:	
(b) 1	Impediments to installation of the infrastructure described in subsection (a) along multistate interstate system route corridors and to connecting such infrastructure to the rural communities along such corridors;	Section 4
(b) 2	The effective geographic range of such infrastructure;	Section 2
(b) 3	Potential opportunities for the private sector to fund, wholly or partially, the installation of such infrastructure;	Section 1, 4, and *Report to States*
(b) 4	Potential benefits fiber optic cabling and wireless communication infrastructure may provide to rural communities along such corridors, including the effects of the installation of such infrastructure on economic development, deployment of intelligent transportation systems technologies and applications, homeland security precaution and response, and education and health systems in those communities;	Section 3
(b) 5	Rural broadband access points for such infrastructure;	Section 1, 4, and *Report to States*
(b) 6	Areas of environmental conflict with such installation;	*Report to States*
(b) 7	Real estate ownership issues relating to such installation;	Section 1 and 4
(b) 8	Preliminary design for placement of fiber optic cable and wireless towers;	*Report to States*
(b) 9	Monetary value of the rights-of-way necessary for such installation;	*Report to States*
(b) 10	Applicability and transferability of the benefits of such installation to other rural corridors; and	Section 3 and 4
(b) 11	Safety and other operational issues associated with the installation and maintenance of fiber optic cabling and wire infrastructure within interstate system rights-of-way and other publicly owned rights-of-way.	Section 4

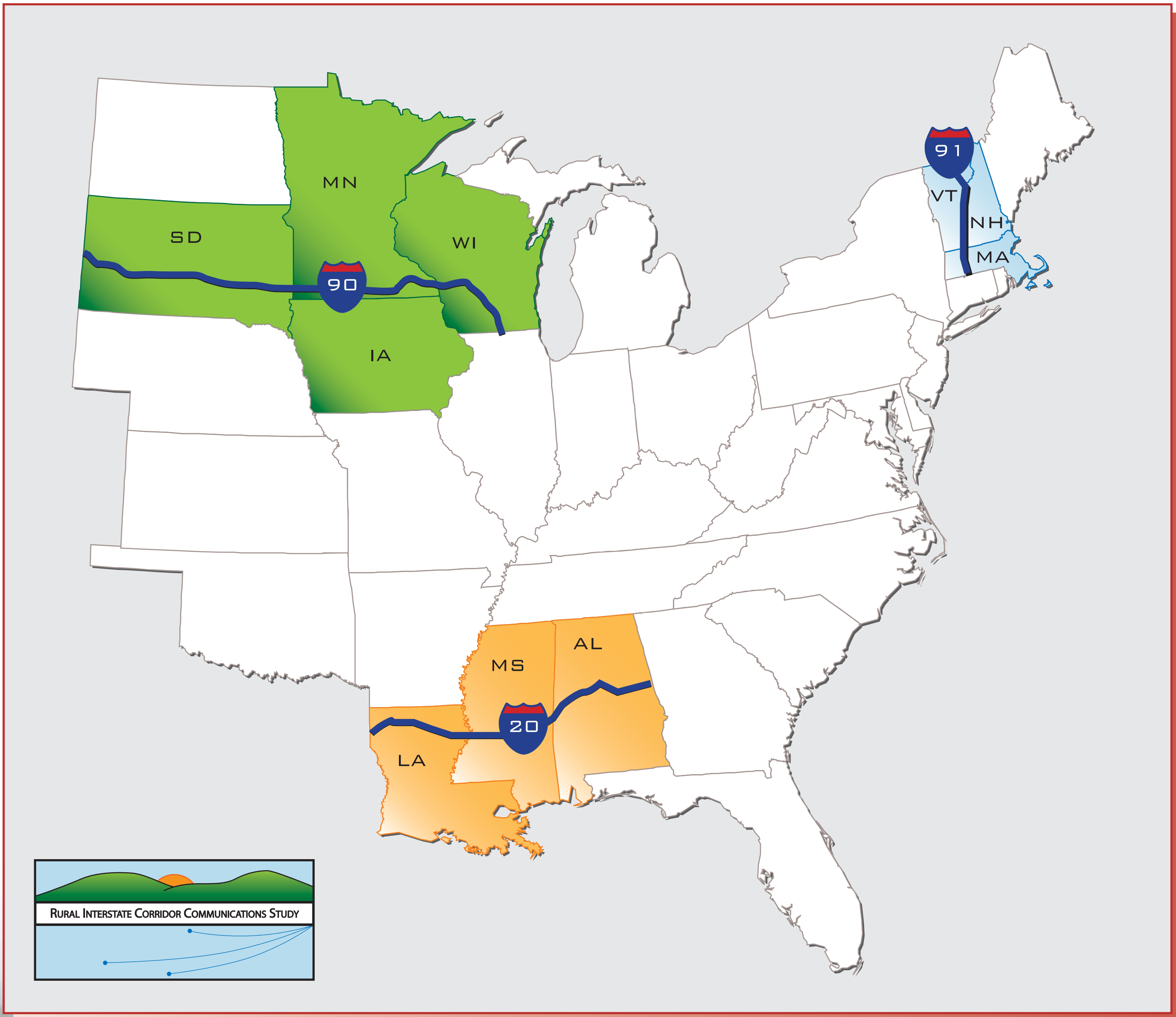
1.a. Purpose of the Study

In 2005, Congress directed the Secretary of Transportation to investigate, in cooperation with the U.S. Department of Commerce, the potential for using interstate highway corridor ROW in mostly rural areas to expand the availability of HST in those areas. Section 5507 of the Safe, Accountable, Flexible, Efficient Transportation Act: A Legacy for Users (SAFETEA-LU) directs the Secretary of Transportation to report on the potential for using rights-of-way along interstate system routes to accommodate a fiber optic and/or wireless telecommunications infrastructure, which would provide "improved communications services to rural communities along such corridors." In studying this concept in three designated corridors, the United States Department of Transportation (U.S. DOT) is to consider possible impediments to implementation, including ownership issues and environmental considerations; the configuration of the system, including a "preliminary design," possible access points, the "geographic range" of the infrastructure, and potential safety and operational issues associated with installation and maintenance of the facilities; potential benefits to rural communities, including economic development impacts, education and health care benefits, easier deployment of intelligent transportation systems (ITS), and benefits for homeland security response and precaution; the possible role of the private sector in implementation; and the applicability and transferability of benefits to other rural corridors.

In support of this investigation, the Federal Highway Administration (FHWA), in cooperation with the National Telecommunications and Information Administration (NTIA), is working with State and local agencies to explore the potential for the installation of fiber optic and wireless facilities in three designated corridors passing through 10 States. These corridors are:

- Interstate Route 90 through South Dakota, southern Minnesota, northern Iowa, and central and western Wisconsin;
- Interstate Route 20 through northern Louisiana, Mississippi, and Alabama; and
- Interstate Route 91 through Vermont, New Hampshire, and Massachusetts.

Three study corridors



This report presents the findings of the investigation and a discussion of the potential benefits and costs associated with the introduction of a high-speed telecommunications backbone facility in each corridor. The report is not a detailed policy, legal, engineering, or cost-benefit analysis. Instead, its intent is to provide a general assessment of the feasibility and desirability of HST deployment along interstate highway corridors, considering factors such as Federal and State policies and regulations, HST needs, demand characteristics, potential public benefits, technology and engineering considerations, and institutional models for deployment. This report is intended to be informational in nature and presents a snapshot of what is known as current in the market place. It does not commit the U.S. DOT, FHWA, the Department of Commerce, nor the participating States to implementing programs nor technologies.

The fundamental concept under examination is the use of the interstate highway rights-of-way to construct a high-capacity backbone system, which would carry large amounts of data over long distances. At the same time, a sufficient number of access points would be designed into the system both to serve the needs of the transportation agency operating and maintaining the highway right-of-way, and potentially to provide broadband service to rural communities adjacent to the right-of-way. The use of interstate highway rights-of-way not only offers a continuous, controlled environment for the construction of telecommunications infrastructure, it also provides a potential benefit to the States that control the rights-of-way to obtain communications capabilities to support existing or planned advanced transportation management technologies in these corridors.

This study is "technology neutral," considering fiber optic, wireless, or conceivably a hybrid system that incorporates elements of each technology. The preferred technology in each corridor will be selected on the basis of both engineering considerations and market factors and may vary by corridor. Regardless of the mode

recommended for the backbone system, other technologies could be selected to provide the connections from the backbone access points to the local providers and to the ultimate users of broadband service. Determining recommended methods of providing connections from the backbone to end users, however, is beyond the scope of this study.

In addition, the study also is "competitively neutral" in that States encourage fair and effective competition in the delivery of goods and services associated with high-speed telecommunications and private sector participation in the traditionally public sector project environment.

In the course of the investigation, the study team has defined and identified an appropriate study area for each corridor; collected information about current and forecast social, economic, and demographic patterns in the study areas; and investigated regional initiatives that could benefit from the increased availability of high-speed telecommunications. To determine the feasibility of deploying such telecommunications facilities, the study team worked closely with the States to examine the physical characteristics, existing facilities, and policies and regulations affecting each corridor. This analysis was undertaken to identify possible barriers to implementation, including physical, environmental, and institutional barriers. Based on the review of current conditions and emerging trends, the potential benefits of expanded high-speed telecommunications capacity were identified for each of the corridors. It is important to note that this study does not offer a detailed benefit-cost analysis. The limited availability of time and resources restricted the scope of this study to a qualitative assessment of potential benefits, and order-of-magnitude estimates of cost will be presented in the follow-on *Report to States*.

This *Report to Congress* presents the study's preliminary findings. The findings are necessarily incomplete due to the time required to work individually with each State and with each corridor; this work is forthcoming in a *Report to States*. Nevertheless this report provides the Secretary of Transportation's current perspective on the feasibility of deploying high-speed telecommunications in the three study corridors. Subsequent to publication of this report, the U.S. DOT will prepare a *Report to States* which provides more detailed information on the conceptual alignments in each corridor, as well as the results of an investigation into the legal and regulatory considerations involved in the ultimate deployment of such a telecommunications capability. The intent of the *Report to the States* is to provide enough information to those States not already engaged in deployment planning, to determine the benefits and risks of such a project, and to provide additional resources to those already involved in such projects. The *Report to States* will concurrently be sent to Congress.

Working with the States, preliminary alignments for deployment currently are under development. In some instances, the States already have begun their own explorations of the potential for deployment of wireless or wireline facilities in the corridors. In these instances, the study team is looking for ways to provide value to the current engineering efforts. In locations where little work has been done to identify options for HST deployment in the corridors, the study team will cooperatively develop concepts for deployment and preliminary documentation of a possible alignment of a communications backbone.

1.B. Common Terms

Common terms used throughout the document are defined below. These terms are common to the telecommunications industry, or are specific to this study:

- **Advanced telecommunications –** a term used by the Federal Communications Commission (FCC) to refer to "services and facilities with an upstream (customer-to-provider) and downstream (provider-to-customer) transmission speed of 200 kilobits per second (kbps) or greater." Such facilities also are referred to as "broadband." "High-speed" or "next-generation" refers to services with more than 200 kbps capability in at least one direction. The concept of "broadband" telecommunications continues to evolve as businesses and consumers gain access to services in the megabit per second (Mbps) range – that is, multiples of thousands of kbps.

- **Backbone –** in the context of telecommunications, a "backbone" facility is a high-capacity element of the communications network that carries large volumes of voice or data over long distances (city-to-city).

- **Dark fiber –** optical fiber cable assembly without a transmitter and receiver.

- **Digital divide –** the gap between those individuals having access to technology (hardware and software) and the skills and resources which allow for its effective use, and those who do not.

- **Handhole/manhole –** an intermediary point in a fiber optic cable assembly that allows for access by installation and maintenance technicians, usually in a manhole-type excavation along the pathway of the conduit installation. Transmission equipment is typically not present at these locations. Another term for handhole is vault.

- **Interstate system –** limited access routes that have been designated as part of the Dwight D. Eisenhower National System of Interstate and Defense Highways. These routes, authorized by the Federal-Aid Highway Act of 1956, now extend to 46,726 miles in 50 States and the District of Columbia, with over 14,000 interchanges.

- **Last-mile –** (also middle-mile) the link from the end user to the first physical location or building on the provider's network; middle-mile is a bit more vague but can mean the link from the long-haul national backbone down into the community that contains the end user.

- **Public-private partnership –** is defined by FHWA as contractual agreement(s) formed between a public agency and private sector entity that allow for greater private sector participation in the delivery of public sector projects.[1] Expanding the private sector role allows for the public agencies to tap private sector technical, management, and financial resources in new ways to achieve certain public agency objectives such as greater cost and schedule certainty, supplementing in-house staff, innovative technology applications, specialized expertise or access to private capital. In some cases public-private partnerships are formed in which the telecommunications company would share their infrastructure with the States and bear most of the construction costs. In return, the State would allow a company to have the right to install their infrastructure on the ROW, sometimes exclusively, and be able to access it as needed. The compensation to the States can be in the form of cash, conduit, dark fiber, communications service, or a combination of the above. This is commonly referred to as a shared resource project.

- **Rural telecommunications –** telecommunications services and facilities outside metropolitan (urbanized) areas, particularly including remote, isolated areas but also encompassing smaller, non-urbanized communities.

- **Wireless –** any system of transmitting and receiving information without wires.[2] Wireless communications includes microwave, cellular, directional radio, broadcast radio, satellite, and dedicated short-range communications (DSRC). Short- and intermediate-range transmission media include wireless local area networks (commonly referred to as Wi-Fi), wireless municipal or metropolitan area networks, and broadband-fixed networks (including technologies such as WiMAX).

- **Wireline –** the transfer of information over a distance with fixed telecommunications facilities, generally using copper wire (twisted pair, Ethernet, coaxial) or fiber optic cables.

1.c. The Broadband Revolution and Rural Access

Broadband telecommunications – the ability to provide large quantities of data over a distance almost instantaneously – is a transformative technology that has the potential to change the way we work, live, and play. Broadband enables "always on" access to the global Internet telecommunications infrastructure for all kinds of information exchange, including electronic mail, file sharing, voice telephony through "voice over Internet Protocol" (VoIP), and a host of new and emerging applications over the World Wide Web. Many of these applications have been around for years in one form or another, but the ready availability and high speeds that broadband affords make them more reliable, accessible, and user-friendly. The adoption of broadband has changed commerce, delivered productivity increases for industry, and revolutionized home entertainment. Rapid data exchange through secure, reliable networks is transforming government simplifying access to local government services, and supporting emergency response and public safety agencies.

Broadband adoption in industrialized nations has been characterized by rapid growth since its inception. In early 2004, a significant broadband milestone was reached: the 100 millionth broadband subscriber connected. From 100,000 subscribers globally in 1996 to 100 million in early 2004, broadband has moved beyond the early adopter stage and has entered the mainstream. It took approximately 3.5 years to reach the first 10 million broadband subscribers and about the same time to go from 10 million to 100 million. In sheer numbers, the United States leads the world in number of Internet users (205 million) and number of Wi-Fi hotspots (40,000, or one-third of all the hotspots in the world). Broadband service in the United States reached anywhere from 49 million to 58 million subscribers at the end of 2006.[3]

While broadband adoption is increasing rapidly, not all parts of the country or population groups are benefiting equally from the broadband revolution. In particular, some critics of national telecommunications policy claim that as high as 90 percent of rural users are unserved by broadband providers.[4] While the FCC reports that "more than 99 percent of the country's population lives in the 99 percent of ZIP codes where a provider reports having at least one high-speed service subscriber,"[5] in many ZIP codes, the actual proportion of people with access to high-speed service is quite low. A recent GAO report found that in 2005, 28 percent of all U.S. households had broadband services, 30 percent had dial-up Internet access, and 41 percent had no Internet access services at all.[6] Of those households with no Internet access at all, 75 percent had no computer, which may explain the lack of adoption of broadband in these households. The GAO report also concluded that although broadband subscribership is lower in rural areas (17 percent) than in urban areas (29 percent), the difference is due to of a lack of availability of broadband services, and is not due to a lower disposition of rural households to purchase broadband services.

The United States lags behind many other industrialized nations in the adoption of broadband and related technologies. A 2002 report from the U.S. Department of Commerce noted that "the United States has the largest total number of Internet users, broadband users, businesses on-line, and e-commerce transactions" (both business-to-business and business-to-consumer), but that other nations were "gaining ground fast."[7] At the time, over 56 million American households had Internet access, (52 percent of households), while only about 10 percent of households (about 11.2 million) were wired for broadband. By comparison, South Korea had nearly 8.3 million Internet households (57 percent), of which 7.5 million were broadband households (almost 52 percent of total households). More recently, a report from the Organization for Economic Cooperation and Development (OECD)[8] showed the

United States with over 58 million broadband subscribers, but the United States ranked 15th out of 30 countries in broadband subscribers per 100 inhabitants. The OECD report notes that the United States is 20th out of 30 nations in the growth rate of broadband penetration over the past year.

The current definition of "broadband" may not adequately characterize the adoption of higher-speed services increasingly required for many Internet applications. The FCC has defined 'broadband' service as an Internet access service that is capable of transmitting at least 200 kbps in at least one direction.[9] In a report to Congress on "Availability of Advanced Telecommunications Capability in the United States,"[10] the FCC observed that the 200-kbps threshold it selected is roughly the threshold speed at which the time taken to download a web page becomes comparable to the time it takes to turn the page of a book. The advent of multimedia and video laden web pages since the time of that observation, however, may indicate that a refreshed definition of what is necessary to constitute broadband may be warranted.[11] For purposes of evaluating various broadband access technologies to enable the expected user web-surfing experience for the typical multimedia content offered today in web pages, it is more realistic to assume that a usable signal to the end user must be at the rate of 1 megabit per second (1,000 kilobits per second) for the simplest of Internet access services. The advent of video-heavy Internet sites is quickly making even this 1 megabit barely adequate. If the service to be delivered is a 'triple play' of services (Internet access, voice telephony, and high-definition video) then a stream of at least 30 megabits is likely necessary.[12] While the definition of broadband is subject to debate, the standard used by the Federal Government remains 200 kbps in one direction.

The low levels of broadband subscribership in rural areas compared to urban areas are in part due to low population densities, which can make construction of access to long-haul fiber routes cost prohibitive. A substantial national fiber backbone system already exists between major metropolitan areas due to prior private sector investments. The high incremental cost of adding access points along long-haul networks, however, makes it difficult for private entities subject to market forces to justify the costs of construction of local broadband access in low-density areas. The construction of long-haul fiber networks requires the regeneration of the fiber optic signal approximately every 40 miles. These regeneration points are typically located in one story, flat roofed, concrete buildings. The average cost of these regeneration points (including cost of the building, environmental systems, and electronics to regenerate the signal) is $250,000 to $500,000 depending on the cost of the rights-of-way and electronics utilized.

The placement of regeneration electronics at a point along the route is not sufficient in itself to provide access for local usage. The additional electronics cost to provide such bandwidth access may be in the range of $100,000 to $200,000. Furthermore, to provide market access to the bandwidth, fiber must be constructed from the long-haul network site into the market to be served, at a cost of $25,000 to $75,000 per mile. The means to then transport the high-capacity bandwidth to the end user within the rural market is likely to be of much higher cost per user than in large markets. It is therefore not surprising that market forces have not resulted in the widespread construction of access into smaller markets from these high-capacity long-haul networks, regardless of which rights-of-way are utilized.[13]

Some government entities at all levels have made efforts to close the "digital divide" that some see dividing urban and suburban America on the one hand, and rural America on the other. At the Federal level, one of the programs of the Universal Service Fund (USF) – known as the High-Cost Fund – has indirectly facilitated broadband service in more rural areas. Similarly, the Department of Agriculture's

Rural Development Telecommunications Program provides grants and loans to promote broadband service in rural areas.[14] Some States and local entities also have undertaken initiatives, often in conjunction with the private sector, to bring broadband to underserved areas. Given the many barriers that must be overcome, further policy initiatives may be necessary to bring the full benefits of broadband to the Nation's rural areas. The use of interstate highway rights-of-way for backbone alignment is one potential tool to support rural HST deployment.

1.D. Federal Policy and Regulatory Context

The Telecommunications Act of 1996 set the stage for extensive Federal involvement in the Internet and in high-speed telecommunications deployments. This involvement has included regulations designed to promote competition, as well as complementary policies and programs that promote deployment of telecommunications technologies to underserved areas and to target populations such as schools. Federal policies and regulations also have established parameters for what can or cannot be done within interstate highway rights-of-way.

1.D.i. Telecommunications Act of 1996

Comprehensive telecommunications regulation in the United States began with enactment of the Communications Act of 1934. For more than 60 years, the 1934 Act intensively regulated almost all aspects of communications "in the public interest, convenience, and necessity."[15] The Telecommunications Act (TCA)[16] was enacted in 1996 to deregulate telecommunications services and to adopt free market competition to provide a broader range of telecommunications choices and lower prices to consumers. At the same time, the TCA also imposed new types of regulation designed to foster competition and to extend telecommunications services to underserved markets. Two of TCA's regulatory initiatives particularly affect installation of enhanced telecommunications backbone in State-owned interstate highway ROW to

provide advanced telecommunications access in rural areas as well as to provide specific benefits to surface transportation agencies. First, the TCA requires existing telecommunications providers to allow competing providers to have access to existing facilities and mandates removal of State and local regulatory barriers to telecommunications competition. Second, the TCA reinforced the more than a century old concept of universal service.[17]

The TCA's deregulated telecommunications mandate has generated extensive Federal Communications Commission (FCC) regulation requiring competition. For example, under the TCA, local telecommunications companies existing in 1996 (called Incumbent Local Exchange Carriers or "ILECs") are required to share their facilities with competitors (called Competitive Local Exchange Carriers or "CLECs") at regulated rates, if "the failure to provide access to such network elements [e.g., telephone lines or broadband backbone] would impair the ability of the [CLEC] telecommunications carrier seeking access to provide the services that it [the CLEC] seeks to offer."[18] Similarly, the TCA modified the Pole Attachments Act to require utilities to permit access not only to poles, but also to conduit, antenna towers, and the like by all types of telecommunications services at regulated rates. These and other competition-promotion regulations are likely to apply to installation of advanced telecommunications backbone along interstate highway ROW, particularly through "shared resources projects."[19] These projects allow telecommunications companies the rights to use State-owned ROW in exchange for State DOT access to telecommunications facilities installed in the ROW.

TCA specifically prohibits State and local regulatory barriers to competition. Section 253 bans State and local statutes, regulations, or legal requirements that "have the effect of prohibiting the ability of any entity to provide any interstate or intrastate telecommunications service." By its own terms, §253 is intended to remove State and local "barriers to entry" that might discourage entry of competing telecommunications providers. Nevertheless, the statute recognizes

"State regulatory authority" and allows "a State to impose, on a competitively neutral basis... requirements necessary to preserve and advance universal service, protect the public safety and welfare, ensure the continued quality of telecommunications services, and safeguard the rights of consumers."[20] This provision has been interpreted to require that States and municipalities establish the "competitive neutrality" of laws and regulations that affect telecommunications services. Another subsection expressly recognizes "the authority of a State or local government to manage the public rights-of-way or to require fair and reasonable compensation from telecommunications providers."[21] But this State and local authority must be exercised "on a competitively neutral and nondiscriminatory basis" and compensation paid by telecommunications companies must be "publicly disclosed."[22] States also are expressly authorized to require that a telecommunications provider meet universal service requirements, if the provider "seeks to provide telephone exchange service or exchange access in a service area served by a rural telephone company."[23]

The most far-reaching part of the "removal of barriers to competition" section of the TCA is the provision authorizing the FCC to preempt State or local statutes, regulations, or legal requirements that the FCC determines constitute barriers to entry by new competitors or are not competitively neutral and nondiscriminatory.[24] Since enactment of this preemption provision in 1996, the FCC has been active in preempting State and local actions that have the effect of discouraging entry by telecommunications providers seeking to compete for telecommunications projects or that function as legal and regulatory deterrents to competition for telecommunications services.

I.D.ii. The "Minnesota Decision"

The most important of the FCC preemption decisions affecting installation of advanced telecommunications backbone in interstate highway ROW is the FCC's

rejection of a petition brought by the State of Minnesota in 1999. The petition sought a declaration by the FCC that the State's contractual arrangement for installation of fiber optic backbone in State-owned freeway ROW was not preempted as a barrier to competition prohibited under TCA §253. Minnesota's arrangement was a "shared resource" program in which a selected telecommunications company agreed to provide various enhanced telecommunications services to the State, including advanced telecommunications services to rural areas, in exchange for the company's exclusive access to freeway ROW. Minnesota explained this arrangement as a way to extend advanced telecommunications to rural areas as well as to avoid the disruption and potential traffic hazards of multiple trenching in a busy highway ROW.

However, the FCC concluded that the State's selection of a single telecommunications provider to install fiber optic backbone in State-owned freeway ROW was anticompetitive, and in violation of TCA's provision regarding "removal of barriers to entry."[25] The FCC's decision particularly focused on unfairness to other telecommunications competitors because Minnesota's arrangement involved a single telecommunications company selected to install the only permitted fiber optic telecommunications line along certain State-owned freeway ROW. The FCC's competitive concerns focused on the fact that other telecommunications companies would not be permitted access to State ROW for 10 years. That exclusion, the FCC concluded, would put those competing companies at a competitive disadvantage. The petition was rejected because, as the petitioner, Minnesota had failed to meet its burden to establish that its single-source agreement was competitively neutral, nondiscriminatory, and not a barrier to competing telecommunications companies.

1.D.iii. FHWA Policy and Guidance

Prior to 1988, Federal policy did not permit States to allow utilities longitudinal access to interstate highway rights-of-way to install their infrastructure, although utilities were allowed to request transverse crossing of the freeways. In 1988, amendments were made to 23 CFR, Part 645, Subpart B that allowed States to expand their utility accommodation policies, to allow longitudinal utility installations

within the access control limits of interstate highways under State-specified circumstances. FHWA retained the authority to ultimately approve each State's freeway utility accommodation plan, although the State would then determine whether to permit specific utility installations, consistent with its policy. While this Federal policy change opened the door to shared resource telecommunications projects, the previous restrictions persisted in many State policies for many years (and in fact continue to do so in some States).

The 1999 FCC Minnesota Decision raised considerable apprehension about State DOT shared resources projects as well as control over State-owned ROW. The potential for required construction of multiple telecommunications installations in ROW along Federally funded highways also raised serious safety and management issues for FHWA as well. Fortunately, FHWA was able to work with the FCC to fashion what amounts to a "shared resources" safe-harbor.[26] Explained in the FHWA's Guidance Regarding Longitudinal Telecommunications Installations on Limited Access Highway Right-of-Way (2000),[27] this safe-harbor was the result of cooperation and consensus between FHWA and FCC. The resulting FHWA guidance regarding ROW installation of telecommunications facilities is based on three general goals: 1) to minimize safety hazards to the public; 2) to retain State control of interstate highway rights-of-way for States; and 3) to ensure nondiscriminatory competition in the telecommunications industry with respect to access to freeway right-of-way. Consistent with this guidance, both FHWA and the American Association of State Highway and Transportation Officials (AASHTO)[28] now provide extensive practical assistance with regard to satisfactory arrangements for longitudinal telecommunications installations along interstate highway ROW.

The FCC's decision was not appealed. Only a few court decisions and a handful of FCC decisions have relied on the FCC decision regarding Minnesota's petition. In these agency and court interpretations, the FCC's rejection of Minnesota's petition has come to stand for two propositions: First, the burden of proof in preemption

cases rests on the party bringing the petition. Second, the TCA's statutory safe-harbors will apply only if the State or local action is competitively neutral and nondiscriminatory. The legality and feasibility of State DOT arrangements for telecommunications installations in State-owned ROW are reflected in a number of successful shared resources programs involving installation of advanced telecommunications backbone in interstate highway ROW.[29] The FCC has not disapproved any of these shared resources programs as barriers to entry under §253.[30] For example, the FCC Wireline Competition Bureau declined to preempt the State of Colorado's contract with Qwest for development, aggregation, and management of a statewide telecommunications network using State-owned ROW.

I.D.iv. Expansion of the Pole Attachments Act

Another important reflection of efforts to promote competition is TCA's expansion of the Pole Attachments Act in §224. Enacted in 1978 to protect cable television providers from exorbitant charges for attaching cable lines to utility poles or for using utility-owned facilities such as ducts, conduits, or rights-of-way, the Pole Attachments Act was substantially extended by the TCA. Section 224 now broadly affects telecommunications providers and local exchange carriers and requires private sector utility companies that control facilities needed by telecommunications providers to allow that access on a nondiscriminatory basis and at regulated rates.[31] These changes in the Pole Attachments Act were enacted for the express purpose of fostering competition by requiring nondiscriminatory access to existing utilities facilities.

Although the amended Pole Attachments Act does not apply to entities that are "any railroad, any person who is cooperatively organized, or any person owned by the Federal Government or any State,"[32] private telecommunications providers in shared resources projects could be included under the competition-promotion features of

the Act. Regulation of just and reasonable rates for the use of poles or other facilities and limits on charges for attachments to a share of the operational and capital costs attributable to the entire pole that is proportional to the amount of the pole or other facility used by the attachment has been controversial.[33] Such regulated rates, together with strong deference shown by courts to FCC determinations under Section 2,[34] can lower the value of the underlying land or easement, including State-owned ROW, where telecommunications facilities are located. The FCC's broad and far-reaching interpretations of these statutory requirements may complicate the economics of shared resources projects involving installation of advanced telecommunications backbone along interstate highway corridors.

1.D.v. Rural Universal Service

In addition to deregulation of telecommunications and promotion of telecommunications competition, the TCA is notable for adoption of universal telecommunications service objectives in the Telecommunications Act of 1996 §254. In promoting universal access to telecommunications services in rural and high-cost areas, TCA included among its universal service principles: "Consumers in all regions of the Nation, including low-income consumers and those in rural, insular, and high-cost areas, should have access to telecommunications and information services, including interexchange services and advanced telecommunications and information services, that are reasonably comparable to those services provided in urban areas and that are available at rates that are reasonably comparable to rates charged for similar services in urban areas."[35]

Rural communities tend to be both high-cost (especially with regard to middle-mile and last-mile interconnection costs) and low-income with regard to the rural populations served. TCA directs the FCC to work toward equalizing access to telecommunications by rural communities that are frequently unserved or underserved by advanced telecommunications services such as broadband.

I.D.vi. Evolving Definition of Broadband

Section 254 establishes a complex statutory program to help make telecommunications services more equitably available. The statute defines "universal service" as "An evolving level of telecommunications services that the Commission shall establish periodically under this section, taking into account advances in telecommunications and information technologies and services."[36] In other words, the nature of advanced telecommunications services that should be universally available is expected to change over time. Accordingly, the FCC is considering redefinition of "advanced telecommunications" that, since 1999, has been understood to refer to "services and facilities with an upstream (customer-to-provider) and downstream (provider-to-customer) transmission speed of more than 200 kilobits per second (kbps)."[37] The FCC also uses the term "high-speed" to describe services and facilities with more than 200 kbps capability in at least one direction.[38]

> "TCA directs the FCC to work toward equalizing access to telecommunications by rural communities..."

In a recently issued Notice of Inquiry under §706 of the TCA regarding the reach of universal service, the FCC pointed out, "Given the rapid technological changes in the marketplace, we seek comment on the need to alter the definitional framework utilized in prior inquiries."[39] Noting that the FCC has not specified what speeds should be encompassed within the term "advanced telecommunications capabilities," the FCC seeks comment on the following questions:

Has technology or the marketplace evolved such that we should redefine the term "advanced services" to require a minimum speed higher than 200 kbps in one or both

directions? Should we adopt a definition that establishes different tiers based on information transfer rates? Have consumer expectations with respect to bandwidth needs changed since prior reports?[40] To what extent is mobility important to consumers when considering broadband alternatives? How has the development of new broadband technologies like wireless affected the marketplace evolution? Has development of the wireless broadband marketplace been affected by ownership of wireless companies by companies with substantial wireline broadband and public switched telephone network (PSTN) facilities? Do these cross-owned wireless companies offer different services or service bundles than wireless companies not controlled by or affiliated with a wireline carrier? What sources of information currently exist regarding the deployment of advanced telecommunications capability under alternative definitions? Are any other attributes, besides the speed in which a particular quantity of information can be transmitted, relevant to the definition of advanced telecommunications capability? Finally, should we adopt a system under which our definition would automatically adjust upwards over time to reflect technological advances? Are there data sources measuring the state of technology in other countries that can guide the Commission in defining 'advanced telecommunications capacity' for the United States? For example, what speed do consumers in other industrialized nations expect from mainstream residential broadband technologies?[41]

In other words, the FCC is opening a dialogue about what types and levels of telecommunications services should be considered "advanced" for the purposes of promoting universal telecommunications services.

1.D.vii. Universal Service Fund

Immediately after enactment of TCA in 1934, the FCC created the Universal Service Fund (USF) to equalize the cost of telephone service which otherwise might be prohibitively expensive, particularly for rural and isolated telephone users. Voice telecommunications providers are required to contribute on an equitable and nondiscriminatory

basis to this fund designed primarily to provide universal voice telephone service.[42] Similarly, most of the universal service funding is restricted to providing voice communications over ordinary telephone lines.[43] USF funding is available only to qualified telecommunications service providers who agree to provide telephone service to rural or high-cost areas at the same rates as to urban areas.[44] Broadband, Internet and other advanced telecommunications, with a few exceptions, are not eligible for universal service funding. Among these exceptions are USF funding of Internet access programs for schools, libraries, and rural health care providers.[45] For the average rural broadband consumer user, USF funding is not available with regard to advanced telecommunications such as high-speed Internet access.

Currently, all telecommunications companies that provide international and interstate telephone service, long-distance companies, local telephone companies, wireless telephone companies, paging companies, VoIP, and payphone providers, are required to contribute to the Federal universal service fund administered by the Universal Service Administrative Company (USAC).[46] USAC allocates these funds to support authorized universal service programs around the Nation. The two main USF programs – the High-Cost Program and the Low-Income Program – are restricted to support only voice communications services. As noted above, the only Internet services authorized to receive USF funding are the Rural Health Care Program and the Programs for Schools and Libraries otherwise unable to connect to the Internet.[47] Section 254 also authorizes the FCC to establish The Federal-State Joint Board on Universal Service. This Joint Board was created by an FCC order to set policies for the various universal service programs.[48]

The Rural Health Care Program of the USF is a support program authorized by Congress and designed by the FCC to provide reduced rates to rural health care providers for telecommunications services and Internet access charges related to the use of telemedicine and telehealth. Support is available for telecommunications

services and monthly Internet access charges used for the provision of health care. Support also is available for limited long-distance charges for accessing the Internet. The level of support depends on the location and the type of services chosen and is calculated individually for each health care provider. A health care provider can save on services it already has, upgrade current services, or install new services.

Under the Universal Service Fund and E-Rate Program, the telecommunications needs of every rural K-12 school can be serviced through subsidized discounts. Libraries or library consortia eligible for assistance from a State library administrative agency under the Library Service and Technology Act and not operating a for-profit business are eligible for discounted services. The level of discount is based on a school's or library's percentage of students eligible for the national school lunch program and its location in an urban or rural area. Eligible schools and libraries may purchase commercially available telecommunications services, Internet access, and installation and maintenance of internal connections at discounted rates. They may choose from a wide array of telecommunications services and technologies, such as basic telephone service, a T-1 line, and wireless telecommunications services. A school or library can apply for a discount on a specific service either as an individual entity or as part of a consortium which has identified common communication needs and planned for a community infrastructure.

There has been considerable debate about expanding the USF High-Cost and Low-Income Programs so that USF funds also would be available to subsidize advanced telecommunications services, such as broadband, in unserved and under-served areas, such as rural communities. In the 110th Congress,[49] "the Universal Service for Americans Act"[50] was reintroduced by Senator Stevens as S.101. This bill would (i) increase the universal service tax base to include broadband providers, and (ii) fund broadband deployment in rural and low-income regions of the country. S.101 was referred to the Senate Committee on Commerce, Science, and Transportation. If

passed, this bill could promote projects deploying advanced telecommunications in the form of backbone installation in interstate highway ROW and interconnection of that backbone with rural broadband providers and ultimately rural broadband subscribers.

1.D.viii. Data on HST Deployment

Promoting access to advanced telecommunications in rural and high-cost areas has become an increasing FCC priority. Non-governmental initiatives calling for universal access and decrying the digital divide have stimulated FCC activities in this area. For example, the FCC recently issued "Lands of Opportunity: Bringing Telecommunications Services to Rural Communities" (July 2006). After establishing the USF, one of the most prominent of the FCC's regulatory activities with regard to extension of broadband service to unserved and underserved rural areas has been collection of statistics regarding areas that are and are not served by high-speed Internet services.[51] FCC statistics regarding high-speed Internet availability in underserved areas are often criticized because they are based on geographical ZIP codes and count a ZIP code as being served by advanced telecommunications even when only one broadband subscriber in that ZIP code has a high-speed Internet connection. Such statistics do not reflect the actual penetration of advanced telecommunications services to populations of rural users.[52]

In April 2007, the FCC responded to dissatisfaction with universal service statistical information regarding broadband availability based on ZIP codes. The FCC's Notice of Proposed Rulemaking regarding *Development of Nationwide Broadband Data to Evaluate Reasonable and Timely Deployment of Advanced Services to All Americans*[53] seeks to improve data so that FCC statistics better reflect the actual availability of advanced telecommunications services in rural and other underserved areas.

Simultaneously, the FCC also issued the Notice of Inquiry,[54] discussed above, regarding “whether advanced telecommunications capability is being deployed to all Americans in a reasonable and timely fashion” under TCA section 706.[55] These recent FCC initiatives appear to indicate that the nature of universal service, particularly in the form of advanced telecommunications, is likely to change, reflecting the TCA’s original concept of universal service as “an evolving level of telecommunications services” defined by the FCC under TCA section 706.

1.E. State Departments of Transportation and Broadband Telecommunications

1.E.i. The Wired Organization

The traditional focus of State Departments of Transportation (DOT) has been just that – transportation. Their mission is to provide a safe and efficient transportation network that promotes commerce and tourism and provides throughput over roadways that are well maintained. This has been their focus for almost 100 years. It is just recently, in the last 15 to 20 years, that Intelligent Transportation Systems (ITS), which utilize electronics and communications to improve transportation operations, have come into being. Although this has not changed the focus of State DOTs, it has changed the way they do business and the tools used to accomplish their mission.

1.E.ii. Telecommunications and ITS

ITS utilizes electronic equipment, software, computers, servers, and communications technology, along with coordinated operations between DOT employees and their partners, to improve the management and operation of the transportation network. ITS equipment comprises closed circuit television (CCTV) cameras, dynamic message

Typical CCTV Camera on Pole

signs (DMS), vehicle detection sensors, environmental sensing stations, traffic signals, highway advisory radio (HAR), warning signs, mobile data terminals, in-vehicle technologies, and a host of other applications. Many of these devices that are located along highway rights-of-way require a connection to an external power source and almost all require communications, either wireline or wireless, or a combination of the two. From the field, the data are transferred back to an office or operations center staffed by State or local agency employees who manage the devices. Data also are transferred from the operations center to the field equipment in the form of commands to post messages to DMS or to manipulate CCTV cameras.

Although wireline technologies can be used exclusively to link field equipment to the operations center, wireless communications are frequently used to connect field equipment from the device to a point where they can be connected to a wireline backbone, from which point data is transported to and from an office or operations center. An example would be a DMS that is located in a remote portion of highway. Many times power is conveniently available in rural areas for these devices, but communications are not. A typical installation might include a directional antenna mounted to a tower or other tall structure on high topography with line of sight

to the DMS, transmitting and receiving data from the sign. The directional antenna will then be connected to a high-speed communications backbone at the base of the tower. The backbone will carry data to and from the tower creating a hybrid wireline/wireless network for communication with the ITS field device.

Typical Handhole or access point

With the proliferation of ITS devices in urban areas across the United States and increasingly in rural areas along major corridors, there has been an increased need for HST to transport data between field devices and centralized operations centers. It has become commonplace for State DOTs to install fiber optic communication cables within the ROW in urban areas to transport video images and data. With a typical density of cameras installed in an urban area of every one-half to one-mile, and vehicle detectors and DMS being installed as well, it has made economic sense for DOTs to deploy their own telecommunications infrastructure that is used exclusively for ITS. Telecommunications infrastructure in this case includes conduits, fiber optic cable, communication electronics, access points, regeneration buildings, wireless communications equipment, and towers. At the same time, urban ROW is one of the more difficult areas to install communications infrastructure due to little or no ROW remaining along some urban corridors.

In rural areas, it is a different story. There may only be one or two ITS devices installed within a 30-mile segment and they may be nowhere near a viable communications access point served by either the DOT or the private sector. Although wireless can be used to connect some of these devices that do not require a high-bandwidth connection, such as DMS or vehicle detection, CCTV cameras require substantially more bandwidth to transmit images and typically optical fiber is used. Microwave systems can be used, but require line-of-sight between the ITS field device and microwave transceiver and most frequencies require FCC licensing. Microwave systems also are subject to weather interference and may require additional maintenance to monitor exact alignment. The cost of installing the communications infrastructure needed to have fiber along the length of a rural corridor is usually not within the budgets of most DOTs. To meet their needs, a DOT will generally pay for a connection to be made from the CCTV camera or other equipment to the local service provider's nearest communications access point, which may be several miles away. Without other users on that line, the State DOT bears the brunt of the installation cost.

1.E.iii. Resource Sharing and Public-Private Partnerships

In the mid- to late-1990s, a new type of telecommunications model arose in the United States. Between State government and private sector telecommunications carriers. As a result of growing demand for HST, telecommunications companies were installing new communications infrastructure as quickly as possible. They had always recognized the value of highway ROW for the creation of utility corridors. Most States freely allowed and still allow utilities to place their infrastructure on highway ROW at no charge. The one exception to this was interstate highway ROW. FHWA policy did not allow utilities to be installed longitudinally along interstate highway ROW, citing safety concerns for drivers if there was constant utility construction and maintenance taking place along the edge of the road. In 1988, this

policy was changed to allow the installation of communications infrastructure only along interstate highway ROW. This change opened the way for the creation of several public-private partnerships, or shared resource projects, across the country.

The private sector telecommunications companies recognized that interstate highway ROW had advantages over other public rights-of-way or private land. It provided a cross-State corridor that was almost devoid of other utilities, provided relatively open areas for construction, had limited crossing roads, and connected major urban areas that were their prime markets. The other options available included easements on privately owned land, which would require extensive negotiations with multiple landowners; use of railroad right-of-way, of which some companies did take advantage; and use of non-interstate highway rights-of-way. These non-interstate highway routes may be used by multiple companies, increasing the risk of damage by other utility operators. Construction is made more difficult due to curb cuts for commercial and residential access, crossing roads, and high-traffic volumes in towns and urbanized areas.

For these reasons, interstate highway ROW has value to companies that need to install infrastructure rapidly. To compensate the States for the use of this ROW, public-private partnerships were formed in which the telecommunications company would share their infrastructure with the states and bear most of the construction costs as well. In return, the State would allow a company to have the right to install their infrastructure on the ROW, sometimes exclusively, and be able to access it as needed. The compensation to the states can be in the form of cash, conduit, dark fiber, lit fiber, communications service, or a combination of the above. This is commonly referred to as a shared resource project.

1.f. Process for Delivering Study

Delivery of this *Report to Congress* has been a cooperative effort involving the Federal Highway Administration (FHWA) of the U.S. DOT and the National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce. FHWA and NTIA staff worked closely to develop a framework for analysis, and brought together stakeholders from State and local government for consultation.

The study process to-date has included:

- Consultation and involvement of stakeholders from participating States, through corridor and State-level workshops as well as a project web site;
- Corridor definition, profiling, and assessment of HST benefits and needs for each of the study corridors; and
- Investigation of preliminary alignment issues, including policy, regulatory, institutional, engineering, cost, and other issues related to design and deployment.

The forthcoming *Report to States* will include a more detailed assessment of potential alignment issues, including conceptual designs, technological and institutional options, and policy recommendations.

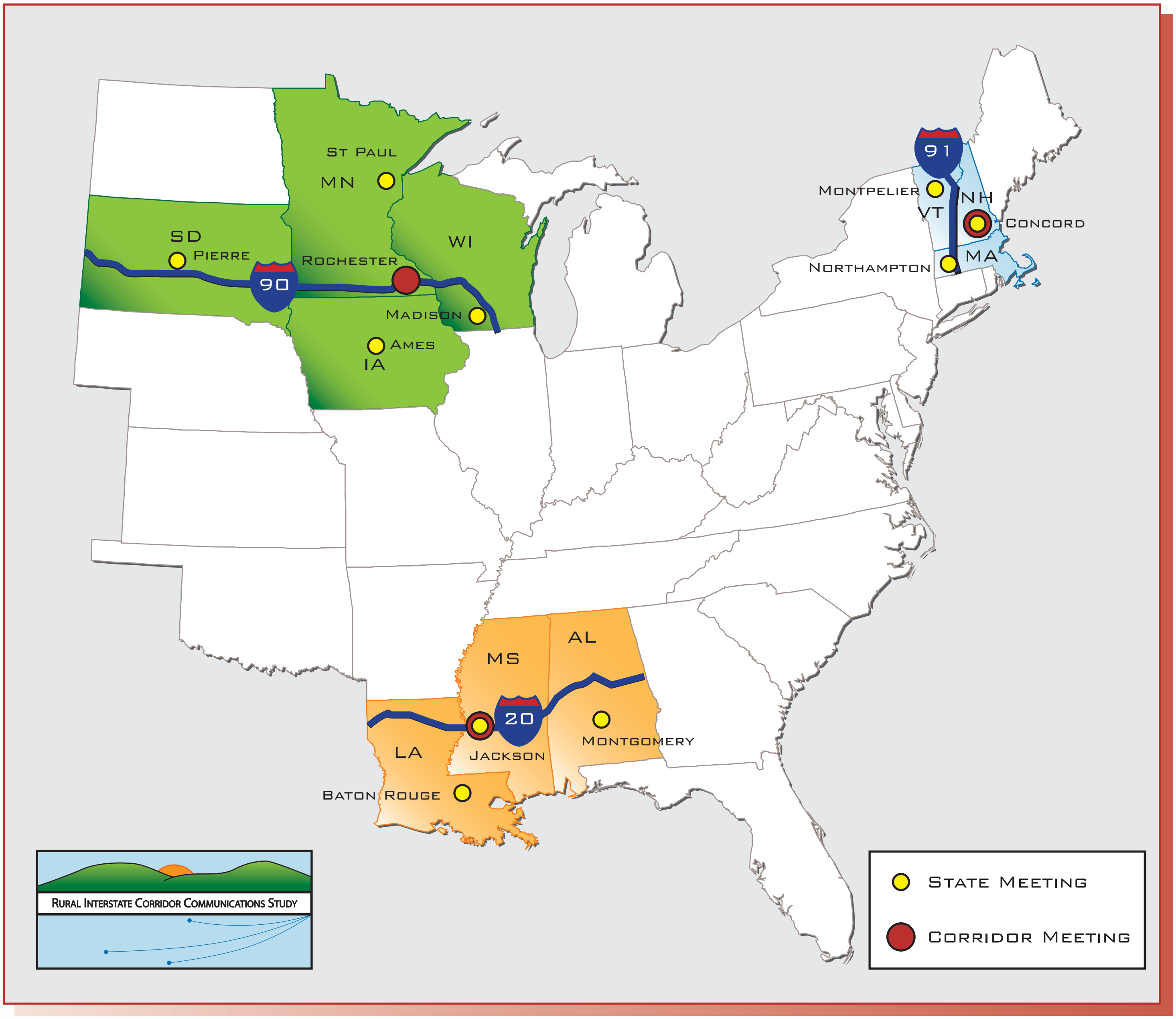
1.F.i. Stakeholder Involvement

In order to determine the current environment for HST projects along interstate highway rights-of-way along the study corridors, it was necessary to gather the opinions of many stakeholders in both the public and private sectors. The State DOTs have a large role in the process of developing a shared resource project and are generally the lead State agency that engages in the partnership. The interstate highway

ROW is controlled by the State DOT and managed in a manner consistent with the State's utility accommodation policy. Many States also manage their telecommunications assets through one agency that procures and maintains the State's communication networks, and works cooperatively with all State agencies to provide services. State DOTs and State information technology offices were the two primary stakeholders from which opinions and ideas were sought by the study team during a series of corridor workshops and State meetings held with each of the 10 corridor States. Through the corridor and State meetings, over 50 stakeholders from the 10 States were given the opportunity to provide input to the report.

In February 2007, three workshops were held, one in each of the three study corridors. All 10 States in the corridors were invited to attend, and at least one representative from each State was present at their respective workshop. The workshops began with an overview and purpose of the study providing background to the participants on why the FHWA was seeking their input. A roundtable discussion followed where a series of topics were introduced and participants' input was recorded. Given the corridor approach to the study, the discussions included information on how the States worked cooperatively across State lines. The meetings ended with a request to the states for various documents and data that the study team would use for this report. Figure 1 shows the locations of the workshops and State meetings along the study corridors.

Figure 1: Location of workshops and State meetings along the corridors



Subsequent to the corridor meetings, one-on-one meetings were conducted with each of the 10 States to continue the collection of key documents and to obtain additional input. During April and May of 2007, all 10 States met with the study team for detailed discussions and to gather the State's input for and expectations from this study.

Another important outreach tool for this study is a project web site (www.ruralcomm.org) established for the study team and project stakeholders to use for sharing information about the study, dissemination of various reports developed as a part of the study, and sharing of documents and data collected from the States. The web site is internal to the study team and project stakeholders and is password protected. A majority of the participating States made use of the project web site for viewing project information and all agreed it is a helpful and beneficial tool for them to use as the study progresses.

1.F.ii. Corridor Definition, Profiling, and Assessment of HST Benefits and Needs

The three rural interstate highway corridors were initially assessed using a regional focus, with stakeholders from the multiple States in each corridor included in the corridor definition process. Corridor boundaries were established using a 25-mile buffer zone on each side of the interstate highway routes, loosely determined by census block group boundaries. This buffer zone represents the approximate area that would most benefit most from access to HST backbone along the interstate highway alignments.

Existing conditions and trends in the three study corridors were mapped and tabulated using a variety of data sources and methods. The objective was to examine key conditions and trends affecting telecommunications needs and demand. The data examined included demographic and socioeconomic data; population growth trends; economic conditions and industry mix; the number and location of key telecommunications

users such as hospitals, schools, and libraries; and the locations of existing communications infrastructure. Given the intended focus of the study on rural telecommunications needs, data were examined separately for urbanized versus non-urbanized areas within the corridors. Figures 2, 3, and 4 display the study area with population density for each corridor.

The corridor data were used to perform a sketch-level assessment of corridor bandwidth requirements. This assessment was based on typical existing HST demand by various user groups (in situations where HST is available). The analysis assumed that current growth rates and economic and demographic patterns in the corridors would remain largely unchanged in the future, and that major advances in HST technology or major increases in bandwidth requirements (compared to current levels of usage) would not occur. This telecommunications analysis is detailed in *Task 3: Corridor Profiles*.

In addition to reviewing data on existing conditions and potential bandwidth requirements, telecommunications needs in the corridors, and the potential benefits of more widespread HST deployment, also were investigated. This investigation included a review of recently published studies on rural telecommunications needs and benefits, as well as interviews with key people knowledgeable about each corridor such as economic development officials, State and regional planners, and staff at educational and health care institutions. Information and views were compiled on specific needs, benefits, and HST-related initiatives underway or planned. Finally, national studies estimating the economic benefits of HST were used in conjunction with corridor-level data to develop rough monetary estimates of the potential benefits that could occur as a result of improved access to HST in each corridor.

Based on these various data, a SWOT analysis was conducted. A SWOT analysis is a tool to delve into the Strengths, Weaknesses, Opportunities, and Threats (SWOT) inherent in a concept or strategy. In the context of this report, the SWOT analysis

Figure 2: I-20 Corridor Population Density

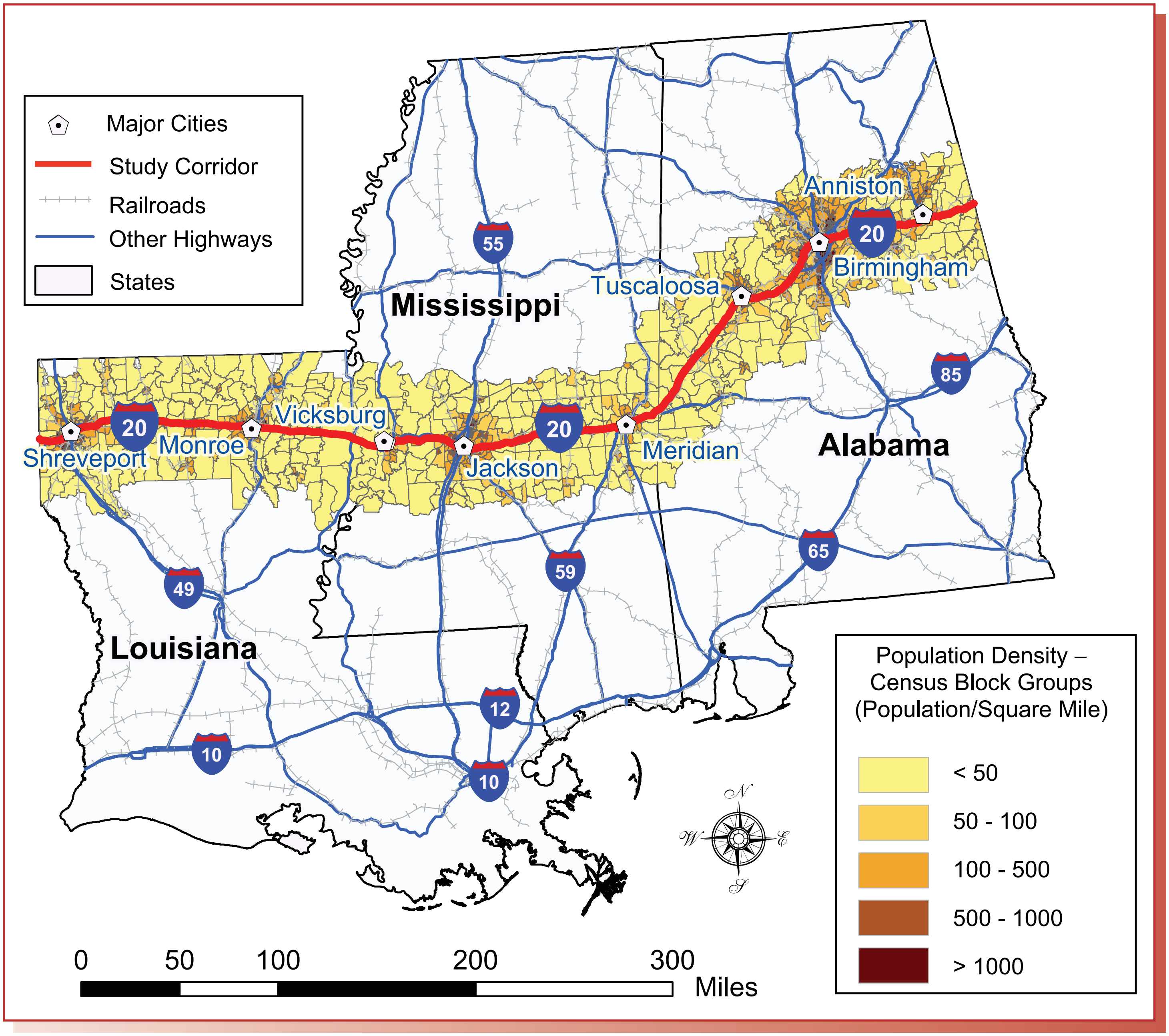


Figure 3: I-90 Population Density

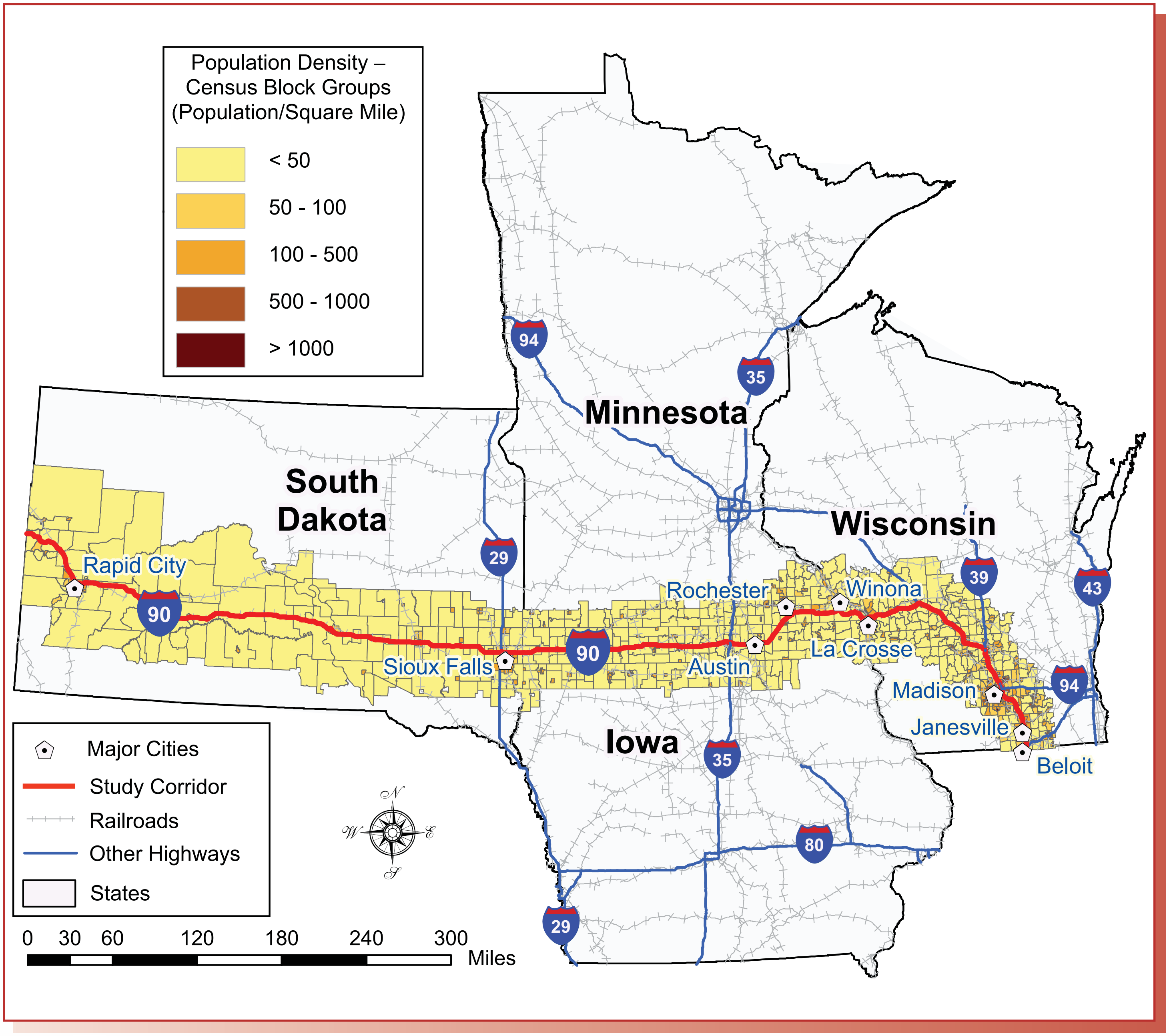
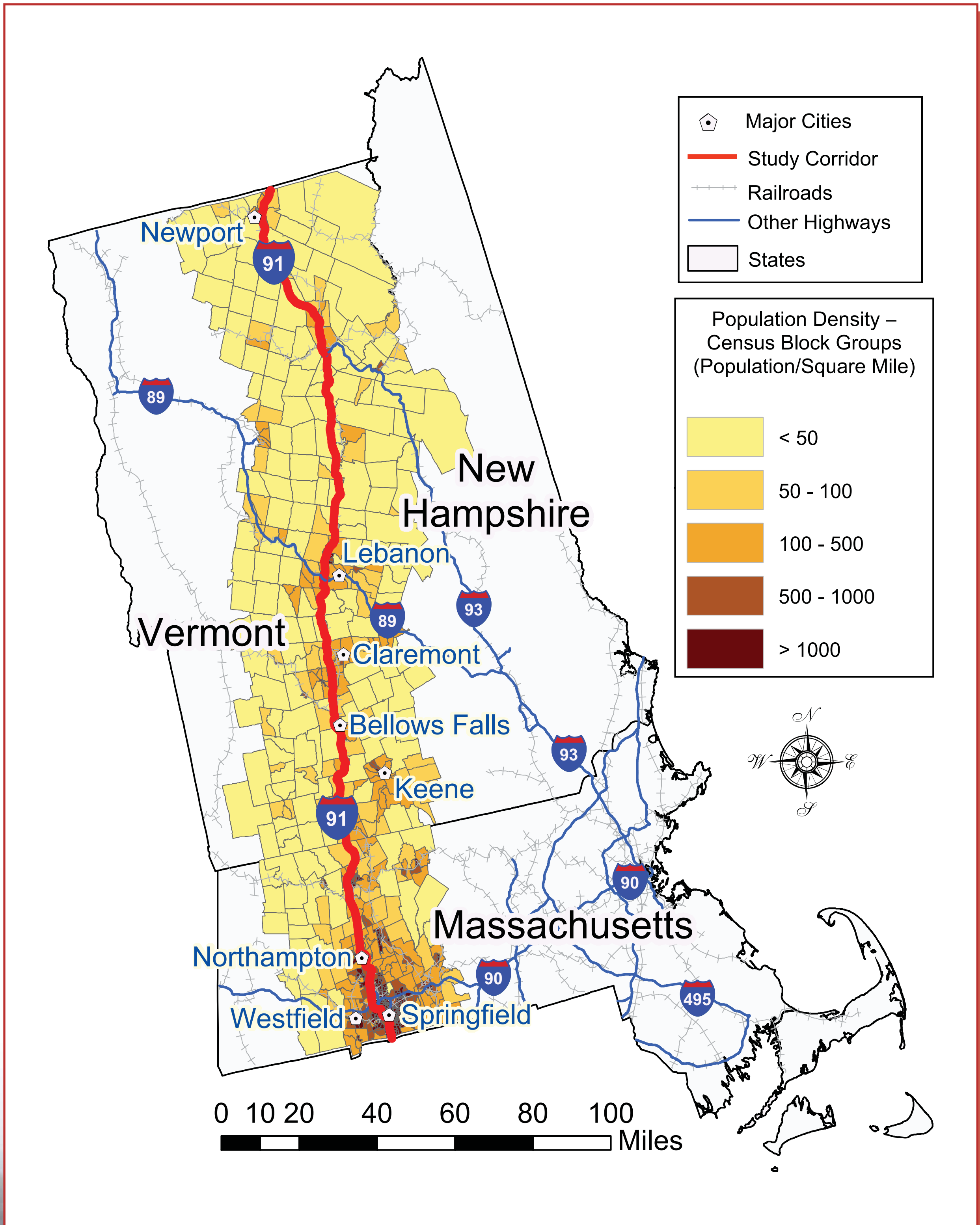


Figure 4: I-91 Corridor Population Density



examines and identifies the benefits and risks of providing broadband service (via a shared resource project) to the rural communities along the I-20, I-90, and I-91 corridors. This analysis is contained in Appendix A. It should be noted that the SWOT analysis considered both the private entity and public agency perspective. Therefore, within the matrix, the public agency perspective is denoted by bolded entries, while the private entity perspective is denoted by italicized entries.

SWOT Methodology

A SWOT analysis was conducted to examine and identify benefits and risks of providing broadband service (via a shared resource project) to the rural communities along the I-90, I-91, and I-20 corridors. It is important to note that the SWOT analysis focused on the strengths, weaknesses, opportunities, and threats with regards to the attainability of the potential benefits identified for each of the corridors. The SWOT analysis did not address the specific technologies (e.g., wireless and/or wireline) used to deploy the telecommunications backbone.

The following definitions apply for the SWOT analysis:

- *Strength is an inherent attribute that can help attain the objective;*
- *A Weakness is an inherent attribute that can interfere with the attainment of the objective;*
- *An Opportunity is an external condition that can help attain the objective; and*
- *A Threat is an external condition that can interfere with the attainment of the objective.*

The ultimate goal of a SWOT analysis is to leverage the strengths and opportunities while minimizing or mitigating the weaknesses and threats.

For each of the three corridors, information was gathered through corridor meetings, telephone conversations, and Internet research with an eye to addressing economic development, deployment of ITS, homeland security precaution and response, education systems, and health systems. A SWOT matrix for each corridor was applied to the information gathered and was summarized in the "Task 4 Report: Potential Impacts Analysis."

The results of the analysis of current conditions and trends, as well as HST needs and potential benefits, have been compiled in a series of technical memoranda, and are available as addenda to this report.

1.F.iii. Preliminary Alignment Approach

As part of the scope of this study, a preliminary telecommunications alignment plan is to be produced, in the *Report to States*, that will provide a guide for the location of telecommunications infrastructure within the ROW along the three identified corridors. The alignment plan is to identify technological options, preferred locations for the infrastructure in the ROW, ideal locations of access points, potential areas of difficult construction, and environmentally sensitive areas that will require extra care during design and construction. This plan is to be produced as part of the *Report to States*, which also will be made available to Congress.

Utilizing the information previously gathered from the States, corridor-specific teams will work with each State to develop a concept for how they would like to have telecommunications infrastructure installed along their interstate highway ROW, if a project were to be developed in their State. No additional surveys will be performed and existing data from the states will be utilized to its fullest extent. Specifically, State utility accommodation policies will be used to determine the preferred location for utilities along access-controlled ROW. Any utility construction standards available also will be used.

Access points to telecommunications along the ROW are critical for the end users. Access can be anything from a fiber vault with a splice enclosure inside to access the fiber backbone or it can be an access connection within a regeneration building (Figure 5 and 6) along the ROW. Candidate location for access points to fiber optic lines, such as at key crossroads, at ITS field devices, at a university campus, or at another State facility, will be investigated and documented by the corridor teams and noted on the preliminary alignment plans.

Figure 5: Regeneration Building – Exterior

Figure 6: Regeneration Building – Interior

In the preliminary alignment plans for each State, a catalog of areas along the corridor that represent environmentally sensitive areas, such as wetlands, streams, or other protected areas will be created. Applicable environmental regulations, both State and Federal, will be cited that any project developer will need to be aware of before beginning construction. Any special environmental issues particular to a State will be identified and addressed. Construction issues will be addressed in a similar way. Standardized design templates will facilitate efforts to design telecommunication infrastructure. Extensive rock outcroppings, narrow ROW, and dense urban areas are examples of items to be explored.

The preliminary alignment plans will identify locations along the corridors that are potential sites for communications towers. This may include locations on State-owned ROW or other property adjacent to the corridor that meet the sizing needs for a tower.

In addition to conforming to all applicable State standards for the construction of utilities within rights-of-way and State utility accommodation policies, the preliminary alignment plan also will utilize and consider specific Federal standards such as the "FHWA Program Guide for Utility Relocation and Accommodation" and the "Federal Rights-of-Way Working Group Report on Improving Rights-of-Way Management Across Federal Lands."

2. Corridor Definitions and Profiles

This section defines the corridors, identifies the sources and methods for collecting data on the corridors, and presents the profile for each corridor. The profiles discuss existing conditions and trends in demographics, economics, health resources, and education resources. In addition, this section discusses the extent of existing telecommunications backbone facilities in each corridor. The information contained in this section is a summary of a more detailed analysis contained in *Task 3: Corridor Profiles* document generated as part of this study.

2.a. Corridor Locations and Study Areas

Section 5507 of SAFETEA-LU identified three interstate system corridors for study. These corridors are described briefly below.

- **I-20 Corridor –** Interstate Highway 20 (I-20) extends 1,535 miles across the southeastern United States, from western Texas to Interstate 95 in South Carolina. This study is concerned with the 542 miles of I-20 that passes through Louisiana, Mississippi, and Alabama. The study corridor encompasses a 25-mile buffer on each side of the interstate highway.

- **I-90 Corridor –** Interstate Highway 90 (I-90) is the northernmost east-to-west, coast-to-coast interstate highway in the United States, extending from Seattle, Washington to Boston, Massachusetts. This study focuses on the 843-mile portion of I-90 that passes through South Dakota, southern Minnesota, and central and western Wisconsin. The study corridor, which encompasses a 25-mile buffer on each side of the interstate highway, also includes portions of northern Iowa.

- **I-91 Corridor –** Interstate Highway 91 (I-91) extends from New Haven, Connecticut at Interstate 95 to Derby Line in Vermont at the Canadian border and runs north and south through the states of Connecticut, Massachusetts, and Vermont. The focus of this study is on the 242-mile portion of the corridor that spans the length of Massachusetts and Vermont. Portions of western New Hampshire also are included in the 25-mile buffer defining the corridor study area.

Study area boundaries for each corridor were established using a 25-mile buffer zone on each side of the interstate highway routes, with the boundaries of the analysis area based on census block group boundaries. This buffer zone represents the approximate area that would most stand to benefit from access to HST backbone along the interstate highway alignments. In some cases, this buffer zone included areas in neighboring states (i.e., Iowa and New Hampshire) that do not actually contain any segments of the interstate highway under consideration.

While the focus of the study is on providing HST to low-density rural areas of the country, each of the corridors also encompasses multiple urbanized areas (UZA), defined by the Census Bureau as an urban nucleus of at least 50,000 people meeting certain density thresholds. Because these urbanized areas are considered to be more likely to already be well-served by HST providers, and because the nature of benefits and needs may vary significantly for urbanized versus rural areas, statistics are presented separately for urbanized versus non-urbanized areas as well as for the corridor as a whole.[56] Nevertheless, the urbanized areas are considered an integral part of this study, given that the corridor communications technologies will integrate with existing and planned systems in these urban areas.

2.b. Data Collection and Management

The study team used a Geographic Information System (GIS) framework to facilitate the assembly, analysis, reporting, and evaluation of a wide range of information on demographics, economics, health and education resources, and land use. GIS can facilitate the integration of data across disparate sources and provide the ability to query data using both spatial and non-spatial properties. A GIS framework provides a convenient method for visualizing attributes and characteristics of the corridors in this study.

The various corridor data collected and analyzed include:

- Demographic and socioeconomic data from the 2000 U.S. Census, examined at a Census Block Group level. Key profiling indicators included race and ethnicity, age and gender distributions, income levels, educational attainment, disability status, and employment status;
- County-level year 2005 population estimates and State-level population projections through 2030 from the U.S. Bureau of the Census;
- Economic data from the 2002 U.S. Economic Census and the Bureau of Labor Statistics (BLS), including the number of businesses and total employment by industry, examined at a county level;
- Locations and population of urban centers in the corridors;
- Locations of Federal and Tribal lands;
- Locations and characteristics of institutions that are potential key telecommunications users, including hospitals, trauma centers, and other medical facilities; primary, secondary, and postsecondary schools; and libraries;
- The locations of State DOT facilities, including headquarters and district offices as well as operations centers; and
- Existing transportation and telecommunications infrastructure, including major roads, river crossings, railroads, and wireless communications towers.

Figures 7, 8, and 9 show the defined corridor areas.

Figure 7: I-20 Corridor

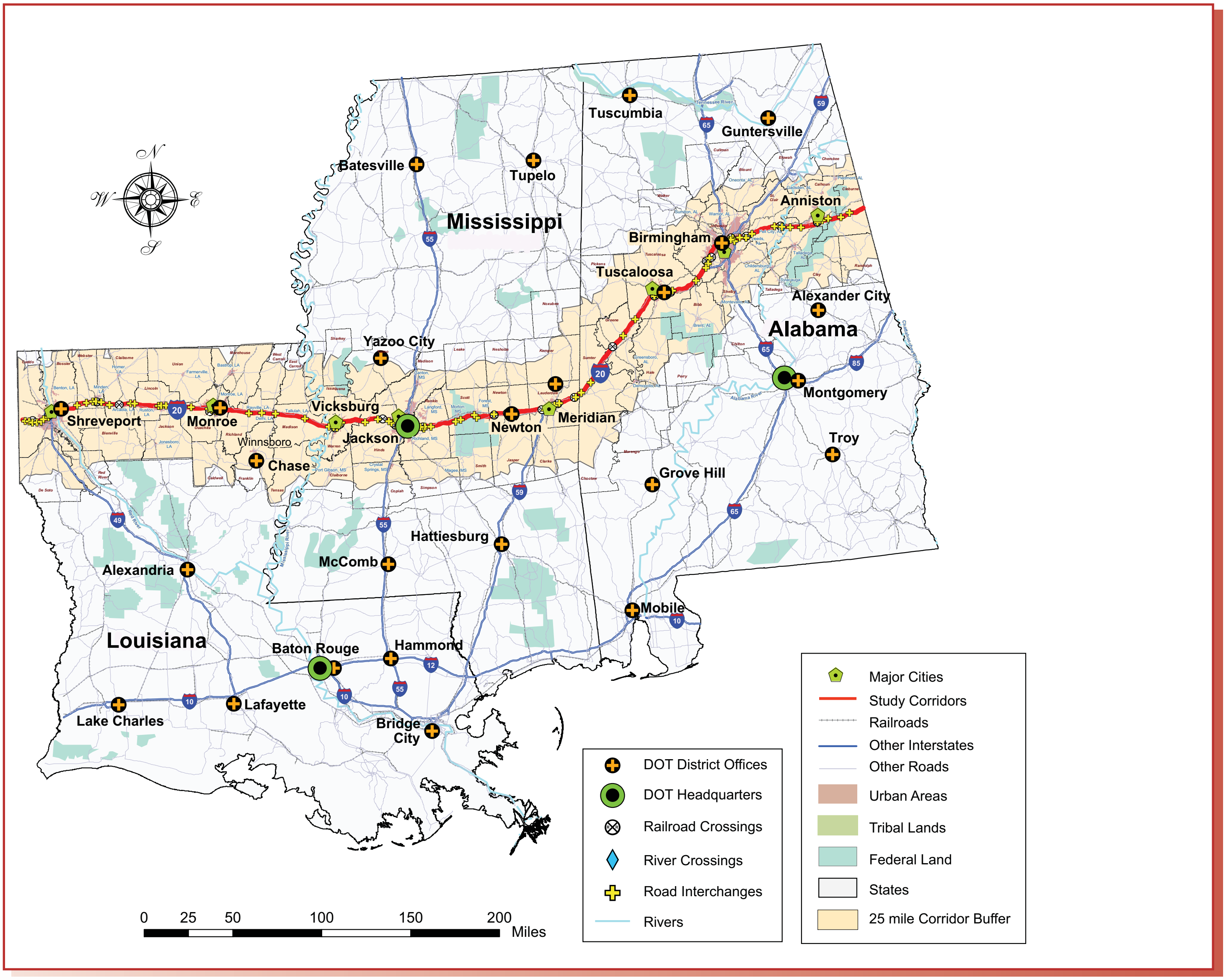


Figure 8: I-90 Corridor

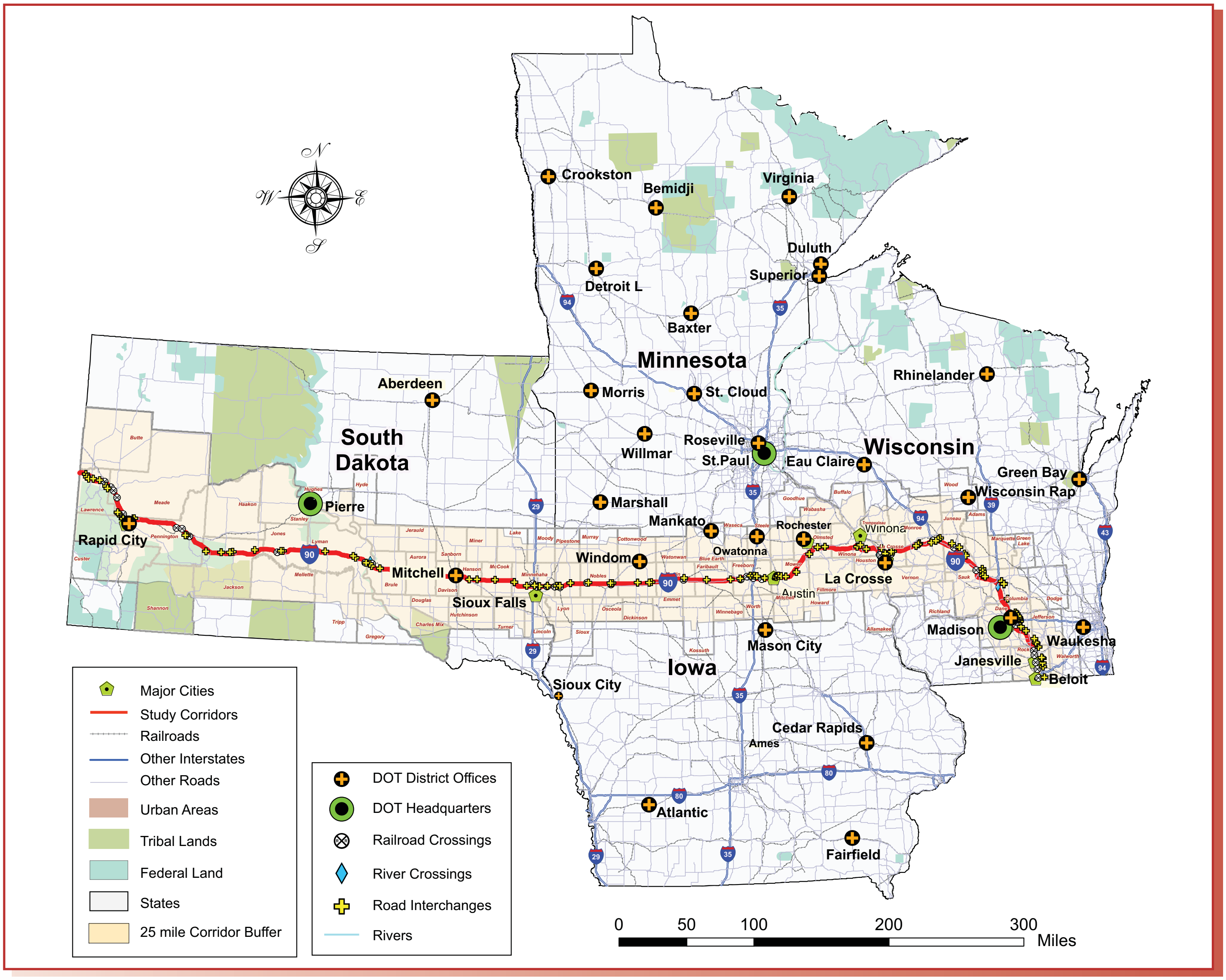
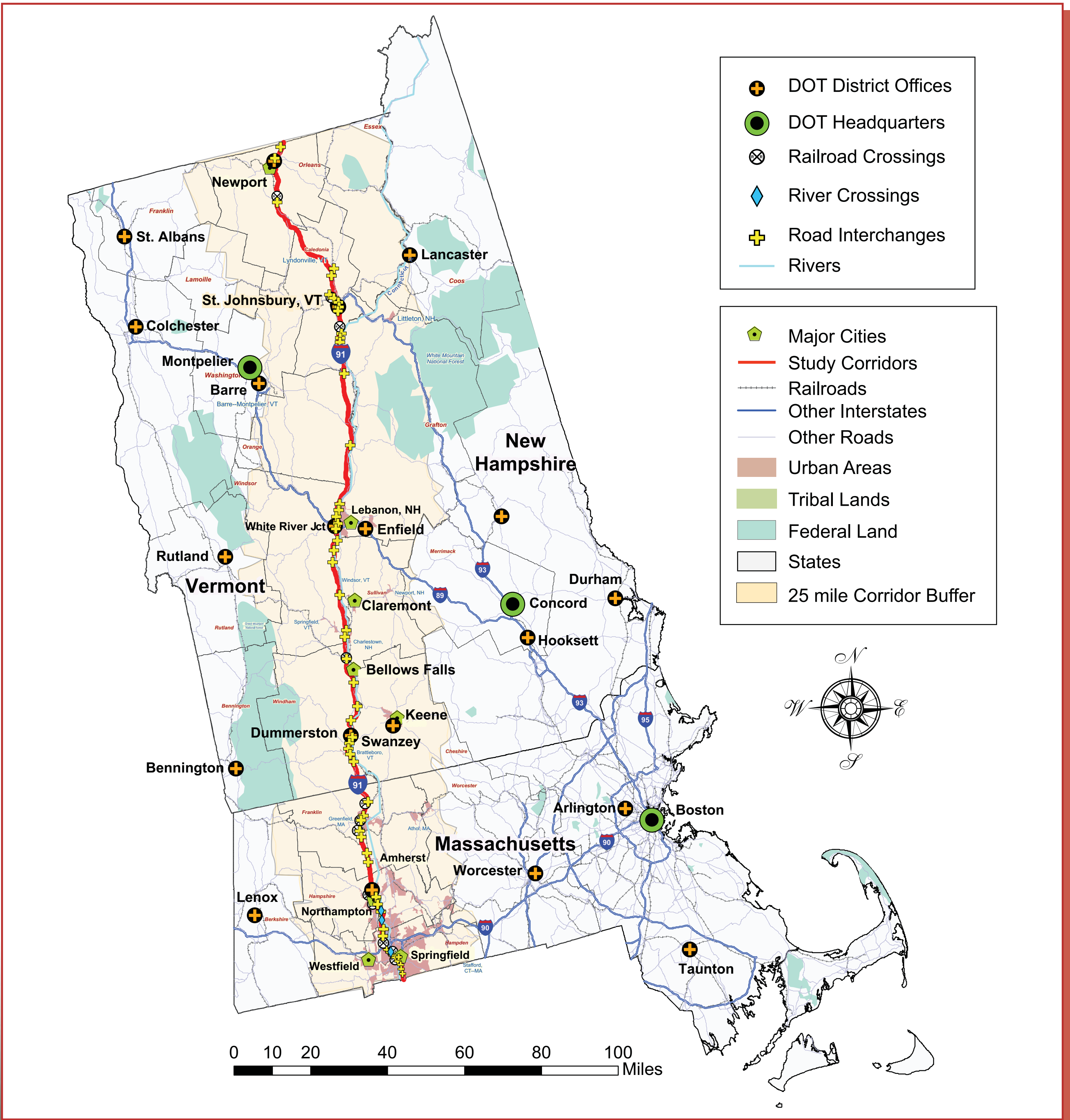


Figure 9: I-91 Corridor



2.c. I-20 Corridor

Demographics

The total population of the corridor in 2000 was 2,909,000, of which 54 percent was outside of the corridor's urbanized areas (UZAs). The non-urban population includes 665,400 people in Alabama, 471,000 people in Mississippi, and 418,500 people in Louisiana.

Outside of the urban areas, the population density was the lowest of the three corridors, averaging 427 people per square mile. The few areas outside the UZAs where the population is higher (between 1,033 and 2,746 people per square mile) tend to be the county seat, or areas with a heavy tourism/recreation base such as Demopolis, Alabama.

Between 1990 and 2000, the corridor experienced some population increase, primarily within and near the UZAs. Population change in rural areas was variable. County population estimates for 2005 indicate that the greatest population growth is continuing to occur in proximity to UZAs.

Whites make up 63 percent of the I-20 corridor population, while Blacks represent approximately 35 percent. American Indians, Asians, and other races collectively make up less than 2 percent of the population. Approximately 1 percent of the total population in the I-20 Corridor is Hispanic (of any race). The Mississippi-Choctaw Indian Reservation is the only reservation in the corridor and has four areas of land within the Mississippi portion of the study area.

Economics

The top three industries in the I-20 Corridor by the percent of population employed are health care (14.0 percent), manufacturing (13.6 percent), and retail (13.5 percent). The portions of Alabama and Mississippi located within the corridor have a

similar profile to that of the overall corridor. Health care, retail, and manufacturing industries are the top three categories, with health care industries employing the most people. The portion of Louisiana that is within the corridor does not have as much manufacturing employment as in the other two States of the corridor, and has higher employment numbers in the tourism industry. The I-20 Corridor has higher percentages of people employed in health care, retail, and manufacturing than the national average.

Unemployment rates for two States in the I-20 Corridor are the highest of the three corridors in the study.[57] While Alabama's statewide rate was 4 percent in 2005, which is below the national average of 5.5 percent, rates in Louisiana and Mississippi were well above the average, at 7.1 percent and 7.9 percent, respectively. For Louisiana and Mississippi the more than two-point increase from 2000 was likely influenced by the hurricanes of 2005.

Health Resources

The I-20 Corridor includes 64 medical centers, typically clustered around the urban centers, with a few substance abuse treatment centers and uncategorized facilities located in the non-urbanized areas. Two trauma centers are located in the I-20 Corridor: one at the University of Alabama at Birmingham and one at Louisiana State University (LSU) Health Sciences Center in Shreveport. Both are Level I facilities.[58]

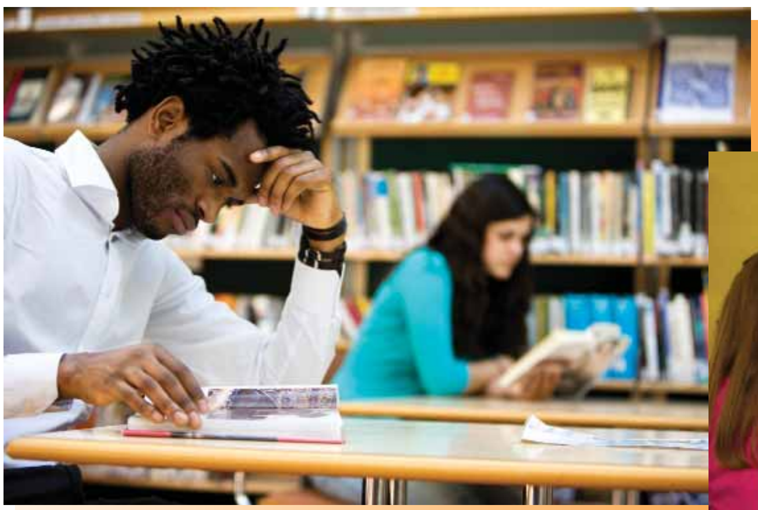
A number of telemedicine programs were identified in the I-20 Corridor. For example, LSU's Medical Informatics and Telemedicine Program supports clinical telemedicine services for various health care providers. The program works in conjunction with the Louisiana Rural Health Access Program to improve health care access for indigent and uninsured people in rural areas. LSU also works with other medical institutions to determine where rural telemedicine services could enhance access to care and efficiency of care delivery. The University of Mississippi Medical Center (UMC) facilitates

a program known as TelEmergency, which trains and places specially trained family nurse practitioners in rural emergency departments, who work under the direct clinical supervision of emergency physicians at UMC via a telemedicine video link.

Education Resources

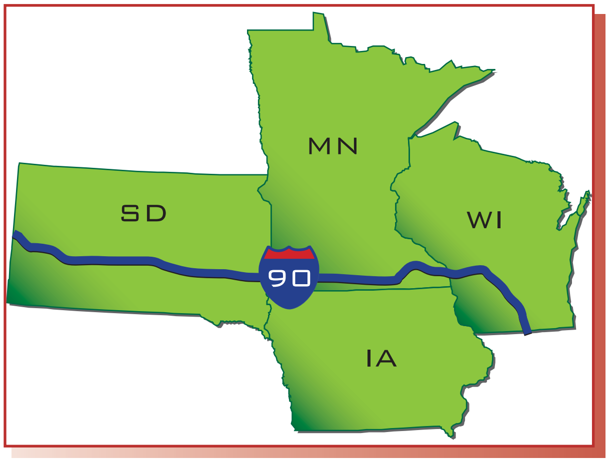
There are 821 elementary and secondary schools located in the I-20 Corridor of which 44 percent are located outside of UZAs. There are 80 postsecondary educational institutions in the corridor, 26 located outside of UZAs. These include public schools such as the University of Alabama at Birmingham, the University of Alabama at Tuscaloosa, several campuses of the Louisiana Technical College, and the University of Mississippi at the Medical Center (Jackson, Mississippi), as well as a variety of private colleges and universities.

There are 212 libraries in the I-20 Corridor, of which the majority (125) are located outside of UZAs. Libraries in the rural part of the corridor tend to exist along major transportation corridors, especially in smaller population centers.



2.d. I-90 Corridor

Demographics



As of 2000, the total population of the I-90 Corridor was almost 2 million, of which 67 percent was outside of UZAs. The non-urban population of the Corridor includes 258,600 people in South Dakota, 368,800 in Minnesota, 79,500 in Iowa, and 627,000 in Wisconsin.

The average population density outside of the UZAs is 847 persons per square mile. Non-urban population density decreases toward the western end of the corridor, averaging only 478 persons per square mile in South Dakota, compared to 808 in Wisconsin, and 1,098 in Minnesota. There are some areas outside of the UZA and well past the urban fringes that have a relatively high density. Mountain Lake and Wells, Minnesota are examples of such places, representing cities and larger towns that are too small to qualify as urban, yet contain a significant population.

Population in the I-90 Corridor has increased overall between 1990 and 2000. From the geographic trend in the corridor, it is evident that much of the increase in those years has occurred on the urban fringes of Madison, Wisconsin and of Rapid City and Sioux Falls, South Dakota. Year 2005 population estimates at a county level suggest that this trend is continuing.

Whites make up 93 percent of the corridor population, while Blacks make up 2 percent. Asians, American Indians, and other races make up less than 5 percent of the population. Hispanics (who may be of any race) make up 5 percent of the population.

Five American Indian reservations overlap the I-90 Corridor study area, including the Crow Creek, Lower Brule, Pine Ridge, Winnebago, and Yankton Indian Reservations. This corridor has the largest number of reservations of the three corridors in the study, and contains the largest number of American Indians (26,200 per the 2000 census).

Economics

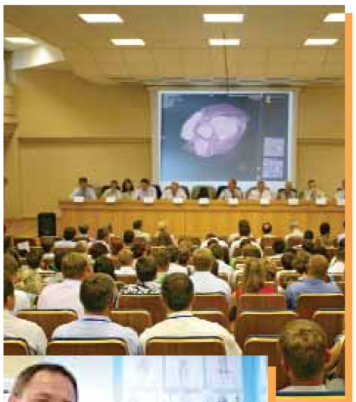
In 2005, the States within the I-90 Corridor had lower unemployment rates than the national average of 5.5 percent. Unemployment rates in 2005 were 4.7 percent in Wisconsin, 4.0 percent in Minnesota, 4.6 percent in Iowa, and 3.9 percent in South Dakota.

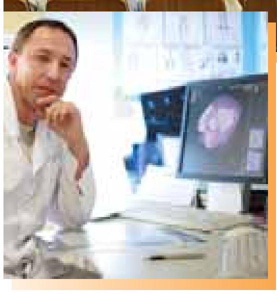
The top three industries in the I-90 Corridor are manufacturing (18.4 percent of the corridor employed population), health care (17.8 percent), and retail (14.7 percent). Examining the corridor by State, health care ranges from 13 to 25 percent of the population employed. Wisconsin has the smallest percentage of people employed in the health care industry, while Minnesota has the highest percentage. Iowa has the highest percentage of people working in manufacturing, while South Dakota has the lowest. Retail employment is fairly consistent across the four States. The I-90 Corridor has higher percentages of people employed in health care, retail, and manufacturing than the national average.

Health Resources

There are 105 medical facilities in the I-90 Corridor, of which 47 are located outside of an UZA. Thirty-two facilities in the corridor are mixed focus with a mental health orientation, and 66 are substance abuse facilities, most are located in or near an UZA. There are 4 trauma centers in the I-90 Corridor, all in UZAs. Wisconsin has 1 Level 1 trauma center at the University of Wisconsin-Madison and 1 Level 2 trauma center at the Gundersen Lutheran Medical Center in La Crosse. The other

2 trauma centers are Avera McKennan Hospital and Sanford USD Medical Center, both Level 2 centers located in Sioux Falls, South Dakota. The trauma hospitals and other medical facilities in the I-90 Corridor are typically affiliated with larger hospitals as part of four larger, regional care networks. For example, Avera McKennan Hospital is part of the Avera Health network, which has 229 facilities in the five-State region of South Dakota, North Dakota, Minnesota, Iowa, and Nebraska. The Sanford Health System, the umbrella organization for Sanford USD Medical Center, also serves this five-State region.





Various telemedicine programs were identified within each of the four major medical networks serving the corridor. For example, Sanford Health systems and Avera Health network both use video technology for telemedicine, distance learning, and video conferencing. Gundersen Lutheran uses video and HST to share information on vital statistics, symptoms, and other case details, as well as for conducting consultations and virtual office visits. Organizations like Gunderson Lutheran also provide oncology service, such as chemotherapy, to rural communities, with the assistance of video conferencing.

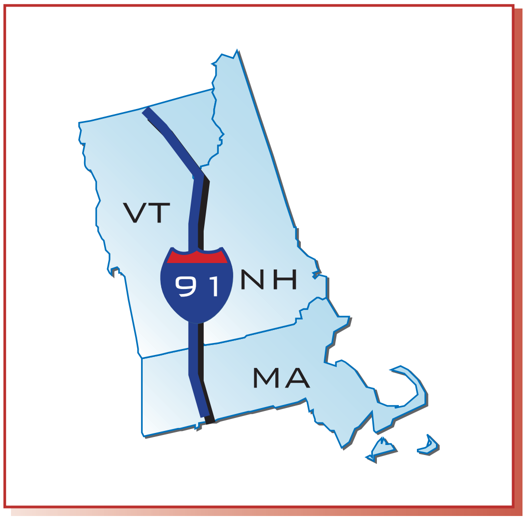
Educational Resources

There are 824 elementary and secondary schools in the I-90 corridor. 76 percent of all elementary and secondary schools in the corridor are located in or within 10 miles of an UZA; 366 are located outside of an UZA. There are 49 postsecondary educational institutions in the I-90 Corridor, 33 of which are located in an UZA.[59] Some of the larger postsecondary institutions in this corridor include the University of Wisconsin-Madison, the Mayo Medical School, Rochester Community and Technical College, La Crosse Lutheran Hospital Medical School, and Northern Iowa Community College. Distance learning courses at the university level are available through the University of Wisconsin system.

The I-90 Corridor contains 254 library facilities, 33 in the UZAs and 221 in the rural parts of the corridor. Outside of clusters in the urban areas, the libraries are typically located along major road corridors, especially in the larger cities and towns.

2.E. I-91 Corridor

Demographics



The total population of the I-91 Corridor in 2000 was 1,082,000, of which 41 percent was outside of UZAs. The non-urban population in the I-91 Corridor includes 254,700 people in Massachusetts, 174,700 in New Hampshire, and 210,200 in Vermont.

The average population density outside of the UZAs is 720 persons per square mile. Population growth from 1990 to 2000 in the corridor ranged from 0 to 9.2 percent at a county level. Most stable was the Springfield UZA (Hampden County) in Massachusetts, with a 0 percent change. The greatest population change was a population increase of 9.2 percent in Orleans County, Vermont. Many of the areas showing the highest percentage increase in population are located away from the urban cores and away from the immediate highway corridor.

Whites make up 89 percent of the corridor population, while Blacks make up 4 percent. American Indians and Asians each make up 1 percent or less. The remaining 4 percent is made up of people identifying as an "other" race, not specifically identified by the Census Bureau. Approximately 7 percent of the total population in the corridor is Hispanic (may be of any race). There are no American Indian Reservations located in the corridor.

Economics

All three States in the I-91 Corridor had unemployment rates in 2005 below the national average of 5.5 percent: 4.8 percent in Massachusetts, 3.5 percent in Vermont, and 3.6 percent in New Hampshire.

The top three industries in the I-91 Corridor[60] are health care (18.4 percent of the corridor employed population), retail (15.3 percent of the corridor population), and manufacturing (14.1 percent of corridor population). The I-91 Corridor has higher percentages of people employed in health care, retail, and manufacturing than the national average.

Health Resources

The I-91 corridor includes 51 hospitals or other medical treatment facilities, of which 30 are located outside of UZAs. The largest hospitals are Baystate Medical Center in Springfield, Massachusetts and Dartmouth-Hitchcock Medical Center in Lebanon, New Hampshire. Both are Level I trauma centers. Most community hospitals are affiliated with the larger hospitals as part of a care network; for example, Franklin Medical Center is affiliated with Baystate, which in turn is part of the Tufts New England Medical Network, and a number of the corridor hospitals are part of the Dartmouth-Hitchcock Alliance. One hospital in Springfield, Vermont is affiliated with Fletcher-Allen Medical Center in Burlington. Another major facility is the White River Junction Veterans' Administration Medical Center, which provides general services to approximately 94,000 military veterans. The corridor also is served by various community health centers; nursing homes, mental health, and substance abuse facilities; and private practices. Many of the private practices include only a single doctor. Often these practices are affiliated with the larger service networks.

Various telemedicine programs were identified within each of the three major medical networks serving the corridor. For example, through its teletrauma program, Fletcher Allen surgeons have direct video access to the emergency rooms of community hospitals and are available to consult on cases 24-hours a day, 7 days a week. Baystate and Franklin Medical Center are both designated as primary stroke treatment centers, and make use of telemedicine technologies to assist in stroke diagnosis and treatment. Dartmouth-Hitchcock is using telemedicine for video consults, and transmission of radiology images, and streaming video for learning services, among other applications.

Educational Resources

There are 391 elementary and secondary schools in the corridor, of which 233 are located outside of UZAs. There are 40 postsecondary schools, including 22 in Massachusetts, 10 in New Hampshire, and 8 in Vermont. Some of the largest include Amherst College, Hampshire College, and the University of Massachusetts – Amherst in Massachusetts; Dartmouth College in Hanover, New Hampshire; and Vermont Law School in South Royalton, Vermont. Twenty-four of the 40 postsecondary schools in the I-91 Corridor are located outside of an UZA.

Of the 276 libraries that exist in the corridor, the vast majority (245) are located outside of UZAs.

2.f. Existing Telecommunications Backbone in Corridors

Telecommunications backbones already have been constructed throughout the United States by both private entities and public agencies. Within the study corridors, the private-sector construction of fiber optics cables along the interstate highway rights-of-way has been limited to Louisiana and Wisconsin. Market forces in the 1990s, however, generally resulted in the private construction of long-haul optical

fiber cable routes roughly parallel to the corridors on different types of rights-of-way such as pipelines, secondary roads, railroads, and private easements to achieve the needed connectivity. These high-level presentations provide a glimpse of private sector HST investments in the area.

Some State agencies have constructed telecommunications backbones within corridor rights-of-way to serve ITS and safety needs, as detailed below:

- **I-20 –** Optical fiber is installed along I-20 around Jackson, Mississippi for use by the Mississippi DOT. The Louisiana Department of Transportation and Development (LaDOTD) has access to private sector optical fiber along I-20 between Shreveport and Monroe, through four access points. Louisiana also has eight microwave towers on I-20. The Alabama DOT has installed fiber on I-20 in the Birmingham area for their ITS needs and in the Tuscaloosa area for use by the State and city.
- **I-90 –** In Wisconsin, optical fiber is installed where I-90 and I-94 are coincident. There are six conduits, including one occupied by Wisconsin DOT 36-count fiber optic cable and one by an AT&T 288-count fiber optic cable. The other four conduits are empty. In Minnesota, there currently is no fiber optics installed on I-90 although there are 800 MHz microwave towers installed on or near I-90. In South Dakota, fiber optic cable has been installed in a three-mile section of I-90 near Sioux Falls and a 100-mile section between Spearfish and Wall. There is a pending installation request for a section of fiber optic infrastructure near Mitchell, South Dakota.
- **I-91 –** The Massachusetts Highway Department has released a request for proposals (RFP) to install optical fiber along I-91 through Massachusetts and I-291 in Springfield. The project will include six conduits, where four have been designated for future use and may be leased out. The private sector partner chosen to perform the work will be required to pull optical fiber through the empty conduits with the intent to provide high-speed communications to local communities along the corridor. In Vermont, the Agency of Transportation has a

funding source of $10 million to support an optical fiber project traversing the State along I-91 and is using that funding to complete the environmental and permitting process. Once that work is complete, the agency will issue an RFP for a public-private partnership to build out the communications network.

Research was conducted to provide a sense of the level of private sector deployment of fiber optic and tower infrastructure in the vicinity of the corridors. Macro-level information was provided to the study team by a private clearinghouse maintaining this information. Figures 10, 11, and 12 show existing fiber optic and tower locations in the defined corridors owned and operated by one or more private communications providers. In addition to interstate highway ROW, these communications facilities most likely run along frontage road systems and railroad lines or where ever the private provider could secure access.

Figure 10: I-20 Existing Private Provider Fiber Networks and Tower Infrastructure

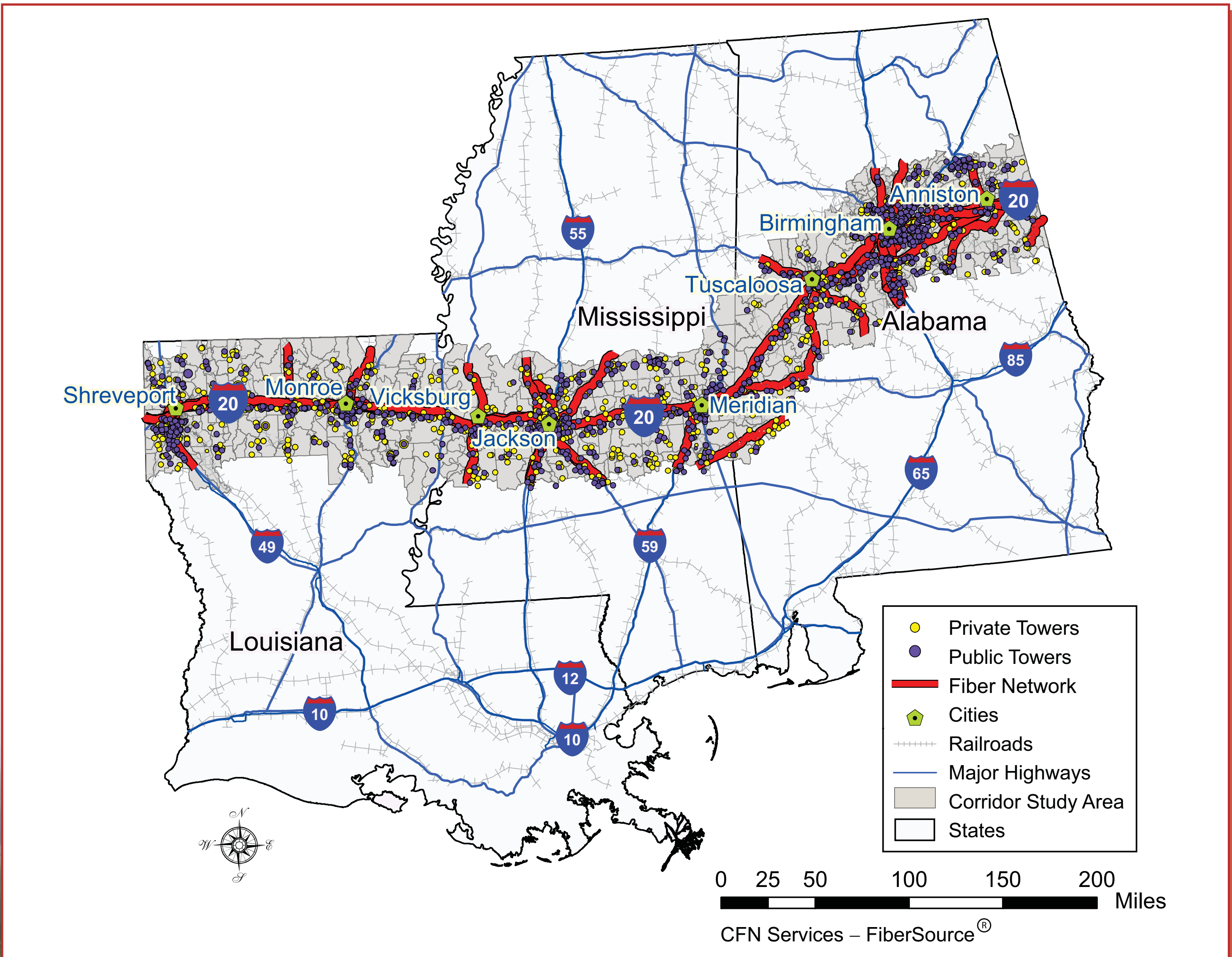


Figure 11: I-90 Existing Private Provider Fiber Networks and Tower Infrastructure

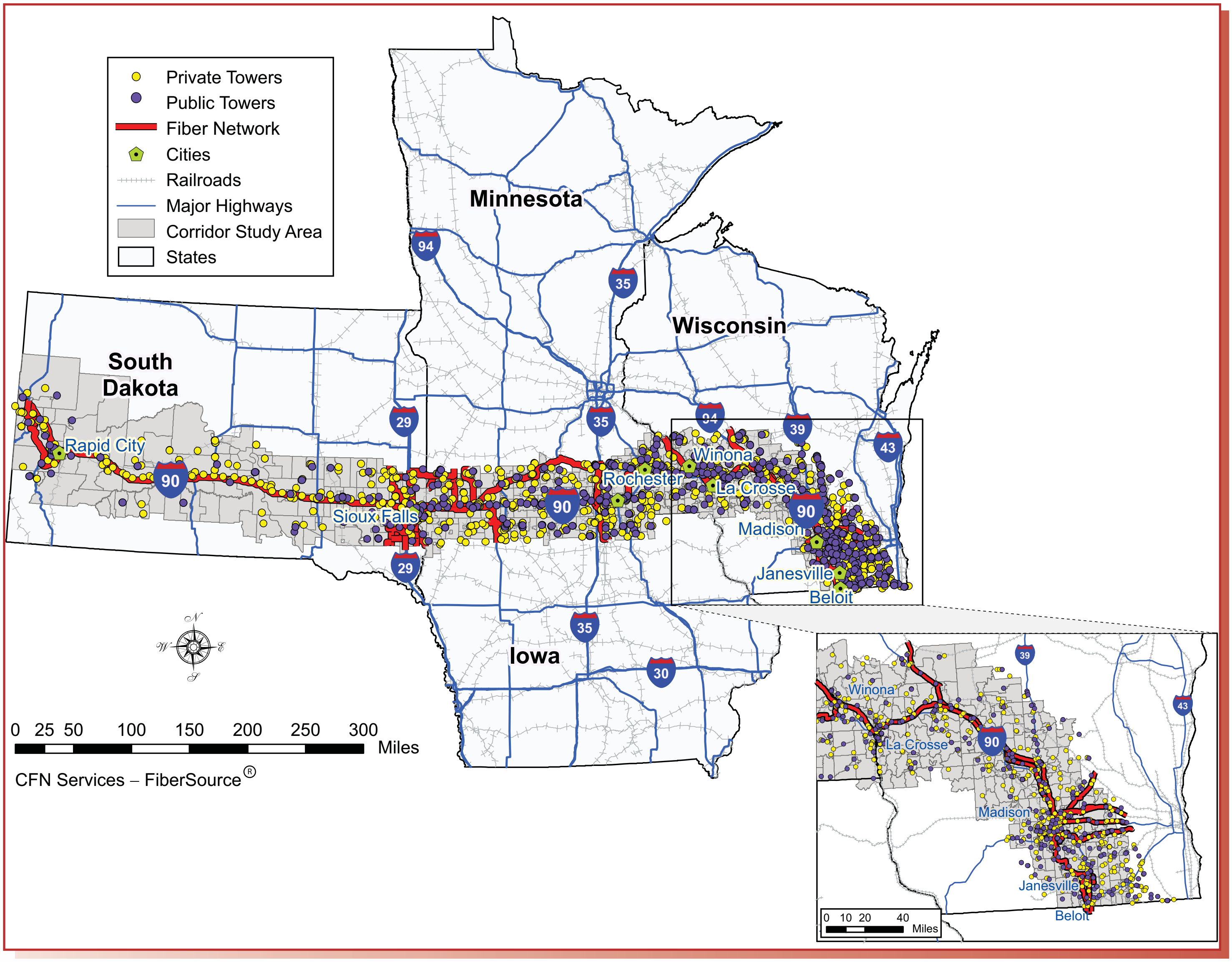
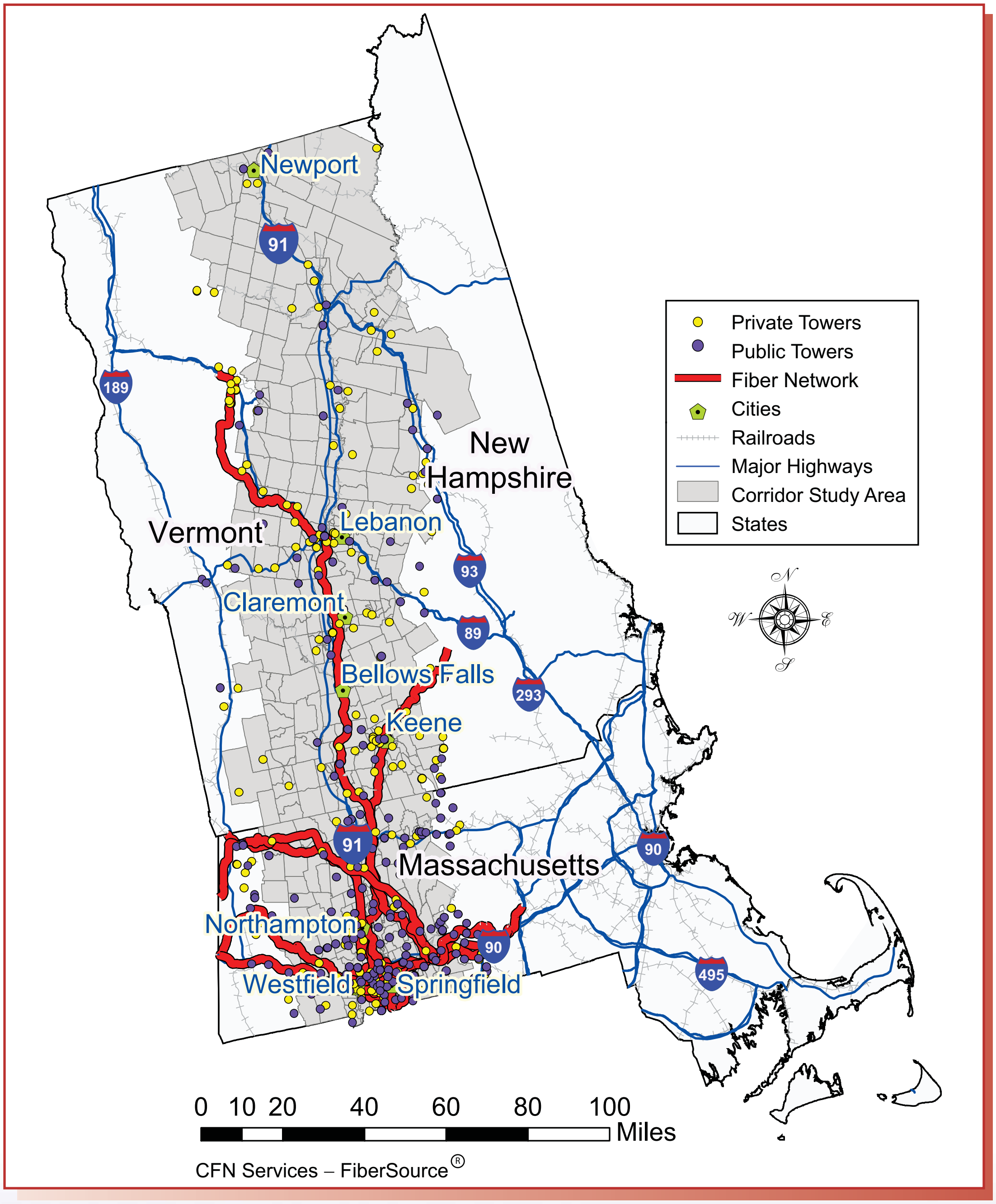


Figure 12: I-91 Existing Private Provider Fiber Networks and Tower Infrastructure



3. Potential Benefits of High-Speed Telecommunications in Rural Areas and Study Corridors

This section discusses the potential benefits of expanded access to HST in rural areas in general, and the study corridors in particular. The discussion is based in part on a review of national studies of HST benefits, especially to rural communities. It is further augmented with information obtained from corridor-level interviews, including State and regional planners, economic development officials, representatives of health care and educational institutions, and people involved with HST deployment initiatives. The following types of benefits are discussed:

- Quality of life;
- Economic development;
- Public safety and homeland security;
- Health care and telemedicine;
- Education and access to knowledge; and
- Transportation.

3.A. Quality of Life

A number of studies suggest the possibility that access to broadband for all Americans will improve the quality of life, provide for economic growth, and educational opportunities. For decades, the policy of the U.S. Government has been to extend basic voice telecommunications services to all its citizens, in all areas of the Nation, at comparable levels of service and at a reasonable cost. This "universal service" policy is articulated in Section 254 of the Telecommunications Act of 1996, which establishes six principles for "the preservation and advancement of universal service":

- Quality services should be available at "just, reasonable, and affordable rates."

- Access to "advanced" telecommunications services should be provided "in all regions of the Nation."

- "Low-income consumers" and those in "rural, insular, and high-cost areas," should have access to telecommunications services, including "interexchange and advanced services that are reasonably comparable" to those provided in urban areas, at rates "reasonably comparable" to rates in urban areas.

- All providers of telecommunications services should make "equitable and non-discriminatory" contributions to universal service goals.

- Mechanisms for Federal and State "advancement" (funding) of universal service should be "specific, predictable, and sufficient."

- Schools, health care institutions, and libraries should be eligible for special rates and other concessions to ensure that they have affordable access to advanced telecommunications and information services.

Millions of Americans use the Internet every day for everything from e-commerce to telework, for entertainment, and for keeping in contact with relatives and friends. According to Nielsen/NetRatings, "Web sites for on-line gaming, instant messaging, e-mail, and social networking all made the top 10 list when ranked by average time per person among broadband users at home...The Web has become an integral part of everyday social life, particularly among kids and teens."[61] The Internet can break down the barriers of distance and geography, making the same services available to people in remote rural areas as those in more densely settled urban and suburban neighborhoods. High-speed telecommunications also has the potential to reduce the isolation of the elderly and people with disabilities by connecting them with the larger community.

Access to broadband is not uniform, however. Policy-makers and public interest groups have expressed concern about a "digital divide" that offers advantages to people with access to the Internet and other computer and telecommunications services, leaving those without such resources behind in the competition for jobs and a better quality of life. This perspective was expressed in a 2005 report published by the Free Press, in which the author argues that "the United States is falling dramatically behind the rest of the industrialized world in broadband deployment. The digital divide seriously burdens economic growth and educational opportunity."[62] The same report points out that "Almost 60 percent of households with incomes above $150,000 have a broadband connection, while less than 10 percent of households with incomes below $25,000 have a connection."

Concerns over a "digital divide" may be overblown in some respects, according to other analysts. One such study suggested that the OECD analysis of broadband penetration on which these concerns are based[63] overlooks factors such as income, income inequality, education, population age, and population density, which have significant impacts on broadband adoption rates. From this perspective, "broadband adoption is not a race – broadband is instead a service purchased by households and businesses, and it is reasonable to expect that households and businesses in different societies with different conditions will make different purchasing decisions," the paper's authors argue.[64]

The U.S. Department of State, in an April 24, 2007, letter to the Secretary-General of the OECD, pointed out that the methodology used to prepare the report on broadband penetration overlooks the fact that many Americans have broadband access available through the workplace or at access points such as libraries, schools, and wireless

hotspots. The United States has more broadband users and more wireless Wi-Fi hotspots than any other country in the world, and many Americans gain access to the Internet through other than the subscriber lines accounted for in the OECD report.[65]

A May 2006 report from the Government Accountability Office (GAO) found that "about 30 million American households – or 28 percent – subscribed to broadband, although households in rural areas were less likely to subscribe to broadband service than were households in urban and suburban areas."[66] The report goes on to note that "households with high incomes were 39 percentage points more likely to adopt broadband than lower-income households, and those with a college-educated head of household were 12 percentage points more likely to purchase broadband than households headed by someone who did not graduate from college. While rural households are less likely to adopt broadband, our findings indicate that this difference may be related in part to the lower availability of broadband in rural areas."

3.b. Economic Development

The adoption of HST can support economic development in a variety of ways. Studies at a regional and national level have shown that HST can increase business productivity and reduce costs by increasing the efficiency of intrabusiness, business-to-business, and business-to-consumer interactions, and by facilitating expanded interaction among businesses, suppliers, and consumers. Furthermore, the availability of HST in specific geographic areas is increasingly becoming a critical factor in business location decisions. As HST becomes the norm, areas without affordable access to HST service will increasingly find it difficult to attract or retain businesses. The same holds true for residential populations, as consumers become more and more accustomed to having broadband connections available at the household level for work and/or personal use.

A Department of Commerce report on "Measuring Economic Impact of Broadband Deployment"[67] and its access in communities "supports the view that broadband access does enhance economic growth and performance, and that the assumed economic impacts of broadband are real and measurable." This report uses total employment in each community as its proxy for economic development. Total employment, when controlled for other possible factors such as overall employment growth nationwide during the study period, population density, or education levels, increased by 1 to 1.5 percent in communities with broadband access when compared to similar communities without high-speed telecommunications. Other possible measures of economic development, such as wages, did not show a significant impact for broadband availability when control factors were taken into consideration. The statistical analysis performed by the researchers also indicated a positive impact for broadband availability on measures such as number of business establishments and industry structure and mix; availability of broadband telecommunications contributed to an increase of about one-half a percentage point for information-technology intensive sectors, as well as a modest increase in the number of business establishments.

A follow-on investigation of the impacts of broadband access in the Appalachian Region showed that communities in which broadband became available by December 1999 experienced more rapid growth in employment and the overall number of businesses than otherwise-similar communities in the region, and also enjoyed higher market rates for rental housing.

An econometric study of the impact of municipal broadband in Florida used gross sales data from a panel of comparable counties to estimate the impact of improved broadband access on economic growth. Lake County, Florida and the City of Leesburg implemented a municipal broadband network in 2001, offering high-speed access to businesses and government institutions in hopes of stimulating economic activity. The analysis indicated that Lake County experienced a monthly growth rate

in gross sales of 0.843 percent, against the matched set of counties that had not implemented municipal broadband access, which grew at an average of 0.419 percent. When results for a similar panel of counties are compared, per capita growth in gross sales showed a similar result, with "per-capita economic activity in Lake County [growing] at more than twice the rate (0.507 percent per month) of the control group of Florida counties (0.222 percent per month)."[68]

For the three rural corridors examined in this study, interviews with local officials (including regional planners, State and regional economic development officials, and others involved with broadband deployment initiatives) provided insights into the specific economic development benefits that might be realized through expanded HST deployment. Interviewees noted that while HST services – especially DSL and/or cable modem – are generally available in the urban population centers in each corridor, their availability in rural areas with low population densities is often limited to nonexistent. Even where HST services are available, they tend to be more expensive as a result of the higher cost of serving these areas and lack of competition. This is especially true for the high-speed services (e.g., T-1 and T-3 connections) increasingly required by businesses. The availability of wireless services is increasing, but lags well behind the traditional wireline services and is hampered by issues such as topography and permitting requirements for tower siting, as well as investment costs.

Interviewees further confirmed that the lack of affordable HST services is increasingly a barrier to retaining and attracting business activity as well as residential population. Many parts of the corridors have suffered from stagnant or declining population over the past few decades as younger residents in particular move to urban areas for educational, employment, and social opportunities, and as traditional employment bases such as agriculture and manufacturing have declined. On the other hand, these areas also have inherent positive attributes such as a more relaxed

quality of life and lower housing costs. As a result, some areas – especially those relatively close to urban centers and major educational and health care institutions, and those with especially noteworthy scenic and natural characteristics – are experiencing a renewed population influx.

> "Interviewees further confirmed that the lack of affordable HST services is increasingly a barrier to retaining and attracting business activity as well as residential population."

Interviewees noted that if the proposed rural interstate highway corridor communications study could influence the availability and/or affordability of HST services, it would generally have benefits for local economic development. In contrast to traditional economic development initiatives, which focus on attracting larger businesses such as manufacturers, the benefits would especially accrue through strengthening the "new economy" – high-technology industries, especially start-ups and small business. These benefits would primarily occur for three reasons:

- Attracting new population, especially of "knowledge workers," who can work remotely while enjoying a rural lifestyle;
- Supporting local entrepreneurs and small businesses, who rely on the Internet for connection to suppliers, consumers, and other business partners; and
- Expanding the geographic areas that already are benefiting from proximity to knowledge-based growth centers in the major metropolitan areas, while providing lower-cost housing and business options.

These themes were generally common across all three study corridors. However, each corridor also has its own unique economic conditions and needs.

The I-20 Corridor is rich in mineral resources and has historically been economically focused on agriculture and mining. The development of oil resources and processing facilities in the corridor has resulted in high production levels of crude petroleum, natural gas, and natural gas liquid. In recent years, manufacturing and tourism have

become an important part of the economies in Louisiana, Mississippi, and Alabama. Various economic development initiatives have been undertaken in the corridor, many of them technology focused. Examples include the Consortium for Education, Research, and Technology of North Louisiana (CERT), formed in 1996 in Shreveport, Louisiana, and the Central Louisiana Business Incubator (CLBI) in Alexandria, Louisiana. CERT organizes and delivers a variety of programs and services to support the growth and success of the region's industry, in particular, providing training and other development programs to the workforce of northern Louisiana.[69] CLBI is a not-for-profit corporation created as an economic tool designed to accelerate the growth and success of entrepreneurial companies through a business support resources and services.[70]

The I-90 Corridor is rich in natural resources and has historically been economically focused on agriculture, mining, and manufacturing. In recent years, however, tourism has become an important part of the economies in Wisconsin, Minnesota, and South Dakota. Popular attractions such as Mount Rushmore, Badlands National Park (South Dakota), and Wisconsin Dells, bring thousands of visitors to the corridor each year. In South Dakota, manufacturing, food processing, technology, back office, and financial services sectors are all experiencing growth along the corridor. South Dakota also is targeting and expects additional growth opportunities in the energy, biotechnology, and advanced manufacturing industries.

In the I-91 Corridor, particular areas of economic opportunity include emerging high-technology, service, and specialty manufacturing sectors – such as biomedical devices, information technology, alternative energy, artisan/specialty product manufacture, and tourism. Two portions of the corridor – the "Five-College" region of Central Massachusetts (including Amherst, Northampton, and vicinity) and the "Upper Valley" region of New Hampshire and Vermont (including Hanover, Lebanon, and White River Junction) are uniquely influenced by the presence of major universities

and research institutions, which have not only created a stable population base but also led to spin-off businesses, especially in the health care and information technology areas. Regional economic development councils exist in all three corridor states to promote economic development, and some have focused on expanding HST access as a key component of their strategy. For example, the Pioneer Valley Connect project is working to bring broadband to the rural communities in Franklin County, Massachusetts, one-third of which have no cable or DSL broadband service. In northern Vermont, the North Link project is an initiative to expand the fiber optic telecommunications backbone across the State from New York to New Hampshire, through public-private partnerships. The project is being coordinated with Vermont's I-91 fiber project and would strongly benefit from the development of a fiber or wireless backbone along I-91.

Interviewees did understand that simply deploying a fiber optics or wireless HST along I-91 was no guarantee that economic benefits would be realized. Many areas already have sufficient backbone – instead, they suffer from a lack of "last mile" connections due to the high costs of serving low-density areas and the resulting lack of private sector interest. Stakeholders noted that the project must not only provide for local access but also sufficiently reduce costs to private providers to make provision of middle and last-mile services economically feasible. Furthermore, many of the rural areas continue to suffer from other, more traditional challenges to economic development, such as lack of an educated workforce and distance from urban centers. Portions of each corridor that are particularly remote and do not have other major attributes of significance (e.g., a tourism or natural resource base) are therefore less likely to experience economic development benefits as a result of improved HST access. Nevertheless, affordable HST service will become increasingly important simply for supporting economic activity in these areas.

3.c. Public Safety and Homeland Security

HST and broadband connectivity can significantly enhance homeland security applications. Public safety and security officials at all levels of government can benefit from the ready availability of sophisticated data in more usable forms (e.g., geospatial data). Robust communications infrastructure can facilitate the availability of such information directly to service providers and first responders, wherever and whenever they need it. Virtually every aspect of homeland security involves information sharing among local, State, and Federal Government officials, including border security, emergency response capacity, biological, chemical, and radiological threat assessment and monitoring, and physical infrastructure management. Broadband will greatly enhance the capacity to share vast quantities of data across government agencies and all levels of government.[71]

In the post-9/11 environment, the effectiveness of public safety partly depends on the ability of government agencies and public officials to collect and assess information about potential threats, and to disseminate critical information quickly and reliably to Federal, State, and local authorities and, in certain cases, to the public at large. Additionally, if civil defense or other information needs to be communicated directly to the public, broadband connectivity to the home would enable individual citizens to receive information quickly and with appropriate graphical, media, and other enhancements. Broadband availability and adoption also will enable the Department of Homeland Security and other Federal Government entities to share information on existing homeland security projects, "best practices," and other useful information.[72]

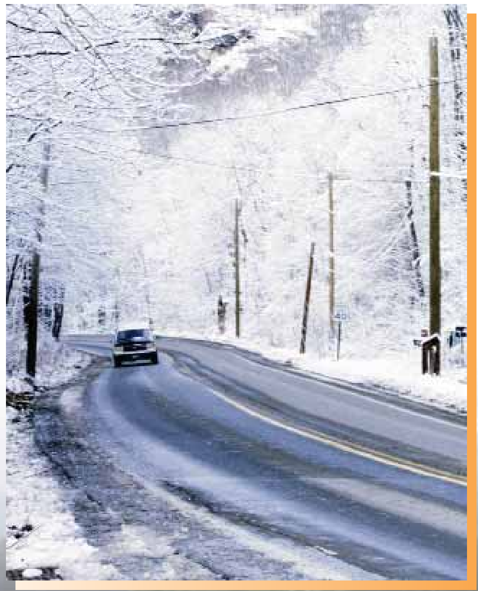
Transportation agencies play a critical role in the response to catastrophic events. In the period running up to a foreseeable natural disaster such as a hurricane, highway and transit agencies facilitate emergency evacuation procedures, and may play a role in the prepositioning of personnel and supplies. While operations may be suspended during an actual disaster event, transit and highway operators also provide vital services in the immediate response efforts by enabling the evacuation of disaster victims and moving first responders to the scene. Over the long term, while operators may themselves face challenges in restoring infrastructure and services, transportation agencies continue to assist in emergency support activities relating to logistics in conjunction with other responders.

In emergencies, local authorities could benefit from a high-speed broadband network and the software tools that enable authorities to immediately access, combine, and visualize critical infrastructure and public safety data without needing to engage in time-consuming and risky data conversion exercises. Fully realized, these systems can quickly draw on and visualize a wide variety of interrelated data, such as building floor plans and other architectural details, location of physical assets, demographic information, evacuation routes, hazardous material threats, and wind direction, among other information. Thus, with a broadband network and sophisticated software deployed among government entities, public safety, and homeland defense can be enhanced in a variety of ways that directly benefit citizens.

The following are examples of homeland security applications where HST is increasingly critical:

- Remote surveillance at border crossings and rural airports;
- Monitoring of critical infrastructure, including bridges, tunnels, railroad facilities, key transfer points, and critical installations (e.g., power plants, water treatment centers);
- Communications during emergencies (public, emergency response/coordination, video conferencing), including information sharing between operations centers (e.g., Traffic Management Center (TMC) to statewide Emergency Operations Center);
- Transfer of data and image files (e.g., photos of suspected terrorists), location photos and video (e.g., information retrieval, risk assessment);
- Remote medical emergency consultation and treatment by first responders on scene;
- Remote control of robotics in dangerous situations; and
- Position location technology to assist in rescue.

Within the study corridors, improved HST availability and reliability can support the mission of first responders and agencies playing a role in public safety and homeland security. Furthermore, all of the study corridor States also are potentially subject to



natural disasters (caused by hurricanes, floods, tornadoes, and winter storms) or man-made disasters. Statewide emergency response coordination increasingly depends on high-reliability, high-speed telecommunications for interoperability among transportation operations centers and emergency operations centers.

States in each of the three study corridors have undertaken a variety of initiatives to protect the security of critical transportation systems and infrastructure throughout the State, and to develop transportation and telecommunications systems to respond to acts of terrorism, natural disasters, and other emergency events. States typically have Emergency Operations Centers (EOC) which are linked to other agencies and emergency responders through a variety of wired and wireless technologies such as traditional radio, telephone, and telefax data systems, which may be supported by virtual private networks, high-frequency phones and radios, satellite networks, and other advanced communications technologies. EOCs may be linked to traffic operations centers (TOCs), as they are in Massachusetts and Mississippi. State DOTs may have access to other agencies' communications networks; for example, the Minnesota State DOT has access to a wireless communications network operated by State Patrol.

> "Communications and Emergency Management are Synonymous"

The State of Louisiana Office of Homeland Security and Emergency Preparedness points out that "Communications and Emergency Management are synonymous."[73] The Office "must be able to pass critical information to all of the parishes, State agencies, and other partner organizations located within Louisiana as well as communicate with the surrounding States and Federal agencies." In addition to traditional methods such as telephone, fax, and basic radio, Louisiana makes use of an 800 MHz trunked radio system maintained by the Louisiana State Police. This system provides both voice messaging and transmission of images. A satellite communications system provides access from all parishes in the State, and utilizes satellite information feeds from the Data Transmission Network (DTN) weather and satellite television, which

supplements traditional wired feeds. The Alabama Department of Homeland Security has placed a priority on improving interoperable telecommunications and on expanding critical infrastructure protection.

All of these information sharing strategies depend on highly reliable, high-speed telecommunications access. Continued, and in some cases expanded, availability of such capacity is a critical element of emergency response and preparedness throughout the corridors. In Vermont, for example, there currently is no system that will permit immediate and secure communications to police, fire, and emergency medical personnel simultaneously. The Vermont Homeland Security Unit proposes to build an enhanced two-way radio system and mobile data network that will meet the communications needs of a variety of State, local, and county emergency service providers (ESP). The exchange of critical information among emergency first responders, whether by voice over a radio handset, via computer systems or face-to-face communications is crucial to the effectiveness of response operations.

Border crossing surveillance at the Canadian border in Vermont represents a potential benefit of HST backbone along the I-91 Corridor. Local officials in northern Vermont note that existing telecommunications capacity in the region is quite limited. Communications along the border currently are run by digital microwave, which is sufficient for transmitting still photos but not much else. As a result, border crossing operations are unable to take advantage of advanced technologies such as linked surveillance cameras and high-speed database access. These technological limitations are leading not only to potential breaches of security at the border but also to long traffic delays at major crossing points, including I-91, due to the lengthy time it takes customs officials to send and receive data over existing Internet connections. Customs processing typically takes 15 to 45 minutes per commercial vehicle, relying on old computer equipment and hampered by slow data connections, and there are occasional border shutdowns due to connectivity issues.

3.D. Health Care and Telemedicine

High-speed telecommunications can make a significant contribution to improvements in rural health care through "telemedicine." Telemedicine encompasses a variety of techniques to bring specialized medical knowledge to remote locations through the sharing of images, health data, and real-time interaction between doctors and patients. HST can further support medical cost savings and improvements in the efficiency and quality of health care service delivery by facilitating the use of electronic health information systems (EHIS) and other administrative systems. As described in Section 1.C of this report, funding to improve telecommunications for health care is available under the Universal Service Fund.

In addition to reviewing national investigations into the benefits of HST for rural communities, the study team conducted interviews with State health officials as well as private and nonprofit health care providers in each corridor to identify specific local needs as well as the benefits of HST backbone deployment. The findings of national studies and corridor interviews are largely consistent. The potential health care benefits of expanded HST availability in the study corridors can be summarized as follows:

- Facilitating high-speed connections to community hospitals and treatment centers, to support the provision of telemedicine services offered through major network affiliates, expanded use of other videoconferencing services, and large data/image file transfer;

- Facilitating adoption of HST by primary care practices and local clinics and treatment centers, thereby encouraging the adoption of practices, including electronic medical records, electronic billing, telemedicine, and distance education; and

- Supporting the introduction of home health care monitoring systems to reduce travel needs and medical costs associated with in-person visits, as well as improve the quality and use of home care.

Case Study:
Telemedicine Working for Massachusetts

Martha's Vineyard, the Massachusetts resort destination off Cape Cod, had a problem. The island, with a year-round population of 15,000 and a summer population peak of 120,000, could expect to see about 25 stroke patients a year, but cost considerations limited the kinds of immediate therapy that Martha's Vineyard Hospital could offer. Administering tissue palsminogen activator (tPA), the only drug shown to be effective, was not an option; emergency room doctors would ideally have an opportunity to confer with a neurologist to determine whether a patient was having a stroke and whether administering tPA was the right response. The problem is the small but significant percentage of patients who suffer bleeding in the brain with tPA, which could be fatal. Emergency room physicians wanted to avoid the risk of giving tPA to patients with stroke-like symptoms who did not actually suffer a stroke.

With only one neurologist practicing on the island, and facing an annual cost of half a million dollars to make a neurologist always available on staff, hospital executives could not justify the cost for the limited number of cases they could expect. In addition, access to MRI images would make diagnosis and treatment easier, but the hospital could not afford the $1.5 million cost to acquire and install an MRI scanner. Enter telemedicine via TeleStroke, a program managed by two Harvard teaching hospitals, Massachusetts General Hospital and Brigham and Women's Hospital.

Martha's Vineyard Hospital signed up with TeleStroke. This gave emergency room physicians access to stroke neurologists at the Boston-area hospitals through videoconferencing and image-sharing technology, enabled by broadband telecommunications. At $10,000 per year, TeleStroke let the attending physicians consult with experienced neurologists, who could examine the patient remotely and help make the decision on whether to give tPA.

"A Vital Link: Cost Put a Stroke Treatment Out of Reach, Then Technology Made It Possible," The New York Times, May 28, 2007. URL: http://www.nytimes.com/2007/05/28/health/28strokehosp.html (accessed 08/30/2007).

Most major medical facilities in the study corridors already are linked into regional and national high-speed telecommunications networks, and therefore may not directly benefit from additional HST backbone infrastructure. They will benefit indirectly, however, to the extent that the HST backbone improves their ability to connect with local clinics, private practices, and home users. Similar to economic development, the primary HST needs in each corridor appear to be for making broadband available at affordable rates to end users outside of the major cities and towns. Some community hospitals and local clinics are still not linked into high-speed networks, limiting their ability to participate in telemedicine programs or to transmit large images or data files in real-time. Many smaller practices do not have broadband access. Furthermore, some interviewees noted that given the potentially huge bandwidth needs of many telemedicine applications – especially those requiring two-way video and audio – more HST backbone capacity may be required in the future in some areas.

HST availability is not the only limiting factor to deployment of telemedicine and other HST-reliant health care technologies. A number of other institutional, technological, and cost barriers need to be overcome before widespread benefits can be achieved. Telemedicine programs must be developed and offered, and capabilities developed at smaller clinics and practices to make use of these programs. States and the major medical networks must establish electronic health information system architecture. In addition, start-up costs and the learning curve for adopting Internet technology can prove a challenging barrier for small, private practices and community health centers. Finally, the same barriers to broadband use – cost and technology – exist at a home level for many potential users. This may be especially true among the elderly populations who are the primary beneficiary of home-based telemedicine applications.

Telemedicine and EHIS initiatives are being led in each of the study corridors by major health care institutions as well as State agencies. Examples of telemedicine programs include the Sanford Health Telemedicine Program in South Dakota in the I-90 corridor, Louisiana State University's Health Sciences Center Medical Informatics and Telemedicine Program in the I-20 corridor, and the Dartmouth-Hitchcock Medical Center in Lebanon, New Hampshire in the I-91 corridor. Most states also have undertaken initiatives to develop electronic health information systems. While these programs are in their nascent stages, they have been growing rapidly just in the past few years. To reduce health care costs, Massachusetts is considering requiring the use of electronic accounting systems by all medical practices – meaning that broadband access will be a virtual requirement throughout the State. As these programs further develop and as HST becomes more widely available, their application in rural areas could increase greatly if HST is available in rural areas.

3.e. Education and Access to Knowledge

Information and communications technology has great power to enhance education. Today's students have grown up with technology and expect to be able to use it. There has been explosive growth in the availability of on-line instruction and virtual schools, complementing traditional instruction with high-quality courses tailored to the needs of individual students. Students can access abundant, accessible, and up-to-date subject information on the Internet. Tests now can be taken on-line, giving students, teachers, and parents almost instant feedback. The U.S. Department of Education suggests, in fact, that information and communications technology could support significant, measurable improvements in the educational performance of the Nation's students over the next several decades.[74]

The potential benefits of the Internet for education extend especially to rural areas. Smaller primary and secondary schools serving dispersed rural populations can share teaching resources and offer access to specialized instruction that would not be possible through face-to-face interaction. At a college and university level, the Internet can make library resources at other universities and in larger cities accessible and on-line course offerings can support home-based learning and reduce travel needs. The Internet also facilitates collaboration among different research institutions. HST is increasingly a necessity for all of these applications due to the growing bandwidth requirements of transmitting graphics-intensive material, as well as audio and video.

As previously noted, the Federal Government has undertaken initiatives to ensure that all schools have access to the Internet through the Universal Service Fund and E-Rate Program. States within the study corridors also have undertaken various initiatives to support K-12 connectivity. For example, South Dakota's Office of Curriculum, Technology, and Assessment provides some form of HST – including a minimum of a T-1 circuit – to every K-12 public school, public higher educational institution, and government office. Iowa's statewide fiber optic network,

the Iowa Communications Network, connects 402 K-12 schools, 148 public community colleges and universities, 17 private colleges or universities, 8 hospitals, and 50 public libraries across the State. The Mississippi Department of Education is presently building a statewide K-12 telecommunications network. Vermont's K12net initiative to provide network access to K-12 schools has linked nearly 300 of the 400 public and independent K-12 schools as well as more than 100 public libraries, although most are connected through one or more dial-in connections rather than dedicated high-speed lines.

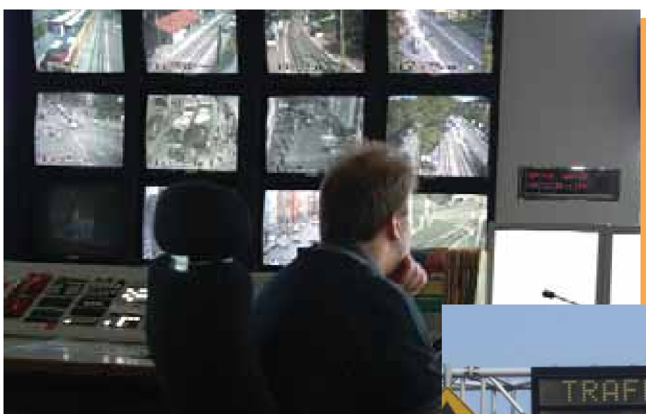
America's colleges and universities, while not eligible for the E-Rate Program, make extensive use of high-speed telecommunications to link research laboratories across different campuses and institutions, and to provide their students with access to course materials, university libraries, and administrative resources. Several university consortia have been established to connect research institutions through the use of leased lines or dedicated facilities. Within the study corridors, for example, all public higher educational institutions in Minnesota belong to one of six Learning Network of Minnesota regions. The Learning Network works with the campuses to ensure that they have HST access to support academic and administrative programs. The University of Alabama System Intercampus Interactive Telecommunications System provides a networked system of conference rooms at 20 sites across the State. In the I-91 Corridor, the Five-College Consortium in western Massachusetts is undertaking its own effort to link its college campuses with a fiber optic loop.

Interviews with education interests in the three study corridors suggest that the primary short-term education-related HST needs appear to be for more universal availability of affordable broadband services to end users, including households, primary and secondary schools, and libraries. For postsecondary institutions, HST capacity is

generally adequate for existing needs, but costs are often a significant concern. Some of the more remote campuses, especially, lack affordable bandwidth. In the long run, even the major institutions of higher education are likely to require increased telecommunications backbone capacity, as data transmission volumes for research, administrative, and distance learning applications continue to increase.

3.f. Rural Telecommunications and Transportation

The Nation's interstate highway system has contributed greatly to improvements in safety, mobility, and economic development. Although interstate highways comprise only 1.2 percent of the Nation's roadways, they carry 24.4 percent of vehicle miles traveled (VMT) per year.[75] Travel on the interstate highway system also is safer than on any other part of the national highway network; the fatality rate of 1.18 per 100 million VMT on rural interstate highways is a rate of between 50 and 60 percent lower than other types of roads in the Nation's road system.[76] The interstate highway system enables the safe and efficient movement of people and goods from city to city and from State to State. The recent celebration of 50 years of the interstate highway system underscored the tremendous contribution made by the partnership between the State and Federal Governments that produced this phenomenal engineering achievement.



In May 2006 the U.S. DOT announced a major initiative to reduce transportation system congestion. This plan, the National Strategy to Reduce Congestion on America's Transportation Network (often referred to as the "Congestion Initiative"), provides a blueprint for Federal, State, and local officials in their efforts to respond to the growing challenge of congestion. It includes six major components: 1) Relieve urban congestion; 2) Unleash private sector investment resources; 3) Promote operational and technological improvements; 4) Establish corridors of the future; 5) Target major freight bottlenecks and expand freight policy outreach; and 6) Accelerate major aviation capacity projects and provide a future funding framework.

Congestion in U.S. transportation systems has a substantial adverse impact on the U.S. economy and on quality of life for millions of Americans. According to the Texas Transportation Institute (TTI), in 2003, congestion in the top 85 U.S. urban areas caused 3.7 billion hours of travel delay and 2.3 billions gallons of wasted fuel, for a total cost of $63 billion. Beyond lost time and fuel, transportation congestion imposes significant additional costs on U.S. businesses. Congestion affects the cost of shipping, and forces manufacturers and retailers to keep additional material on hand to hedge against late deliveries. International trade also suffers; in 2005, congestion at the Otay Mesa and Tecate crossings along the California-Mexico border was estimated by the San Diego Association of Governments to cost the U.S. economy $3.7 billion in output and almost 40,000 jobs.

Aside from the congestion triggered by the rapidly growing demand for travel in comparison with a relatively static supply of highway capacity, congestion is caused by a number of additional factors, including traffic incidents, special events, weather, work zones, and poor signal timing. According to FHWA, approximately half of all congestion can be traced to "recurring" causes such as physical bottlenecks and poor signal timing, and the other half to "non-recurring" causes such as crashes, work zones, and weather. While congestion is primarily a problem in larger urban areas, it is increasingly occurring in small urban as well as rural areas. Causes of rural congestion include seasonal traffic to major weekend and tourist destinations, as well as events such as work zones, severe weather, and traffic incidents.

As the Nation's transportation system operators deploy more advanced ITS technology for traffic management and traveler information, the ability to communicate in real-time, or near real-time, becomes critically important. Intelligent transportation systems contribute to improved transportation safety and mobility and enhance productivity through the use of advanced communications and transportation management technologies. ITS uses a broad range of wireless and wireline communications-based information and electronics technologies. When integrated into the transportation system's infrastructure, and into vehicles themselves, these technologies relieve congestion, improve safety, and enhance American productivity.[77]

Reliable, high-speed communications and appropriate interfaces and data processing technology are vital to any ITS deployment. A high-speed telecommunications backbone along the three corridors will not only enhance existing ITS services, but also will facilitate and accelerate the deployment of new ITS technologies and services. A telecommunications network supports ITS which in turn supports improved mobility, safety, and efficiency in the transportation network.

From a rural corridor perspective, the following are the major ITS strategies that could be relevant and useful:

- **Crash prevention and safety –** e.g., ramp rollover systems, advanced curve warning systems, downhill speed detection systems, highway-rail intersection safety systems, intersection collision avoidance and warning systems, road hazard detection and management systems. As an example of benefits, a ramp rollover warning system for trucks was installed at three curved exit ramps on the I-495 beltway around Washington, D.C. in 1993. Prior to deployment there were 10 truck rollover accidents at these sites between 1985 and 1990. After deployment, no accidents were recorded between 1993 and 1997.[78]

- **Roadway operations and maintenance –** e.g., winter weather management systems such as fog detection and warning systems, road weather information systems, bridge de-icing systems, and automated ramp and road closure systems; and work zone safety and management systems. As an example of benefits, the Minnesota DOT uses mainline and ramp closure gates to close segments of freeways during severe weather. During a 1998 storm, closure allowed Interstate 90 to be cleared four hours earlier than nearby Highway 75, with I-90 clearance costs being 18 percent lower than those for Highway 75.[79]

- **Regional and interstate traveler information dissemination and coordination –** e.g., traveler information provision at rest areas, dedicated traveler information for long-haul truck traffic, coordination of information across State lines. For example, 75 to 85 percent of travelers in rural tourist areas in Missouri and Arizona expressed satisfaction with overall travel conditions as a result of advanced traveler information systems.[80]

- **Emergency management –** e.g., severe weather-related traveler and traffic information provision, hurricane evacuation and warning, AMBER alert systems.

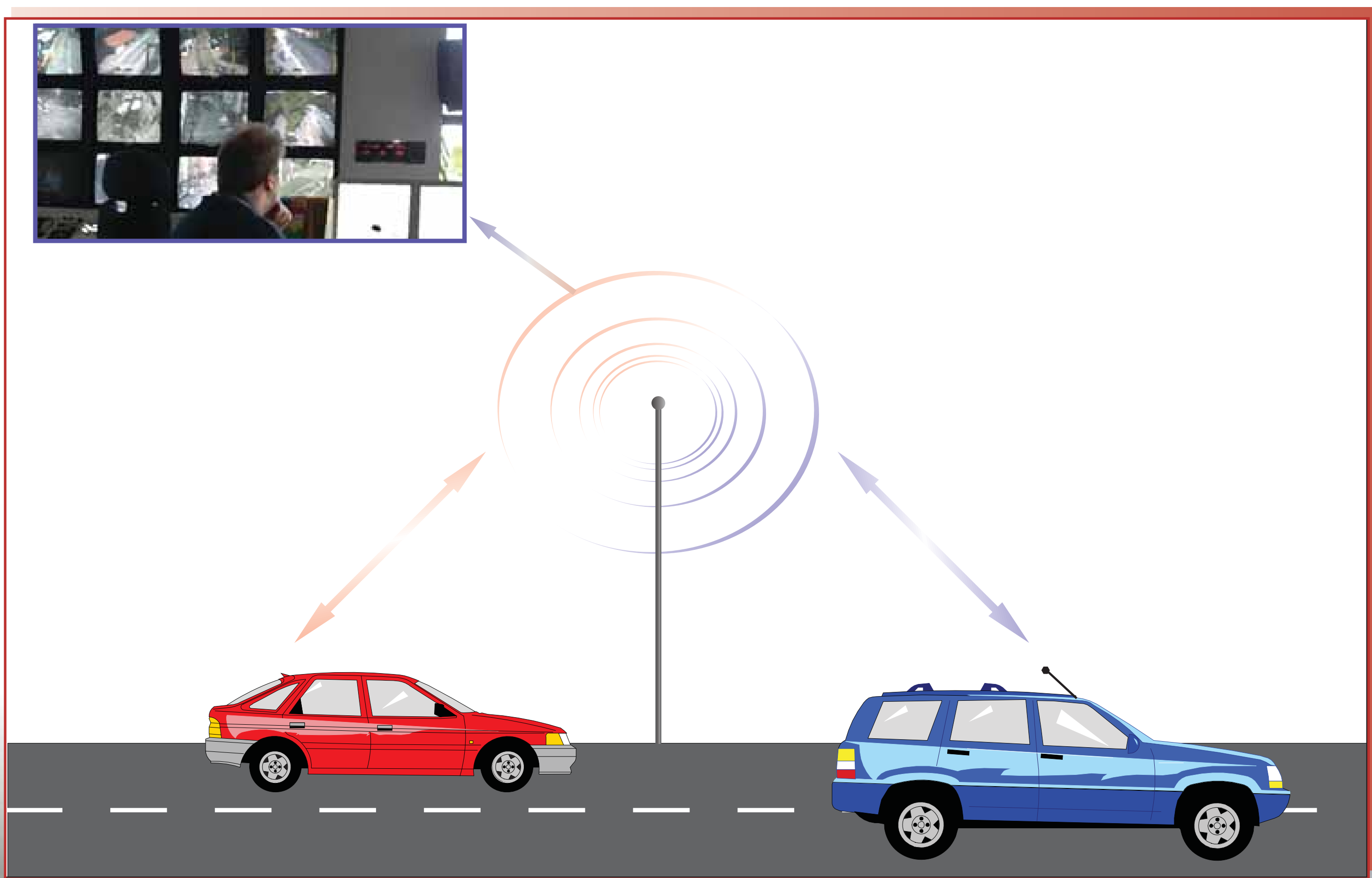
- **Paratransit management –** e.g., automated scheduling and dispatch systems for transportation of disabled and elderly persons in remote locations.

- **Intermodal freight management and commercial vehicle operations –** e.g., automated weigh-in-motion systems, oversize/overweight load permitting systems, specialized traveler information provision for long-haul truck traffic, commercial vehicle onboard safety and inspection, commercial vehicle information systems and networks, hazardous materials management, intermodal asset terminal and shipment security systems. As an example of benefits, a study in Montana indicated that using automated weigh-in-motion (WIM) data instead of weigh station data for freeway pavement design could lead to savings of about $4.1 million each year in construction costs.[81]

Strategies such as arterial management, freeway management, transit management, incident management, and special event management also apply to rural corridors, but to a lesser extent; these strategies already may be in use in some of the urbanized areas within the corridors, where greater availability of high-speed telecommunications would contribute to more widespread deployment.

Intelligent Transportation Systems (ITS) apply advanced technologies, particularly telecommunications, to the field of transportation in order to improve the safety and efficiency of travel. One well-known example is electronic toll collection, whereby motorists can pay roadway tolls using special transponders without the need to stop and pay at a conventional tollbooth.

Figure 13: Vehicle Infrastructure Integration (VII)



3.F.i. Vehicle Infrastructure Integration

Despite the progress that has been made with ITS and other transportation initiatives, each year over 42,000 fatalities occur on U.S. roadways and billions of hours are lost to traffic congestion. The Vehicle Infrastructure Integration (VII) initiative is an ambitious ITS concept that seeks to enable substantial improvements in safety and reduction in delays via a nationwide, coordinated network of communications between vehicles and the roads they are traveling on, as well as among vehicles themselves as shown in Figure 13. These communication capabilities would be used to exchange safety messages and improve traffic flow. For example, a vehicle that is braking sharply could send a warning message (wirelessly and instantaneously) to the vehicles behind it, allowing those drivers to take action to avoid a rear-end collision.

VII is a Federal initiative, with research and planning sponsored by the Department of Transportation's (DOT) Intelligent Transportation Systems Joint Program Office. A public-private partnership, bringing together the DOT, State, and local governments, the automobile manufacturers, and other private partners such as technology and telecommunications providers and consultants, has been established to investigate the feasibility and advisability of creating such a network.

VII communications are based on a protocol called Dedicated Short Range Communications (DSRC), operating at 5.9 gigahertz, a frequency designated for this purpose by the Federal Communications Commission. (Further technical details can be obtained from the VII program.) The VII initiative envisions that at some point in the future all vehicles sold in the United States would be equipped with compatible communications equipment – that is, a DSRC radio, along with a Global Positioning System to pinpoint the vehicle's location. Likewise, DSRC units would be installed at regular intervals along the sides of all major roadways to provide communications links between vehicles and the roadways.

With this basic infrastructure in place, any number of specific applications could be enabled. Since the primary goal of VII is to improve the safety of travel, many of its envisioned uses are safety-related warnings and driver assistance programs. A secondary aim is to reduce delays and congestion, and the associated air pollution and wasted fuel, through applications such as improved traffic signal timing patterns and information for travelers. For transportation agencies, an additional benefit of VII is that it would capture an enormous store of real-time data on traffic volumes, vehicle speeds, and roadway weather conditions, which could be used to improve traffic management, incident management, maintenance, and local transportation planning. Successful implementation of VII would require high speed communications links between roadside equipment and a national network of servers to accommodate back office functions that would support safety- and mobility-related functions, as well as other lower-priority applications that would be permitted by rule.

3.g. Economic Value of Potential Benefits

While some national studies have been conducted on the potential monetary economic benefits of HST improvements, these studies are by necessity incomplete and speculative. As a result, a full analysis of the potential value of improved HST access in each of the study corridors could not be conducted. Nevertheless, some sketch-level estimates were made to examine the order of magnitude of potential benefits, based on national studies of monetary benefits per household scaled to corridor populations and characteristics.

Previous studies have quantified three general types of benefits:

- Benefits to households adopting broadband, as measured through either consumer welfare (surplus) or through direct cost savings;
- Producer surplus benefits from increased output of telecommunications equipment and services; and
- Medical cost savings and increased labor force participation specifically for the elderly and disabled.

Estimates of corridor-level household benefits are based on a well-publicized study for Verizon by Criterion Economics (Crandall and Jackson, 2002), which claimed that a $500 billion cumulative nationwide impact from broadband would be possible. The authors take two independent approaches to estimating the potential annual nationwide benefits resulting from increased broadband adoption at a household level – one based on consumer surplus (peoples' willingness to pay for service), and one based on direct cost savings for shopping, entertainment, telecommuting, home health care, and telephone services. For purposes of this study, these national benefits were scaled to a corridor level based on the total number of households in the rural portions of each study corridor. It was further assumed that the impact of the Rural Interstate Corridor Communications Study would be to increase the adoption of broadband from the current adoption rate in rural areas (17 percent) to the current adoption rate in urban areas (29 percent). This assumption implies that the HST backbone would be paired with private and/or public sector investments to bring "last mile" broadband service from the backbone to individual households in the corridor, at rates comparable to those offered in urban areas. The estimates further assume 10 years of benefits – i.e., the project would accelerate adoption by 10 years compared to the rate at which broadband would have been adopted without public sector intervention to provide HST backbone in the study corridors.

The results suggest total annual benefits in all three study corridors ranging from a conservative estimate of $146 million to an optimistic estimate of $1,591 million. These translate into cumulative total benefits (discounted over time) ranging from $1.7 to $19 billion in 2005 dollars.

The estimates of producer surplus are based on the same study as the household benefits (Crandall and Jackson, 2002). The authors begin with estimates of the increase in total sales to consumers of broadband services, computer equipment, general consumer goods, and new services that are developed because of widespread diffusion of

broadband access. They then calculate the share of such revenues that could be reasonably assumed to accrue to suppliers as producer surplus. To apply these results to the study corridors, similar assumptions were made as for the household benefits calculations. The results suggest that $306 million annually could be realized nationwide in additional producer surplus, as a result of increased broadband adoption in the corridors. This translates into a cumulative benefit across all three corridors of $3.7 billion in 2005 dollars, assuming a 10-year accelerated deployment period.

Estimates of benefits specifically to the elderly and disabled are based on Litan (2005). This study estimates three categories of benefits: medical cost savings, including savings for chronic care for the elderly through home monitoring as well as savings for care to the non-elderly disabled; cost savings from more independent living as an alternative to institutionalized care; and output gains from increased labor force participation. These benefits estimates were applied to the study corridors based on elderly and disabled study area populations, and assuming the same increase in broadband adoption levels assumed above. Cumulative benefits through the year 2030 are estimated to include $2.27 billion in medical cost savings and $2.88 billion in increased labor force participation by the elderly. Additional benefits would be realized from increased labor force participation by the disabled, which could not be estimated due to a lack of available data.

The estimates are based on a range of gross assumptions and therefore should be considered "order-of-magnitude" estimates only. Nevertheless, they serve to illustrate the potentially significant value of the benefits that could be obtained through policy initiatives to increase HST deployment and adoption in rural communities.

A nationwide review of State-level programs yields two initiatives designed to expand the availability of broadband in rural communities specifically for the potential economic development and quality of life benefits to rural citizens. Both programs are quasi-governmental coalitions involving government backed programs and private sector participation. These programs showcase the progress made in bringing broadband to rural communities through collaborative efforts:

The Utah Telecommunication Open Infrastructure Agency (UTOPIA) is a consortium of Utah cities engaged in deploying and operating a fiber to the premises network to every business and household (about 140,000) in its member communities. UTOPIA is a coalition of 14 cities using an active Ethernet infrastructure to provide an open public network for private service providers to offer advanced telecommunications services to member cities' residents. This approach is intended to promote economic development and improved quality of life. UTOPIA operates as a political subdivision of the State of Utah and has the same rights as other political entities (cities, towns, counties, etc.). As an organization, UTOPIA exists to represent the needs of its individual member cities and is dedicated to accelerating economic development and quality of life for its citizens and businesses by deploying a publicly owned advanced telecommunications network over the last mile to all homes and businesses within member communities. As of the end of June 2006, according to UTOPIA financial statements, 451 miles of duct had been placed along with 130 miles of aerial strand and 680 miles of fiber cable. Additionally, 63,500 fibers had been landed in community cabinets and approximately 54,000 splices had been completed. Within the 52 production footprints there are a total of 43,450 addresses. Phases II and III will complete the network in these cities and extend its reach into Brigham City, Centerville, Layton, Perry, and Tremonton. When completed, the network will pass in excess of 170,000 prospective subscribers.

ConnectKentucky's mission is to accelerate the growth of technology in support of community and economic development, improved healthcare, enhanced education, and more effective government. ConnectKentucky develops and implements effective strategies for technology deployment, use, and literacy in Kentucky, creating both the forum and the incentive for interaction among a variety of people and entities that would not otherwise unite behind common goals and a shared vision. A recent progress report highlights the Commonwealth's efforts to accelerate the availability and adoption of broadband. Since its launch the availability of broadband across Kentucky has increased more than 50 percent. Approximately 532,000 previously un-served Kentucky households can now access broadband as private investment in telecommunications infrastructure has reached unprecedented levels. This represents an increase of more than 1.4 million additional Kentucky residents gaining broadband service since January 2004. Currently, 94 percent of Kentucky homes can access broadband, and ConnectKentucky expects every household to be capable of accessing high-speed Internet by the end of 2007.

4. Building a Telecommunications Backbone in Interstate Highway Rights-of-Way (ROW)

4.a. Advantages of Using Interstate Highway ROW

In many respects, interstate highway corridors are ideal places to build telecommunications networks. The controlled-access corridors of interstate highways were designed to interconnect disparate parts of the United States, and to transport people and goods across the Nation. A telecommunications backbone has a role similar to that of the interstate highway system. The telecommunications backbone also is controlled-access in the sense that it handles long-haul data transmission, with relatively few access points (interchanges) interrupting the data-traffic flow. Moreover, as explained elsewhere in this report, just installing additional backbone will not necessarily bring the benefits of advanced telecommunications to the people and communities adjacent to interstate highways; access points are critical to the use of the network.

For many rural communities, a nearby interstate highway that also accommodates high-speed Internet backbone could result in significant benefits. The interstate highway provides a physical link to the rest of the State, the Nation, and the world. Similarly, high-speed telecommunications backbone that is interconnected with rural communities affords digital transmission of data that connects people and institutions. Potential synergies between telecommunications and transportation would clearly benefit rural communities. The rural community must be connected to the telecommunications backbone, however, for benefits to be realized – a step that requires

additional investment by the private sector and/or municipal interests. Furthermore, both costs and risks accompany the complex undertaking involved in building telecommunications backbone in interstate highway rights-of-way.

From the perspective of potential private sector partners, the prospect of a partnership for a corridor-level high-speed telecommunications could be enticing. A national or regional telecommunications provider could enter into a single agreement to obtain statewide rights-of-way, rather than undertaking multiple agreements with several different entities. This process could reduce risk, minimize the number of potential partners, and minimize the number of different regulatory and operating rules across jurisdictional boundaries.

> "The Interstate system rights-of-way themselves are attractive because of the standards to which the Interstate highway routes are constructed."

The interstate system rights-of-way themselves are attractive because of the standards to which the interstate highway routes are constructed. Interstate system ROWs present fewer right-of-way obstructions than would be encountered in using secondary road rights-of-way. Secondary rights-of-way often have multiple utilities already installed, thus making it harder to create a conduit pathway for new optical fiber installation, and creating a higher risk of optical fiber being cut by other parties accessing or maintaining their facilities in the ROW. The limited number of intersections/interchanges also contributes to lower costs for construction. This advantage is somewhat diminished as construction at highway interchanges requires boring instead of trenching, and boring is significantly more expensive than trenching.

The financial characteristics of possible shared-resource agreements also may make the interstate system corridor approach more attractive, since in-kind payments to State DOTs rather than cash payment to private land owners means less well capitalized companies may find these deals more affordable.

4.B. Disadvantages and Risks of Using Interstate Highway ROW

Despite these advantages, both costs and risks accompany the building of a telecommunications backbone in interstate highway rights-of-way, which can be a complex undertaking. Right-of-way ownership issues represent one complicating factor. A variety of other State and private sector concerns about financing, institutional arrangements, and other factors also must be addressed.

4.B.i. Right-of-Way Ownership

Installing advanced telecommunications backbone facilities in interstate highway rights-of-way requires basic knowledge regarding ownership of and control over interstate highway ROW. Although interstate highway ROW is almost uniformly State-owned, quite a number of stakeholders, each with a different role, are involved in ownership and control of interstate highway ROW. Starting from the ground up, these ROW stakeholders include the States that own interstate highway rights-of-way and the Federal Government (primarily FHWA), which provides funding for acquisition of these rights-of-way and general oversight of the interstate highway system. In addition there are the owners, installers, and maintainers of the telecommunications facilities – whether wireless or wireline, or some combination.

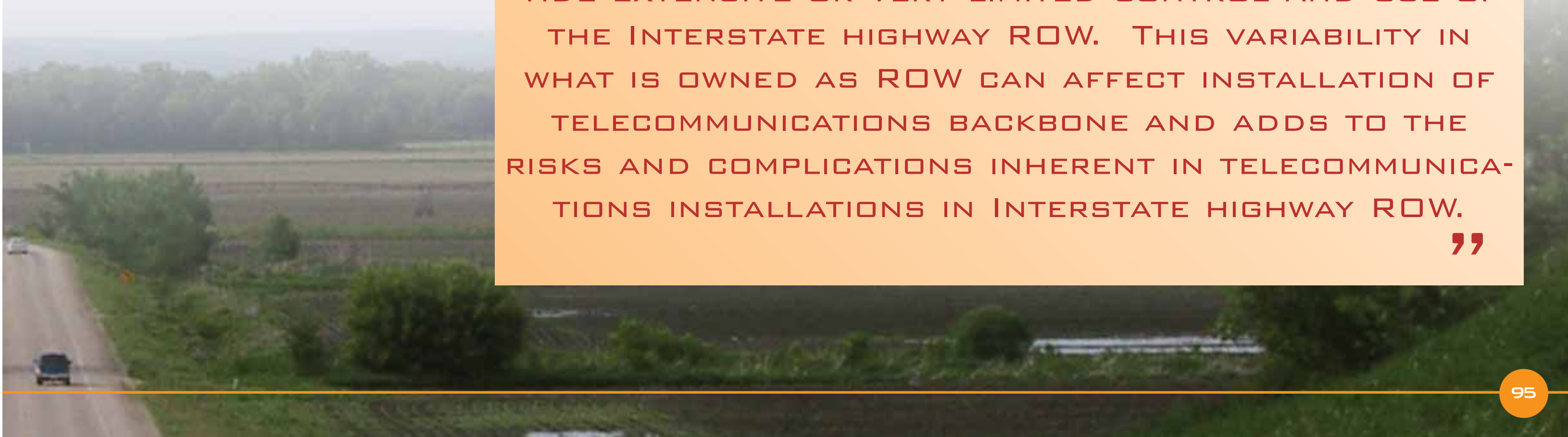
The land on which interstate highways are built forms a longitudinal strip of real property known as the right-of-way. ROW ownership may in fact take several different forms. ROW may be held in full fee ownership, including control over all underground and overhead airspace rights. Interstate highway ROW also can be owned as an easement to use the surface of the land for limited transportation purposes. As a result, the nature of the property rights involved in ownership of ROW is not always a single type of all-encompassing right, but rather is a variable set of real property rights that may provide extensive or very limited control and use of the interstate

highway ROW. This variability in what is owned as ROW can affect installation of telecommunications backbone and adds to the risks and complications inherent in telecommunications installations in interstate highway ROW.

Interstate highway ROW is, for the most part, acquired by States through negotiation between State DOTs and landowners or by State exercise of the power of eminent domain. The ROW taken through this process is owned by the State and managed either by the relevant State DOT or the State agency that manages State-owned lands. When the interstate highway ROW is held in full fee ownership, the State owns all rights above, under, and on the strip of land where the interstate highway is situated, as well as its clear zones, interchanges, and the like. Other interstate highway ROW is controlled by the State as an easement for transportation purposes. The particular land interests and uses within the scope of these easements vary. Even within a single State, the precise nature of rights included within particular ROW easements may differ depending on the particular times or circumstances of their acquisition, as well as the language used in conveying the ROW easement to the State. This variable nature of the rights owned by States in interstate highway ROW creates some fundamental uncertainty, and risk, in determining whether State ROW ownership encompasses sufficient rights to use the ROW for telecommunications installation.

Most ROW acquisition for the interstate highway system is Federally funded under the Federal Aid Highway Program, which is managed by the Federal Highway Administration in cooperation with State DOTs. FHWA is responsible for oversight of interstate highway projects, which are required to follow Federal requirements for project eligibility, as well as standards for contract administration and construction standards. Part 710 of Title 23 of the Code of Federal Regulation (CFR) contains the FHWA ROW regulations. Section 710.105, defines "right-of-way" to mean "real

"As a result, the nature of the property rights involved in ownership of ROW is not always a single type of all-encompassing right, but rather is a variable set of real property rights that may provide extensive or very limited control and use of the Interstate highway ROW. This variability in what is owned as ROW can affect installation of telecommunications backbone and adds to the risks and complications inherent in telecommunications installations in Interstate highway ROW."



property and rights therein used for the construction, operation, or maintenance of a transportation or related facility funded under (the Federal-Aid Highway Program) Title 23 of the United States Code." This definition encompasses both full fee ownership of interstate highway ROW land, and more limited real property rights in the form of easements discussed above. Since interstate highway projects tend to be undertaken in segments over an often extended period of time, different types of ROW rights will frequently have been acquired along a single interstate highway. Ascertaining particular State land titles to ROW can be complicated and present some risk that a ROW easement's scope does not include installation of telecommunications facilities. Moreover, rights to use ROW along the length of an interstate highway corridor that crosses many States will multiply concerns that ROW ownership rights may not include telecommunications installations. In any event, ROW ownership will always change at the State line.

Some interstate highways require Federal lands for interstate highway ROW. The Federal Lands Highway Program (FLHP), managed by the FHWA, assists States in planning for and acquiring necessary interstate highway ROW from Federal agencies. The Federal Lands Highway Program was created in 1983 and coordinates relationships with various Federal land management agencies, including the Bureau of Indian Affairs (BIA), U.S. Forest Service (USFS), National Park Service (NPS), Fish and Wildlife Service (FWS), Bureau of Land Management (BLM), Military Surface Deployment and Distribution Command (MSDDC), U.S. Army, U.S. Army Corps of Engineers (USACOE), U.S. Navy, Tennessee Valley Authority, and the Bureau of Reclamation (BOR). Interstate highway ROW acquired from these Federal agencies is often restricted to easements for transportation purposes. To the extent that ROW over Federal lands is used for installation of telecommunications backbone, it is necessary

to interpret the easement to determine whether the easement is sufficient to permit installation of telecommunications transmission facilities as an aspect of transportation purposes. If not, it may be necessary to acquire an additional easement for telecommunications installations through the FLHP from the agency managing the Federal land. Extending the use of interstate highway ROW to include a private telecommunications installation may well exceed the scope of some ROW easements. This uncertainty adds to the time involved, and may present some risks, when telecommunications backbone is installed in interstate highway ROW that runs through Federal lands.

Until 1988, installations of utilities and telecommunications facilities along interstate highway corridors (longitudinal installations) were not generally permitted as a matter of Federal law. In some states, this past Federal policy not to allow longitudinal installations of telecommunications in interstate highway ROW persists in State policies. After the FHWA revised its policy on utility accommodation to allow States which had FHWA-approved utility accommodation plans to permit installation of optical fiber cables and other utility infrastructure along interstate highway rights-of-way, the Federal regulatory door to shared resource telecommunications projects was opened, and remains open as a means to bring additional advanced telecommunications capacity to rural areas.

When the Telecommunications Act of 1996 became effective, both FHWA and AASHTO already had prepared guidance regarding shared-resources telecommunications installation, as well as utilities access and accommodation in interstate highway ROW. When AASHTO updated its guidance regarding "Accommodating Utilities within Highway Right-of-Way" in 2005, it continued to differentiate between communications facilities and utilities. Indeed, whether

utilities are considered to include telecommunications facilities depends on the circumstances. In some States, broadband facilities are treated as utilities for some purposes but not for others. Since there are many physical and practical differences among installations of optical fiber cable, of wireless towers or antennae, and of power lines or gas pipelines, AASHTO provides separate guidance for locating different types of utilities in ROW. These AASHTO standards help to provide consistency and uniformity among States with regard to physical and engineering aspects of the layout and dimensions of construction in ROW, but establish different guidelines for wireless and wireline installations.

In 1999 FHWA regulations related to interstate highway ROW were restructured to provide greater discretion to States in permitting, or not permitting, longitudinal telecommunications projects. These regulatory changes may have the effect of making the acquisition and management of interstate highway ROW somewhat less uniform across jurisdictions.

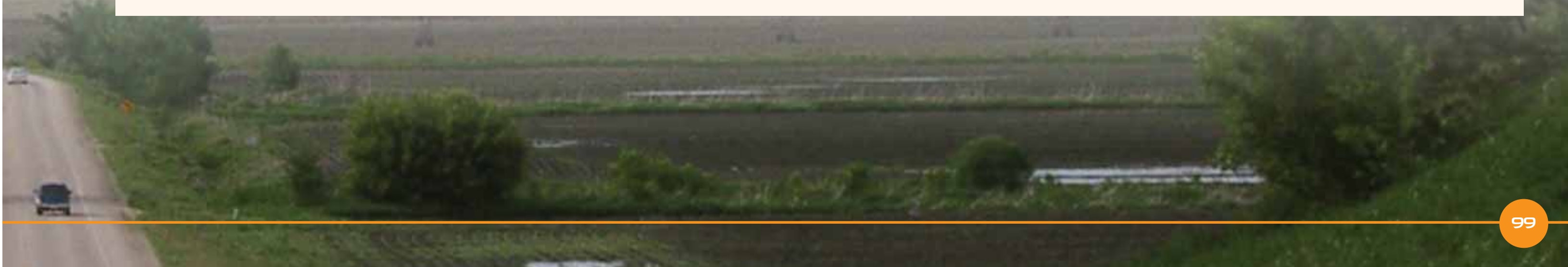
FHWA requires each State to compile and to make public a State ROW manual. Many of these ROW manuals (often highly detailed and many hundreds of pages long) are posted on the Internet by State DOTs. The availability of such specific information about the standards for permitted telecommunications installation in a specific State's ROW helps to control risks caused by lack of authoritative information regarding standards that apply to advanced telecommunications installation in a State's interstate highway ROW. One potential disadvantage of these highly detailed State DOT ROW manuals is that their requirements are not the same from State to State. Even along a single interstate highway corridor, adjacent States' ROW regulations often vary considerably. For example, some State ROW policies facilitate shared resources telecommunications projects; but other States do not enter into shared resources projects at all. In addition to these ROW standards variations, other types of permitting standards, such as environmental and natural resources requirements,

are also variable from State to State. Indeed, land use planning and environmental reviews can be time-consuming and costly preconditions for telecommunications installations in some States. In other States, centralized permitting processes for telecommunications installations reduce the risks and costs of securing State permits.

Current Information on ROW Use and Activities in the Study Corridors

Workshops, meetings, and interviews were conducted with the States involved in this study. Individuals from the State DOTs, information technology, economic development, and planning organizations provided their insights and experiences in advancing HST for transportation use and beyond. These are the expert voices of those currently operating and maintaining the corridors:

- *Since 1997, South Dakota has allowed telecommunication utility access to interstate highway ROW without compensation to the State. To date, the State has allowed two installations, a 3-mile segment in Sioux Falls and a 100-mile segment near Spearfish, but has received no requests to completely traverse the State along Interstate 90.*
- *Louisiana DOTD's established compensation program for telecommunications access to their ROW allows the State to charge a cash value for the permit. Although cash is accepted, the State prefers to barter for the equivalent value in services to LaDOTD. This allows for quick procurement of the needed ITS communication services directly from the State's partner without having to go through the State's telecommunications procurement system.*
- *In Mississippi, State laws currently do not allow the possibility for a public-private partnership on State-owned ROW or telecommunication easements.*
- *Minnesota would like to see the results of the study not just focus on any one corridor, but rather consider infrastructure installed along a corridor to be a part of a larger State network or regional network devoid of State line issues. Economic drivers are needed to make communications installations happen.*
- *Iowa DOT stated that their business is providing mobility, which in turn leads to economic benefits and societal benefits. Communications are a necessity rather than a luxury. VII is going to have a large impact in the future, and communications are required for Real-Time Traveler Information. DOT representatives further stated that the Federal Government will need to facilitate the provision of communications, by eliminating FCC restrictions and encouraging new innovative ways of leveraging resources.*
- *Massachusetts has moved more aggressively over the last few years to support telecommunications infrastructure, which in turn will support initiatives already underway outside and in the vicinity of their ROW.*
- *Alabama currently does not allow the installation of telecommunications infrastructure on their ROW through public-private partnerships as this may require them to open their ROW to all providers.*



4.B.ii. Other State and Private Sector Concerns

Barriers and risks to implementing corridor communications along a multistate interstate highway may be substantial. To begin with, there is great variation among States with regard to their enthusiasm for such projects. Some States are simply not willing to enter into shared resources projects, particularly with unfamiliar private-sector telecommunications partners. Other States appear to feel that State government should not invest State resources, such as State-owned ROW, in telecommunications projects that are essentially private-sector business undertakings. Still other States are risk-averse and fear potential liabilities arising out of road hazards and disruptions in traffic flows along their interstate highways. Overall, there appears to be relatively little corridor collaboration that would bring neighboring States together to harmonize their policies in ways that would facilitate installation of advanced telecommunications facilities within their respective segments of interstate highway ROW. Without collaboration for corridor communications, the pattern of telecommunications is likely to remain on a State-by-State basis.

There also are some disadvantages to making use of interstate highway rights-of-way from the private sector perspective. The long cycle-time associated with a typical State DOT procurement process, which may involve requests for proposal and other contractual delays, may mean that such arrangements may only be attractive for long cycle-time, national, or regional infrastructure projects. Such an approach is not likely to be attractive for customer-specific builds in interstate highway rights-of-way since such projects require short time lines in order to meet customer needs.

Another factor is that State DOTs may harbor unrealistic expectations with respect to the value of rights-of-way, given the availability of other no-cost public rights-of-way and of dark optical fiber in existing routes. Private sector partners also may fear that they may encounter problems in getting DOT permission for new lateral access points added to network after initial construction.

In terms of achieving the ultimate goal of linking up with rural users in need of high-speed telecommunications access, participants in the process are faced with geographic, demographic, and financial issues. As a rule, larger population centers are located along interstate highway right-of-way, while rural markets may be located several miles away from the interstate highway ROW. Factors such as low population densities and low revenue potentials often make the cost to construct access from the interstate highway into the rural markets and all of the way to the end user cost-prohibitive.

Perhaps the biggest barrier to implementation is the cost of construction. The cost of installing telecommunications infrastructure, including conduits, optical fiber, handholes, and other appurtenances is estimated to be between $75,000 and $125,000 per mile, depending on the difficulty of construction, number of conduits, and amount of optical fiber installed. Most State DOTs either cannot afford these costs or cannot justify the expense to State policy-makers when the private sector is willing to provide service for a lower initial cost.

State policies regarding utility installations may not allow utilities to be located within interstate highway ROW. Citing safety and liability concerns, some States have not changed their policies to match the latest guidance from the FHWA regarding use of access controlled ROW for telecommunications facilities. Related to this is State legislation restricting use of ROW in a public-private partnership. Either through fear of losing control of the ROW, in response to a perceived failure, or in response to public pressure, the State legislature can prohibit a State agency from engaging in a public-private partnership.

Lack of a coordinated utility access policy between adjacent States along a corridor will create a difficult atmosphere for a private sector partner to be able to install communications infrastructure expeditiously along the entire length of the corridor. In addition, the lack of coordinated or consistent procurement practices between States

> "Lack of a coordinated utility access policy between adjacent States along a corridor will create a difficult atmosphere for a private sector partner to be able to install communication infrastructure expeditiously along the entire length of the corridor."

Project champions working together

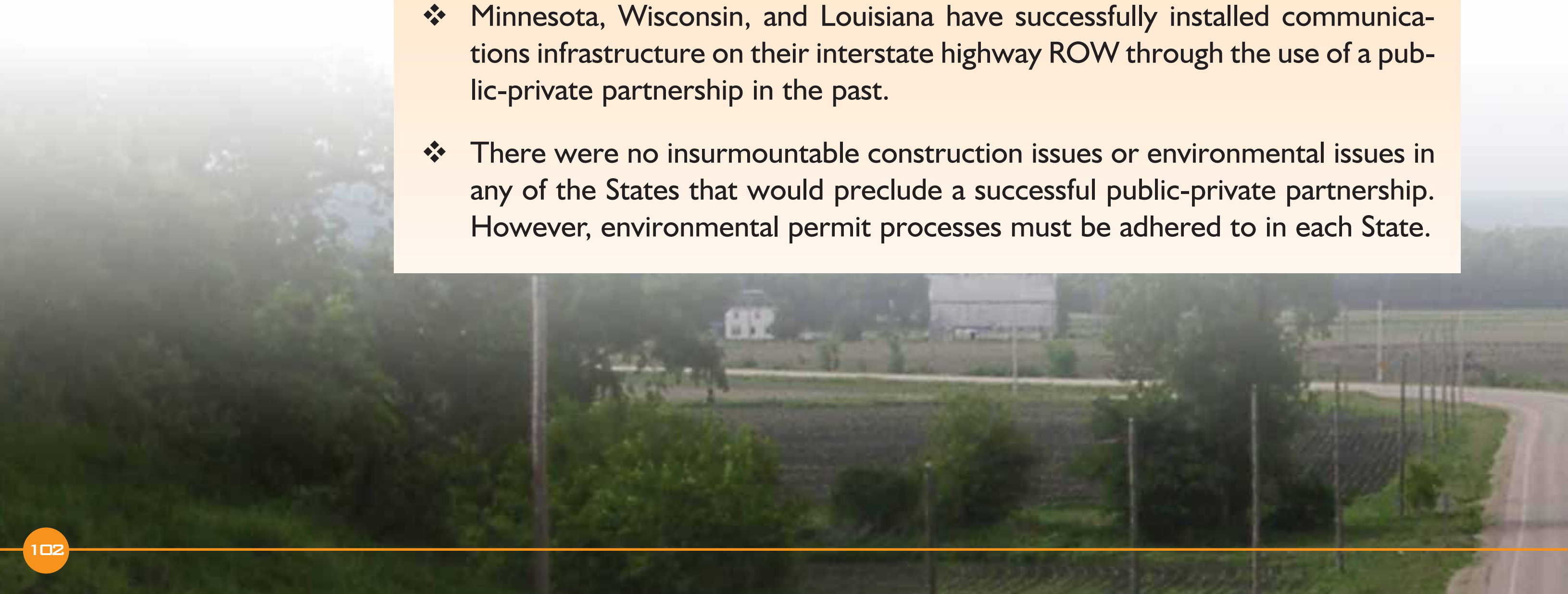
will make the creation of a corridor-wide public-private partnership all but impossible. There needs to be a common approach among all States along the corridor to ensure success.

Key to making a public-private partnership work is a project champion within the State. This person needs to be the point person for the State on all matters related to the partnership, including making presentations to various agencies, the legislature, and groups that can provide support to the project. The project champion will prepare request for proposal (RFP), perform proposal evaluations, and guide the project through the State procurement process. Without this project champion, the project will likely fail as lack of interest and lack of time by others will overtake the project.

Current Information on Public-Private Partnership Activities in the Study Corridors

Workshops, meetings, and interviews were conducted with the States involved in this study. Individuals from the DOTs, information technology, economic development, and planning organizations provided their insights and experiences in advancing HST for transportation use and beyond. These are the expert voices of those currently operating and maintaining the corridors:

- *Not all the corridor States have the ability to enter into public-private partnerships. Alabama and Mississippi have internal policies restricting the use of interstate highway ROW by utilities. Minnesota has restrictions on entering into public-private partnerships.*
- Two States, Wisconsin and Louisiana, have established policies that allow public-private partnerships along with corresponding compensation structures.
- Two of the States, Massachusetts and Vermont, are in the process of advertising for a public-private telecommunications partnership.
- Minnesota, Wisconsin, and Louisiana have successfully installed communications infrastructure on their interstate highway ROW through the use of a public-private partnership in the past.
- There were no insurmountable construction issues or environmental issues in any of the States that would preclude a successful public-private partnership. However, environmental permit processes must be adhered to in each State.



4.c. Technology

Technology choice is an important factor in building telecommunications backbones in the interstate highway rights-of-way. Therefore, it is crucial to understand enough about the variety of telecommunications choices currently available and on the horizon so that the appropriate telecommunications solution is chosen for the project. A single choice or a combination of telecommunications choices may be used in each project.

This report is focused on the backbone or trunk line telecommunications network. The 'last mile' connection between the end-user and a telecommunications service provider is beyond the scope of this document and must be addressed specifically for each community. This report will, however, make some initial recommendations about how to potentially reach the end-users.

4.C.i. Wireless and Wireline Technologies

Current telecommunications technology can be broken down into two basic types; wireless and wireline. Wireless includes microwave, cellular wireless, Wi-Fi, and the emerging WiMAX technologies. Wireline includes optical fiber, copper, and coaxial cable technologies.

Wi-Fi is short for wireless fidelity and is a term for certain types of wireless local area networks (LAN) that are designed to the IEEE (Institute for Electrical and Electronics Engineers) 802.11 standards. WiMAX is defined as Worldwide Interoperability for Microwave Access in accordance with the IEEE Standard 802.16. WiMAX aims to provide wireless data over long distances.

Table 2 illustrates types of commercial providers, the telecommunications transport medium used, example companies, and typical data rates to end users. Note that Mbps stands for mega (million) bits per second and Kbps stands for kilo (thousand) bits per second.

Table 2: Local Transport Providers and Technologies Utilized

Type of Provider	Transport Medium Used	Example Companies	Typical Maximum Data Rate to End User
Local Telephone Companies	Copper and optical fiber	ATT (SBC and Bellsouth), Verizon, Qwest	10 Mbps for non-fiber served premises
Competitive Local Exchange Carriers (CLECs)	Copper and optical fiber	Level 3 (Telcove, KMC Telecom), XO	10 Mbps for non-fiber served premises
Cable TV Providers	Coaxial cable, copper and optical fiber	Charter, Mediacom, Time Warner	28 to 37 Mbps for non-optical fiber served premises
Cellular Telephone Carriers	Cellular wireless, copper and optical fiber	ATT/Cingular, Verizon Wireless, T-Mobile, Sprint	100 Kbps to 2 Mbps for newest technology
Wi-Fi Providers	Unlicensed wireless, copper and optical fiber	T-Mobile	54 Mbps (distance and line of sight dependent throughput)
Wi-Max Carriers	Licensed and unlicensed wireless, copper and optical fiber	Sprint	75 Mbps (early stage technology, distance and line of sight dependent throughput)
Broadband Over Powerline	Electrical transmission lines	Early stage industry without a leader	4 Mbps

4.C.ii. Long-Haul, Local, and Last Mile Networks

The type of networks utilized to transport telecommunications traffic can further be categorized into Long-Haul networks, Local Transport networks, and Last Mile networks. Long-Haul networks are those networks that connect one community to another. Local Transport networks are those networks that move telecommunications capacity around within a community. Last Mile networks are the portion of the networks connecting the end user locations to the first physical location of the Local Transport networks.

The technological convergence of data, voice, and video into one uniform format of bits has eliminated the practice of distinguishing networks on the basis of the content of the traffic transmitted. Table 3 describes each type of telecommunications technology along with advantages and disadvantages.

Optical fiber technology has emerged as the clear leader in reliability and cost effectiveness for Long-Haul high-capacity networks. There is no currently known technology that appears capable of displacing optical fiber as a mainstay of Long-Haul, high-capacity telecommunications transport. Some microwave transport is still in use in niche applications, such as in Long-Haul transport between the smallest markets, however it is being displaced by optical fiber. Optical fiber transport also is becoming the preferred technological choice for Local Transport uses.

Broadband over Power Lines (BPL)

Broadband over Power Lines (BPL), also known as Power Line Communication (PLC), is a technology that allows Internet data to be transmitted over utility power lines. To use BPL the subscriber needs to use a special BPL modem that plugs into an electrical outlet. Internet services are received via radio waves over electrical lines, using many of the same frequencies that are traditionally used for ham radio. There are two types of BPL: 1) in-building BPL technology, which uses the electrical wiring within a building, and 2) access BPL, which uses the electrical power distribution grid to provide broadband Internet access.

The City of Manassas, Virginia had a successful one-year pilot with BPL. Based on the success of the pilot phase, in October of 2003, the City Council of Manassas voted to award a franchise to a provider for city-wide deployment of the service. BPL has also been deployed in Cincinnati, Ohio; Dallas, Texas; and other U.S. cities, and trials are underway in other nations worldwide.

Table 3: Advantages and Disadvantages of Technology Types

Transport Technology Type	Advantages	Disadvantages	Use (Long-Haul, Local transport, Last Mile)
Wireline Technologies			
Optical Fiber Cable	Virtually unlimited bandwidth; future proof for application of different transport protocols (time division multiplexing (TDM), Internet protocol (IP), Ethernet); highest quality of service/reliability	High upfront installation costs; slow/costly right-of-way acquisition; slow installation times	Long-Haul, Local Transport, Last Mile
Coaxial Cable/ Cable Modem	Inexpensive installation; high-level of installed base of cable	Limited bandwidth capabilities (38 Mbps); limited geographic range without regeneration (2,000 feet)	Local Transport, Last Mile
Copper Pair/ Digital Subscriber Line (DSL)	Inexpensive installation; high-level of installed base of cable	Limited bandwidth capabilities (10 Mbps); limited geographic range without regeneration (10,000 feet)	Local Transport, Last Mile
Broadband Over Powerline	Inexpensive installation; high-level of installed base of cable	Limited utility for any use other than distribution within a building; limited bandwidth capabilities (4 Mbps)	Last Mile
Wireless Technologies			
Cellular Wireless	Well developed technology; large installed base of equipment; roadmaps to much higher bandwidth services are being developed	Capital investment intensive; must have licensed spectrum to avoid interference and therefore expensive; limited geographic range without regeneration means will remain a local transport technology	Last Mile
Wi-Fi	Inexpensive for pick and choose hot spot type locations; expensive to blanket an entire community with Wi-Fi mesh capability	Limited bandwidth capabilities (54 Mbps); limited geographic range without regeneration (100 feet) means it will remain a pico-cell application; interference issues due to use of unlicensed spectrum	Last Mile
WiMAX	Greater range than Wi-Fi; fewer right-of-way issues than cable, copper, or fiber	Limited bandwidth capabilities (54 Mbps); unproven technology and limited equipment availability currently; limited geographic range without regeneration (two to three miles) means more likely a local transport technology; must have licensed spectrum to avoid interference and therefore expensive	Local Transport, Last Mile
Satellite	Can be used nearly anywhere; may be only option for those without DSL or cable modem option	High-cost of satellite deployment, low bandwidth; very expense cost of service	Converged Long-Haul, Local Transport, Last Mile
Microwave	Well developed technology; fast installation; low capital expenditure per link	Limited bandwidth (155 Mbps); expensive to change to different transport protocols; moderate quality of service/reliability (rain fade); limited geographic range without regeneration	Long-Haul, Local Transport, Last Mile

Figure 14 illustrates the basic construction and operation of a local telephone company network connected to a Long-Haul fiber network that serves both its own end users as well as a third party wireless company. As can be seen from the figure, even the wireless company relies on the local telephone company to provide the transport from its wireless towers. The local phone company itself also is dependent on the long-haul company in order to get its own long-distance voice and Internet traffic out of the market. This type of dual competitive/cooperative relationship is normal in the telecommunications market.

An access point to the long-haul optical fiber is typically a manhole and building where the optical fiber can be accessed (spliced) and then connected to an interexchange carrier (IXC) point of presence (POP). An IXC is a Long-Haul telecommunications provider that supplies long-distance and Internet connectivity to a Local Phone company, and point of presence is the physical location where the networks are connected. Local Phone Company Central Office is the aggregation point of all the end user connections and the distribution point for telecommunications services (i.e., local telephone, long-distance telephone, and Internet).

4.C.iii. Selection of the Appropriate Telecommunications Transport Technology

As is clear from the above discussion, there are many different telecommunications technologies that could be used for any particular application. The selection of the appropriate technology for any given need or set of needs must be informed by a combination of technological, economic, and other factors. This selection must be made for virtually every individual link in the network since the characteristics, geographies, and bandwidth needs will vary along the multiple links in network from the end user to the ultimate end point of the communications.

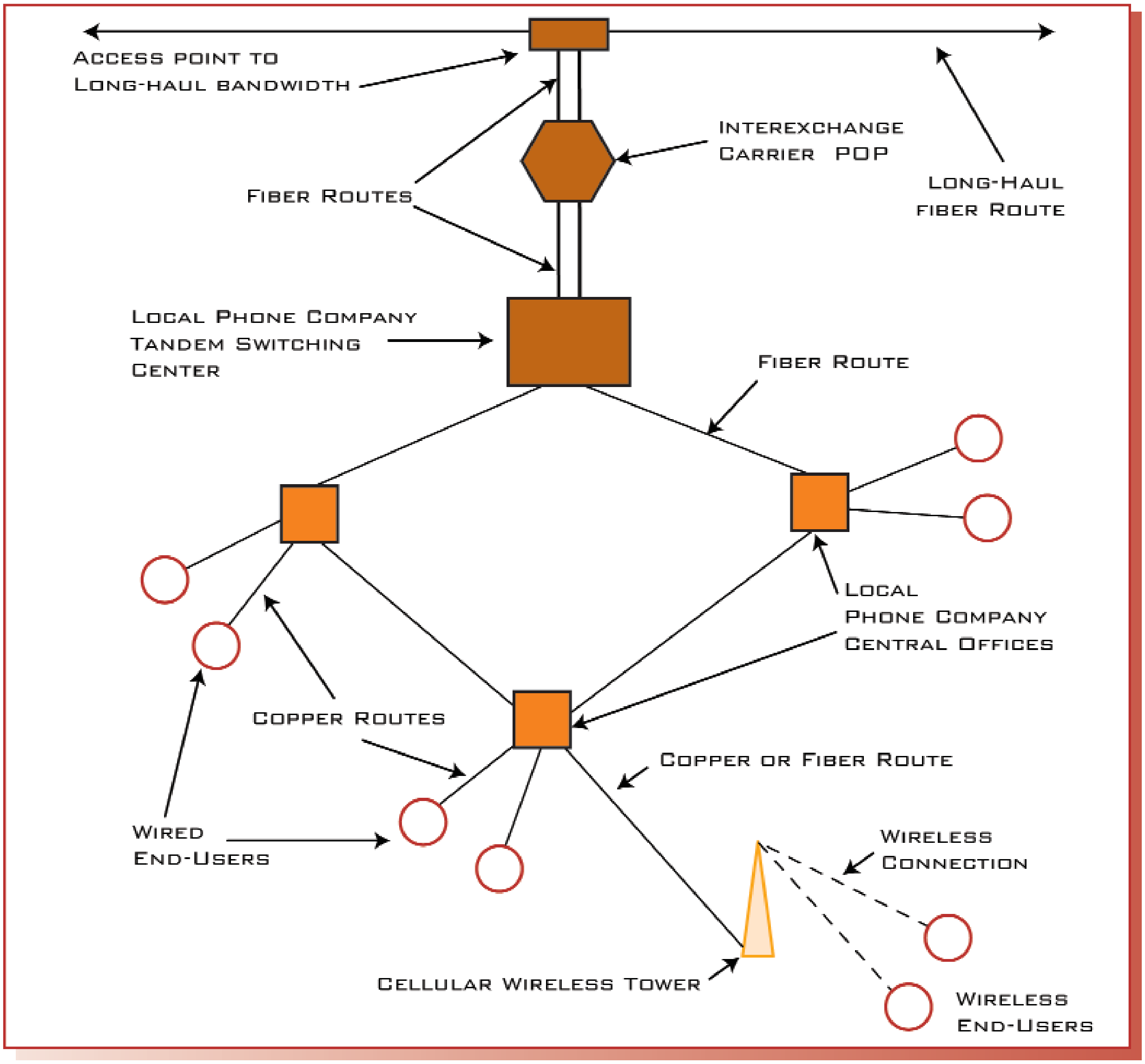


Figure 14: Basic Elements of a Local Telephone Company Connected to a Long-Haul Fiber network

The selection of the correct technology at each point in a telecommunications network to deliver telecommunications service must consider each of the following factors:

- How much bandwidth is sought to be delivered both now and in the future?
- Is the end-user located at a fixed or mobile location? Wireline technologies cannot be used to deliver the last mile of service to mobile phones.
- What quality of service is required? Voice and video require a greater quality of service than data services.
- What is the density of population of the area to be served? The business case for deploying a high-cost technology is unlikely to make economic sense when deployed in a low population density area.

Each of the above factors is essential in selecting the correct technology or combination of technologies to deliver a given telecommunications service or set of services. The selection of technology also varies by what portion of the network need is sought to be fulfilled. Some technologies such as Wi-Fi and DSL are only usable as a solution for the 'last mile' to the end-user. Generally, optical fiber makes economic sense to deploy only when there is a need for high-bandwidth services. The selection of the correct technology is very fact-specific and must be undertaken with great care.

4.C.iv. State Department of Transportation Requirements for Selecting Telecommunications Transport Technologies

State DOTs have used two approaches to addressing their telecommunications needs, namely building the telecommunications networks and/or leasing telecommunications service from a private sector provider.

From a leasing perspective, the DOT would not be concerned with the transport technology used by the service provider, as the only consideration for the DOT would be the delivery of the required bandwidth for an acceptable price and term of contract. This approach of using private sector services to meet DOT telecommunications transport needs provides a model for backhaul communications capabilities required for VII and other transportation data initiatives. The DOT telecommunications network becomes another DOT need that must be fulfilled in the same way as computer LAN/WAN (wide area network) connections, telecommunications voice services, and Internet access services. In these instances of computer, voice, and Internet services, the DOTs have historically relied on the private sector to fulfill these needs rather than building potentially duplicative and competitive telecommunications networks to meet these DOT needs. Bringing services to rural areas to meet the transportation needs of the DOTs also would assist the private sector in making the business case that construction of broadband networks can be utilized by others in the community. One of the difficulties with leasing telecommunications service is that operational costs are typically disallowed expenses as part of a Federal grant. Under this type of scenario, it may be necessary to alter the way Congress views operational and capital costs.

The choice of telecommunications transport becomes much more important if the DOT decides to construct, or to enter into a public-private partnership to construct a telecommunications network. There already is a considerable long-haul optical fiber infrastructure installed throughout the United States. It is unlikely that a private sector company will be interested in entering into a public-private partnership to install just optical fiber along an interstate highway right-of-way. However, private sector companies might be interested in installing a hybrid project involving wireless infrastructure (towers, antennae, small buildings) that will connect communities to the existing long-haul network.

4.D. Implementation Issues

A number of practical policy and institutional issues must be addressed in determining how to implement HST infrastructure along interstate highway corridors. These include:

- State rights-of-way and utility accommodation policies;
- Statewide telecommunications plans; and
- The role of the private sector.

4.D.i. Rights-of-Way Policy

Each State has a Utility Accommodation Policy (UAP) regarding public and private utility access to State-owned ROW. The UAP defines what types of utilities may access certain types of ROW and provides construction guidelines. One of those guidelines is where within the ROW a utility may install their infrastructure. Some States have a defined utility corridor adjacent to the outside ROW line while others allow utilities to be installed adjacent to the roadway or wherever available space is in a corridor. No matter the State's approach, the ROW is a finite commodity that needs to be treated as a valuable resource.

During the course of this study, each State was asked to estimate the value of the ROW along the subject corridor. The purpose of this is to identify what the value of the land is if a telecommunications company needed to access private land versus public ROW to install infrastructure. The answers received varied greatly based on what part of the country the ROW was located, urban versus rural, agricultural versus commercial, etc. In general, rural area agricultural ROW values were $1,000 to $5,000 per acre. In urban areas the amounts varied dramatically and should be considered on a case-by-case basis.

“In general, rural area agricultural ROW values were $1,000 to $5,000 per acre. In urban areas the amounts varied dramatically and should be considered on a case-by-case basis.”

One interesting exception to the standard approach of purchasing ROW for fair market value was in Minnesota. In the case of buying land for telecommunications towers, rather than paying the landowner for the property based on the value of adjacent land, the State is required to pay the landowner for the value of the land based on what it is to be used for, in this case telecommunications. In other words, the property the State may be interested in can be in the middle of a corn field, but rather than paying the landowner for one-acre of corn field, the State must pay the landowner for one-acre of telecommunications property. In Minnesota, the average value of land used for telecommunications is $25,000 to $40,000 per acre.

For interstate highway ROW, ownership lies with the State. There are some exceptions to outright ownership of the ROW if the State has an easement with an adjacent landowner that restricts the use of the ROW. For the corridors that are part of this study, the ownership of the ROW and areas subject to easement restrictions will be investigated with the development of the preliminary alignment plans.

> "When structuring public-private partnerships certain elements should be incorporated to help ensure successful implementation and long-term success."

4.D.ii. Statewide Telecommunications Plans

All of the States interviewed for this study had an established agency or organization within the State that manages telecommunications assets for State government. These organizations negotiate telecommunications contracts, maintain State networks, and provide for IT services between offices for all State agencies. In Iowa and Minnesota, these agencies are enterprise agencies, which means that they are self-sustaining and their operating budgets come from the fees they charge State agencies for their services. In most cases, there is good cooperation between the DOT and the State telecommunications agency.

One of the questions to be answered by this study is whether or not the establishment of a HST backbone along an interstate highway corridor is of benefit to the State as a whole, not only the DOT. The answer appears to be yes. The representatives interviewed from the State telecommunications agencies stated they can absolutely make use of the infrastructure to enhance their networks and provide better services to their customers.

One fear expressed by private sector stakeholders is the loss of business if the States create their own networks for carrying data versus leasing service. One potential solution is for the private sector to be contracted to manage State-owned telecommunications infrastructure. The private sector is better equipped to manage the rapidly changing technology and keep personnel trained than State government, and costs may be offset by sharing use of the infrastructure with the private sector manager.

4.D.iii. Role of the Private Sector

In the 1990s, when fiber optic companies were seeking rights-of-way on which to construct Long-Haul fiber routes, several public-private partnerships were created in which the private company received the use of interstate highway rights-of-way in exchange for providing to the DOT telecommunications services and telecommunications assets along the rights-of-way. The current lack of market demand for new Long-Haul fiber routes means there is little market demand for Long-Haul rights-of-way for the installation of fiber. Nevertheless, the interstate highway rights-of-way and the DOT need for telecommunications services may have value to different companies within the telecommunications sector which could be leveraged to further rural broadband penetration rates.

> "...DOTs should explore possible relationships with cellular wireless carriers who are augmenting their existing networks to meet the explosive growth in demand for wireless mobile data services, and emerging WiMAX-based wireless carriers."

Partnerships for Infrastructure Construction

When evaluating public-private partnerships with a particular industry sector for infrastructure projects, the most fertile ground for such relationships will be found in those companies that are still in the expansion portion of their business life cycle. Those companies will likely have not only a current infrastructure need to be filled but also will have access to capital that can be utilized to add value to the project. Currently, within the telecommunications sector, one such fertile ground is the wireless sector. More specifically, DOTs should explore possible relationships with cellular wireless carriers who are augmenting their existing networks to meet the explosive growth in demand for wireless mobile data services, and emerging WiMAX-based wireless carriers.

Wireless carriers are experiencing high growth rates of usage of their networks due to increasingly bandwidth intensive mobile applications on wireless devices such as live video news feeds, streaming video, streaming audio, and general Internet access. This growth has lead to the need for a higher density of tower sites and higher capacity fiber-based services to each tower site. Likewise, the emerging companies building their businesses around the new WiMAX technology are building new 'greenfield' networks, and therefore have an even broader need for tower sites.

Value Proposition to Telecommunications Companies

The value of a public-private partnership to a private telecommunications company for use of interstate highway rights-of-way can be realized by the private partner through:

- Lower capital expenditures to build out a network;
- Lower operating costs after completion of network construction; and
- Other softer cost savings that are harder to quantify but which are readily understood in the telecommunications industry.

Lower Capital Expenditures

The capital expenditures necessary to construct a telecommunications network (whether fiber or wireless) can be reduced through the use of interstate highway rights-of-way rather than other types of rights-of-way. The interstate highway rights-of-way have a lesser number of interchanges than do secondary roads on which fiber may be constructed. Digging trenches in the ground is the most inexpensive method of fiber installation but can only be utilized where the rights-of-way are unobstructed by crossing roadways. Interchanges and secondary road intersections have lateral roadways which require the use of more expensive subterranean boring to install the fiber. Fewer road crossings or interchanges mean a lower overall cost to install a fiber route. This dynamic is of lesser importance when considering partnerships with wireless telecommunications companies due to the only intermittent need for rights-of-way to place towers.

One Right-of-Way Provider for the Entire State/Corridor

A telecommunications company can obtain use of rights-of-way throughout the State with one transaction or relationship in a public-private partnership. This single agreement will reduce operating costs and potentially speed construction since there will be only one group of decision-makers on business issues in the relationship, one process for permit issuance, one set of construction standards, and one set of maintenance standards.

Use of secondary rights-of-way involves winding through the permitting and, in the case of wireless towers, the zoning and siting processes, of multiple entities. Municipalities are becoming increasingly difficult to appease regarding aesthetic issues surrounding tower sites. There also are a myriad number of such municipalities on a given route, each of which has its own differing and sometimes conflicting standards for tower placement. The time that can be saved by working with just one right-of-way provider on these complex issues has real value to a telecommunications service provider seeking the fastest construction time for its network.

Stability of Right-of-Way

Utilizing a State DOT or other State entity as a right-of-way provider eliminates some risks that would otherwise accompany having a private entity as the right-of-way providers. The risk of bankruptcy of the right-of-way provider and potential rejection of the right-of-way agreement by the bankruptcy party is much lower when the provider is a governmental entity. To the extent that the right-of-way grant can be made in the form of an easement, the telecommunications company partner enjoys even greater stability of the right-of-way grant under State property laws.

Recently, lawsuits have been brought by various utility right-of-way landowners against the utilities that utilize those rights-of-way. Generally, these lawsuits arise where the easement the landowner granted had a limited scope of usage, such as usage only for railway purposes. These lawsuits seek damages from telecommunications utilities for usage that is beyond the permitted railway scope of use. This issue also has arisen on State and county secondary roads built on easements with a scope limited to highway purposes. To the extent that a State DOT acquired full legal title to the rights-of-way containing the interstate highway, any private partner of the DOT would be exposed to little or no risk of liability for underlying rights-of-way issues.

Public-Private Partnership Tools for Success

When structuring public-private partnerships certain elements should be incorporated to help ensure successful implementation and long-term success.

Short Time to Commencement of Construction

Any public-private partnership should be evaluated, reviewed by decision-makers, and approved in a short timeframe; for example, six months or less for all negotiations, documentation of the transaction and the commencement of construction. Telecommunications is a highly competitive industry. Accordingly, the time that it takes to bring any particular product to market must be short to protect the competitive

advantage that can be of such great value to the private partner. Longer lead times to close the transaction mean more time in which the network is not creating revenue and in which the cost of borrowing the dollars to fund the capital expenditure is essentially getting a zero-dollar return.

Private Sector Ownership of a Portion of the Telecommunication Assets

A public-private partnership for telecommunications purposes could be constructed such that the public sector owns the asset and simply leases capacity to the private sector. However, private sector ownership of a portion of the assets is essential to realizing the full value of the transaction. Generally, if the private partner owns its portion of asset, it reduces long-term variability of costs, and thereby lowers the overall business risk compared to a non-owned assets scenario. Owning an asset from the transaction also makes it more likely that the private partner will make additional capital investment that is dependent on the partnership obtained asset.

For example, if the WiMAX company obtains a short-term lease to a tower constructed on the interstate highway rights-of-way, the private company will be less likely to spend capital to construct additional towers from the interstate highway to rural markets for broadband assets. With only a short-term lease for use of the tower or a short-term lease to capacity provided from the tower, the private company has the risk that the transaction with the DOT will falter and therefore any capital expended for a network asset that is dependent on the existence of that tower lease or capacity is at risk of becoming a useless asset.

In addition, if lit capacity or dark fiber were to be leased from the DOT to the private partner, it is unlikely that a large commercial carrier would be comfortable that the DOT has sufficient core competencies to meet the stringent maintenance and repair standards required in the telecommunications industry. These dynamics make it less likely that telecommunications companies would participate in a public-private partnership in which the telecommunications company does not get ownership and control of a portion of the telecommunications asset.

4.e. Preliminary Alignment Approach

A portion of the work for this study is to aid in the development of preliminary alignment plans for telecommunications infrastructure along interstate highway ROW of the three identified corridors, including wireless structure locations. One obvious challenge to developing a comprehensive approach will be to meet the varying needs of the States involved in the study. This section discusses these challenges and how they will be addressed in the *Report to States* which will subsequently be developed as part of this study.

4.E.i. State Needs

Each of the 10 States involved in this study is different with respect to the development of telecommunications public-private partnerships, and is therefore different with respect to their need for a preliminary alignment plan. For instance, South Dakota DOT has never engaged in a public-private partnership for telecommunications, but would like to have a preliminary alignment developed so that they are better prepared to determine what will be required should they choose to develop a partnership. Massachusetts and Vermont already have preliminary designs for upcoming shared resource projects and therefore have little need for an alignment plan. Mississippi and Alabama laws do not allow shared resource projects, so these States also have no need for an alignment plan to be produced.

The study team is proceeding with the development of conceptual alignment plans that showcase typical construction design challenges that will assist all States as programs move forward. These challenges would include difficult soil conditions (rock), environmentally sensitive areas such as wetlands, and construction issues with bridge attachments and complex interchange configurations.

"...THERE ARE A NUMBER OF EXAMPLES IN WHICH STUDY CORRIDOR STATES HAVE SUCCESSFULLY DEVELOPED PUBLIC-PRIVATE PARTNERSHIPS..."

4.E.ii. Representative Segments

The proposed approach to the development of preliminary alignments is to develop standard sections over representative segments of roadway. This will entail the determination of the applicable standards of each State for telecommunications utility installations and likely the creation of standard alignment plans for each State that the corridor traverses.

4.E.iii. Location of Access Points

Fiber optic infrastructure requires access in order to connect various field devices or make connections to adjacent rural communities. Access points in the form of handholes or at regeneration buildings should ideally be spaced to accommodate the needs of the State DOT based on their deployment plan for ITS devices in the future. One methodology is to locate access points at or near interchanges. This allows connection to field devices that may likely be located at or near that interchange, and also provides an access point for future communication connections to communities or facilities accessed via the roadway served by that interchange. At a minimum, access points should be provided at every regeneration building and provisions made in any agreements that will allow the State to create an access point at locations of their choosing in order to access the telecommunications backbone (if provided for in their contract).

4.E.iv. Design Challenges

There are numerous differences in design standards and accommodation policies among the States included in this study. Minnesota and Wisconsin have well-defined utility corridors adjacent to the ROW line. Massachusetts is anticipating a design that would install conduit and fiber optics very near the shoulder-line of the roadway. Louisiana allows their utilities to incrementally move away from the ROW line in order to avoid utilities already in place. Any alignment plan developed will need to

take into account the differences among the States and make accommodations for those differences. Ideally, consensus among corridor States will allow cohesive designs in a corridor spanning several States.

Different construction and environmental issues also will need to be addressed in each State and will affect any alignment plans. Avoidance of environmentally sensitive areas, such as wetlands and crossing of streams and rivers, is common to all of the States. In addition to the Federal environmental review and permitting process that each State follows, however, there are State environmental regulations that must be met. In South Dakota, for example, no construction near streams is allowed during the spawning season of the Topeka Shiner. In Vermont, there are rock protectionist groups with concerns that need to be addressed.

Construction issues vary greatly by State as well. In Mississippi, there is a layer of Yazoo clay in places that shrinks and swells dramatically and can deform conduits. Flexible conduit needs to be used in these areas. Some of the States routinely allow conduit attachments to bridges; others do not without just cause. Bullet-proof conduits on bridges are a requirement for most of the states. Areas where rock and wetlands are located adjacent to the highway in Vermont will require median installation of fiber along Interstate 91. Louisiana requires conduit to be installed at least six-feet deep or be encased; other states have a three-foot minimum. Other than occasional rock outcroppings, the States along the I-90 corridor have very few construction issues due to the openness and accessibility of the ROW.

The variability in the State construction standards and the differing issues in each State will represent a challenge to producing a one-size-fits-all alignment plan. This should also be an indication of the challenges presented in developing public-private

partnerships involving multiple States along the same corridor. Although these elements are discussed here as challenges, for a corridor to be successful, addressing these challenges allows a project to take form rapidly.

4.f. Operational Issues Associated with Installation and Maintenance

Among the major concerns for the FHWA and States with respect to opening interstate highway ROW up for telecommunications utility installations is the safety of the driving public. Traditionally, access to interstate highway ROW has been restricted to avoid creating potential hazards to the motorists. One of the fears with allowing utility contractors on interstate highway ROW is the potential for hazards to be created by the presence of construction equipment within the ROW. This would include the equipment for installation of conduit and towers as well as equipment carriers used during mobilization and offloading in the ROW. Post installation, maintenance vehicles accessing regeneration or control buildings along the ROW and performing repairs may represent a hazard as well. As reported by the States involved in this study, there was one State that had anecdotal information from the State patrol that a couple of accidents had been caused due to the installation activities of a contractor. No other information beyond that was available. No other States reported this as being an issue and they did not feel this was going to be an issue as long as the contractors exercised proper traffic control during all activities.

4.g. Case Studies of Successful Practices

Despite the various challenges involved, there are a number of examples in which study corridor States have successfully developed public-private partnerships to deploy fiber optics or other HST communications systems along interstate highways and other corridors. Examples of such successful partnerships are highlighted in Louisiana, Massachusetts, and Minnesota.

4.G.i. Louisiana

The State of Louisiana has successfully engaged in public-private partnerships with telecommunications companies since 2000. State law permits the LaDOTD to partner with the private sector to install fiber optic infrastructure along interstate highway ROW and to share tower space with private companies. In exchange for allowing access to the interstate highway ROW and towers, the LaDOTD receives compensation in the form of cash, infrastructure such as dark fiber or conduit, or bartered telecommunications services. The State's telecommunications utility access policy is to allow anyone on the ROW at anytime, subject to approval. This means that they do not advertise for companies to partner with nor provide them exclusive access. Access to interstate highway ROW in Louisiana is on a first-come, first-serve basis and theoretically, there is no limit to the number of companies that may install infrastructure along a certain stretch of highway. For State-owned towers, the LaDOTD allows private companies access to their towers. There is a permit fee and the company must perform a loading study based on the equipment they wish to install on the tower. In one case, LaDOTD has allowed a private entity to build a tower on State property for their use. There are no restrictions on to whom the private telecommunications company may market their services.

Compensation rates are pre-established and the private company must accept the rates or not perform their installation. By law, the LaDOTD can only recuperate administrative costs associated with the permitting process. Therefore, the LaDOTD tries to balance the cost of the installation permit with the value that the State receives. Currently, the permit cost in Louisiana is a one-time fee of $5,000/mile for fiber installations on interstate highway ROW and $3,500/year per tower permit. The tower permits are generally set up on a 10-year basis. These fees are considered by LaDOTD to be a bargain for telecommunications companies as opposed to those companies negotiating and purchasing their own easements.

This established process for allowing utility installations for a set compensation rate has been very successful for Louisiana. They have extensive fiber networks throughout the State and their tower usage fees are used to fund ITS projects within the State through a barter system. In order for LaDOTD to get telecommunications services for data transport between field equipment and a TMC or between other offices, they would normally have to contract with their Office of Telecommunications Management and be subject to the rate structures they have negotiated. With the ability to barter with telecommunications providers for services under their established procedures, LaDOTD can directly receive telecommunications service for their needs.

This case study shows how the establishment of an access policy and predetermined rate structure can prepare a DOT to react quickly to requests for ROW access and receive fair compensation that can be used to improve their ITS communications network.

4.G.ii. Massachusetts

In 1997, Massachusetts developed a shared resource policy initiative to promote public-private cooperation to facilitate deployment of telecommunications systems along Massachusetts highways. The policy generally contemplated fiber optic infrastructure construction within State/interstate highway ROW funded by the private sector. In exchange for use of the ROW, MassHighway standardized and streamlined its telecommunications project approval and permitting processes and received defined system capacity in the form of two 1.25-inch conduit, one empty and one containing 12 strands of unused (i.e., dark fiber) single mode fiber optic cable. There were a few projects, e.g., Level 3 Communications, completed in Massachusetts under this policy initiative.

Today, MassHighway is revising their wireline policy. The policy currently under development is an entirely different model than the Wiring Massachusetts initiative of 1997. Pending approval for funding, MassHighway has initiated a project to pay for and construct 63 miles of conduit and fiber optic cable within ROW on the I-91 and I-291 corridors to support expansion of ITS and promote economic development. The project will provide for six conduits within the highway ROW, five of which are empty for future use, including four that can be leased out by the Division of Capital Asset Management (DCAM) with one empty spare reserved for MassHighway's future use. Ninety-six fibers will be installed in one conduit for MassHighway use. Private entities seeking access will pull fiber through the empty conduits. In this way, MassHighway has complete control over how excess capacity is built out and how access is provided to the infrastructure.

Central to MassHighway retaining this control is the ability of DCAM to execute long-term, revenue generating agreements on behalf of the State and MassHighway with private providers. Similar to the wireless policy already in place, DCAM will execute necessary agreements to lease capacity to the private sector in an open and fair environment.

This important project currently is being procured. To reduce risk and accelerate project delivery, MassHighway has initiated necessary environmental reviews. Recently they have secured decisions of non-applicability from all 12 conservation commissions covering the I-91 and I-291 corridors. They have developed a preliminary design positioning the conduit pathway within 10-feet of the edge of pavement in order to construct in areas previously disturbed as an aid to securing permits for construction.

The current market climate has dictated that MassHighway put in the conduits versus letting the private sector do so. There is not enough positive economic benefit to a private sector provider for them to fund the installation independently. MassHighway has recognized this and updated the traditional public-private partnership model to meet their needs as well as provide a business case for a private sector partner to join them. The specific language to govern future public-private partnership is being written into the Massachusetts Utility Accommodation Plan, with the wireless language complete and the wireline language currently under review.

4.G.iii. Minnesota

The State of Minnesota created a project called "Connect Minnesota" in 1996. The project was designed as a public-private partnership in which private telecommunications companies were given the opportunity to bid on the project and propose the level of compensation that would be provided to Minnesota in exchange for access to interstate highway ROW and other highways. Connect Minnesota was to provide communications services between several major cities in Minnesota as well as penetrate into rural areas of the State.

Two bids were received and ultimately one was accepted from ICS/UCN LLC. An agreement was reached between the State of Minnesota and ICS/UCN and construction began in 1998. The first route to be constructed was Interstate 94 from the Minnesota-Wisconsin border to the Minnesota-North Dakota border, approximately 250 miles. Ultimately, Connect Minnesota was to build out over 2,000 miles of telecommunications infrastructure by the time it was completed.

Soon after construction began, there was a downturn in the HST industry. Without a market to sell their services to and a large investment in the construction of the Interstate 94 infrastructure, ICS/UCN LLC was forced to file for bankruptcy. Interstate 94 was the only route where construction had been started and Minnesota ended up with multiple conduits and access vaults along the entire length of the route, but no private service provider to operate or maintain a network. Ultimately, AT&T entered into an agreement with the State to take over management of the infrastructure along Interstate 94 in exchange for the right to use the infrastructure and the provision of telecommunications services to the State.

As a result of the Connect Minnesota project not delivering on its advertised goal, the Minnesota State Legislature enacted a law that prohibited State agencies from engaging in public-private partnerships with values in excess of $100,000 without legislative approval. This in effect prohibited any type of shared resource project in Minnesota. While the project was initially characterized as a failure, ultimately it provided for the installation of several million dollars worth of telecommunications infrastructure along the major east-west route in the State and is providing a large benefit to the State to this day.

This case study demonstrates that these projects are risky and there will be successes and failures, but if the risks can be overcome and expectations managed for what each partner can bring to the table, then a benefit to all parties can be achieved. The case study also demonstrates the need for a DOT to be flexible when working with the private sector. Market forces can shift the direction of a project and partnering is required to deal with unavoidable changes over the course of a project's life.

5. Findings and Conclusions

This study has examined the feasibility and potential benefits of installing high-speed telecommunications backbone along interstate highway rights-of-way. The findings of the study do not provide a "one-size-fits-all" recommendation as to whether such deployment should take place, or the specific methods of the deployment. The existing availability of HST infrastructure, including both public and private infrastructure, varies across and even within corridors. Some States already are undertaking initiatives to expand HST deployment. Others have policies discouraging or prohibiting the use of interstate highway right-of-way for utilities including telecommunications. The potential market for HST services and the resulting benefits of deployment also vary across the corridors. Furthermore, specific design and engineering issues have not yet been investigated, or potential costs determined; these will be addressed in the subsequent *Report to States*.

Despite these disparate findings, a number of general conclusions can be drawn from the results of the study to date:

- **Expanded HST deployment in each corridor could potentially lead to significant benefits,** including benefits to State transportation agencies and the traveling public, as well as general benefits to residents of rural communities in each corridor through economic development, improved health care and education opportunities, and enhanced quality of life. Rural areas are lagging in broadband adoption compared to urban areas, and as a result are failing to reap the benefits provided by HST services.

- **No single technology will provide the solution to HST needs** in all rural corridors. Fiber optics, wireless, or a hybrid of the two technologies may be most appropriate depending on the specific conditions and needs within each corridor.

- **The Federal Government must continue to play an active role** if the full benefits of HST deployment are to be realized. A precedent exists for such involvement through the development of policies at both the legislative and executive level, as well as programs such as the Rural Development Utilities Program and Universal Service Access Fund. Federal leadership is especially critical to establish a framework that will promote creative approaches to multistate deployment without imposing unnecessary new requirements. DOT could provide technical assistance and/or incentives for States to enter into multistate agreements and public-private partnerships.

- **The most direct benefits will be to transportation agencies**, for whom public-access HST along the highway corridors will support a set of advanced traffic management applications that will enhance mobility and safety. **Additional benefits to rural communities will be realized only if the HST backbone is deployed in such a way that it spurs additional local public- and/or private-sector investment** in providing HST connections to end users. This will require the creation of public-private partnerships so that private sector providers have access to the HST backbone infrastructure. Fortunately, precedent for successful public-private partnerships exists.

- Individual States execute **laws and policies that may limit the deployment** of a corridor-wide communications backbone. Absent Federal law or regulations this condition will in all likelihood continue to persist.

- **Infrastructure deployment can be greatly facilitated by the establishment of uniform design guidelines and standards.** The Department of Transportation and AASHTO can revisit current policies and guidelines regarding HST implementation to address new issues stemming from advanced communications technology.

- A substantial national fiber backbone system already exists between major metropolitan areas due to prior private sector investments, and thus **opportunities for resource-sharing agreements for new fiber capacity are limited.** In areas where backbone capacity already exists, the provision of additional backbone services along interstate highways will only benefit communities if access is

provided at a cost low enough to induce additional private-sector investment in "last-mile" connections. An optimal strategy will rely on public-private partnerships to make use of existing infrastructure and to promote investment in new infrastructure only where it is needed.

- **States also have a strong potential interest and role in deploying HST in interstate highway corridors.** Congestion and incident management is not just an urban issue. Congestion relief through ITS implementation (e.g., at border crossings) is to some extent contingent on availability of HST. However, State DOTs generally do not have resources readily available for major investments in HST. Supplemental funding will be required to build out communications infrastructure for future public applications in cooperation with the private sector. Especially where existing private-sector backbone capacity is limited, State DOTs would be well advised to recognize and take advantage of the potential value of their property to the private sector by offering consistent rules of access.

- **An HST backbone along an interstate highway corridor provides benefit to all State functions** and to the State as a whole, not just to transportation interests.

- **The private sector is a critically important partner** in any HST deployment initiative, not only for providing last-mile connections and potential financial support, but also for maintaining and operating the system. The way that State DOTs are currently constituted and operated, oriented primarily toward capital construction, presents a challenge for deploying and maintaining telecommunications capabilities. Telecommunication entities with State oversight are better able to manage telecommunications resources and to keep up with the rapidly changing technology.

- Looking toward the future, **Vehicle Infrastructure Integration (VII) could establish the need for a nationwide communications backbone** that uses interstate highway corridors. The USDOT is continuing to work with States and other stakeholders to determine whether such an opportunity exists and what appropriate governance models can be applied.

END NOTES

1 Adapted from http://www.fhwa.dot.gov/PPP/defined.htm#1(accessed August 30, 2007).

2 Newton, Harry, "Newton's Telecom Dictionary", 19th edition, CMP Books, 2003, page 891.

3 Estimates vary depending on definitions of broadband and the estimating techniques used. The OECD reports 58.1 million subscribers, using download speeds of 256 kilobits per second as its metric; Kyle McSlarrow of the National Cable & Telecommunications Association cites a Kagan Research report estimating 49 million households with broadband access. Some of this uncertainty may relate to how many "subscribers" are residential or small business, as opposed to larger employers.

4 Rowley, Thomas D., "Where No Broadband has Gone Before," Rural Policy Research Institute, August 19, 2005. URL: http://www.freepress.net/news/11114 (accessed August 30, 2007).

5 "High-Speed Services for Internet Access: Status as of June 30, 2006." Industry Analysis and Technology Division, Wireline Competition Bureau, Federal Communication Commission (January 2007).

6 Broadband Deployment Is Extensive throughout the United States, but It is Difficult to Assess the Extent of the Deployment Gaps in Rural Areas, U.S. Government Accountability Office, May 2006, GAO-06-426.

7 "Understanding Broadband Demand: A Review of Critical Issues," Office of Technology Policy, US DOC, September 23, 2002 URL: http://www.technology.gov/reports/TechPolicy/Broadband_020921.htm (last accessed August 30, 2007).

8 OECD Broadband Statistics to December 2006. URL: www.oecd.org/sti/ict/broadband (last accessed August 30, 2007).

9 The Federal Communications Commission has recently initiated studies on two items involving broadband deployment in the United States. The first is a Notice of Inquiry into whether broadband services are being provided to all Americans in a timely and reasonable fashion. The second is a Notice of Proposed Rulemaking on methods of collecting information needed to set broadband policy in the future. Both were announced by the Commission on April 16, 2007.

10 "Availability of Advanced Telecommunications Capability in the United States," Fourth Report to Congress, September 9, 2004; Federal Communications Commission, FCC 04-208, GN Docket No. 04-54, Washington, D.C.

11 Two recent Swedish Governmental commissions took a look at the question of what constitutes broadband and adopted substantially higher-speed thresholds: symmetric 2 Mbps and 5 Mbps. (Swedish Special Infrastructure Commission (June 1999): Broadband should be defined as at least 2 Mbps (symmetrical) to the user. Swedish IT Commission (November 1999): Minimum 5 Mbps to the user).

12 With current compression technology, each high definition video stream requires a sustained 8 megabits per second of transport capacity, meaning a typical household with three televisions would need 24 megabits just for the video portion of the services. More advanced compression technology such as MPEG-4 is on the horizon that would reduce the required bandwidth for each high definition stream, but comes at a high capital cost. It is unclear whether or when it will see widespread adoption in the industry.

13 Some newer long-haul fiber optic transport technologies such as Reconfigurable Optical Add Drop Multiplexing technology (ROADM) and silicon based fiber optics transceivers are lowering the cost of transforming a regeneration site into a site at which the bandwidth can be locally accessed. These new technologies do not address the cost of establishing fiber connections from the Long Haul route to the local markets or the cost of transporting the bandwidth within the local markets.

14 "Broadband Deployment Is Extensive throughout the United States, but It Is Difficult to Assess the Extent of Deployment Gaps in Rural Areas." GAO-06-426, United States Government Accountability Office, Washington, D.C., May 2006.

15 Communications Act of 1934, §301, 307(a, d), 308(a), 309(a, d).

16 Telecommunications Act of 1996, Pub. L. 104-104, 110 Stat. 56 (1996), codified in title 47 of the United States Code.

17 Telecommunications Act of 1996 Section 254. Universal Service aspects of the TCA are discussed below.

18 Telecommunications Act of 1996 Section 251(3)(2)(B) of P.L. No. 104-104, 110 Stat. 56 (1996).

19 "Shared resources projects" are also known as public-private partnerships (PPPs). See Shared Communications: Volume I. A Summary and Literature Review (2004) http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//14075.htm (accessed August 30, 2007). This publication recounts a number of shared resources success stories.

20 Telecommunications Act of 1996 Section 253(b).

21 Telecommunications Act of 1996 Section 253 (c).

22 Telecommunications Act of 1996 Section 253(c).

23 Telecommunications Act of 1996 Section 253(f).

24 Telecommunications Act of 1996 Section 253(d).

25 Telecommunications Act of 1996 Section 253(a).

26 Background Guidance on Longitudinal Telecommunications Installations on Limited Access Highway Right-of-Way December 20, 2000, prepared by the ITS Joint Program Office, explains the circumstances of these FHWA-FCC discussions. http://www.its.dot.gov/telecom/tele_srbackground.htm. (accessed August 30, 2007).

27 http://www.its.dot.gov/telecom/tele_srguide.htm (December 22, 2000) (accessed August 30, 2007).

28 Guidance on Sharing Freeway and Highway Rights-of-Way for Telecommunications (1997) and, more generally, A Policy on the Accommodation of Utilities within Freeway Right-of-Way, 5th Edition (2005).

29 See Shared Communications: Volume I. A Summary and Literature Review (2004) http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//14075.htm (last accessed August 30, 2007). This publication recounts a number of shared resources success stories.

30 Telecommunications Act of 1996 Section 253 – Removal of Barriers to Entry.

31 In 2002, the United States Supreme Court decided in National Cable & Telecommunications Ass'n v. Gulf Power, 534 U.S. 327 (2002) that wireless telecommunications providers were protected by the Pole Attachment Act, whether the attachments were of wireline or wireless equipment. The Supreme Court deferred to FCC determinations regarding the meaning of TCA changes to the Pole Attachments Act.

32 Telecommunications Act of 1996 Section 224(a)(1).

33 Telecommunications Act of 1996 Section 224(d).

34 The decision of the Court of Appeals for the District of Columbia in Southern Company Services v. FCC, 313 F.3d 574 (D.C. Cir. 2002) applied the Supreme Court's strong deference to FCC regulatory interpretations of the Pole Attachments Act in a case involving the "overlashing" rule with regard to poles as well as conduit space rules.

35 Telecommunications Act of 1996 Section 254(b)(3).

36 Telecommunications Act of 1996 Section 254(c).

37 Availability of Advanced Telecommunications Capability in the United States, GN Docket No. 04-54, Fourth Report to Congress, 19 FCC Rcd 20540, 20551-52 (2004).

38 Ibid. at 20551. The FCC requires filing of FCC Form 477 in which filers must determine what percentage of their broadband or high-speed connections is faster than 200 kbps in both directions, and to categorize these connections into five "speed tiers" based on the information transfer rate in the connection's faster direction: (1) greater than 200 kbps and less than 2.5 Mbps; (2) greater than or equal to 2.5 Mbps and less than 10 Mbps; (3) greater than or equal to 10 Mbps and less than 25 Mbps; (4) greater than or equal to 25 Mbps and less than 100 Mbps; and (5) greater than or equal to 100 Mbps. See 2004 Data Gathering Order, 19 FCC Rcd at 22347, para. 14.

39 In the Matter of Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, GN Docket No. 07-45, Notice of Inquiry, FCC 07-21 (rel. Apr. 16, 2007), para. 12.

40 The FCC notes, "For example, AT&T and Verizon offer residential DSL products with maximum downstream capacities of up to 3.0 Mbps. See AT&T DSL Plans and Pricing, http://www.usa.att.com/dsl/index.jsp (accessed Feb. 12, 2007); Verizon DSL for Home Packages and Pricing, http://www22.verizon.com/content/consumerdsl/plans/all+plans/all+plans.htm (accessed Feb. 12, 2007). Time Warner Cable offers residential cable modem service products with maximum downstream capacities of up to 6.0 Mbps. See Time Warner Cable – Why Road Runner?, http://www.timewarnercable.com/corporate/products/highspeedInternet/whyroadrunner.html (accessed Feb. 12, 2007). Verizon recently began offering its FiOS service, which may include Internet access speeds of up to 30 Mbps. See Verizon FiOS Internet Packages & Pricing, http://www22.verizon.com/content/fiostv/packages+and+prices/packages+and+prices.htm (accessed Feb. 12, 2007)."

41 In the Matter of Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, GN Docket No. 07-45, Notice of Inquiry, FCC07-21 (rel. Apr. 16, 2007).

42 Telecommunications Act of 1996 Section 254(d).

43 Telecommunications Act of 1996 Section 254(g).

44 Telecommunications Act of 1996 Section 253(g). Section 253(k) prohibits subsidizing competitive services, so that universal service bears no more than a reasonable share of the joint and common costs of facilities used to provide those services.

45 Telecommunications Act of 1996 Section 253(h).

46 FCC Regulations regarding Universal Service are published at 47 C.F.R. Part 54.

47 Telecommunications Act of 1996 Section 254(h).

48 Established by FCC Order, CC Dkt 96-45, FCC 96-93 (Mar. 8, 1996).

49 The One Hundred Tenth United States Congress is the current Congress meeting from January 3, 2007 to January 3, 2009.

50 S.101, 110th Cong., 1st Session (introduced January 4, 2007).

51 See High-Speed Services for Internet Access: Status as of June 30, 2006 (rel. Jan. 31, 2007) (June 2006 Statistical Summary), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-270128A1.pdf. (accessed 08/30/2007) Information is compiled from filings of FCC Form 477 by broadband providers.

52 See, GAO Report 06-426 regarding Broadband Deployment is Extensive throughout the United States, but It is Difficult to Assess the Extent of Deployment Gaps in Rural Areas (May 2006).

53 WC Docket No. 07-38, Notice of Proposed Rulemaking, FCC 07-17 (rel. Apr. 16, 2007).

54 In the Matter of Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, GN Docket No. 07-45, Notice of Inquiry, FCC07-21 (rel. Apr. 16, 2007). This inquiry focuses, in part, on whether FCC definitions of “advanced telecommunications” and “broadband” should be updated.

55 See Section 706(b) of the Telecommunications Act of 1996, Pub. L. 104-104, 110 Stat. 56 (1996) (1996 Act), reproduced in the notes under 47 U.S.C. §157.

56 Rural portions of the corridor are defined for the purposes of this study to include what the Census defines as “urban clusters” – that is, settlements with at least 2,500 but less than 50,000 persons. See http://ers.usda.gov/Briefing/Rurality/WhatIsRural/ (accessed August 30, 2007) for a discussion of definitions of rural versus urban areas.

57 Recent unemployment data was not available at the corridor level, so State-level data are reported.

58 A trauma center is a hospital equipped to perform as a casualty receiving station for the emergency medical services by providing the best possible medical care for traumatic injuries 24 hours a day, 365 days per year. There are four distinct levels of trauma care: Level 1 through Level 4. Certification as a Level 1 trauma center requires a full range of specialists and equipment available 24 hours a day, the admission of a minimum required annual volume of severely injured patients, a program of research, leadership in trauma education and injury prevention, and referral resources for communities in neighboring regions community outreach. A Level 2 trauma center works in collaboration with a Level 1 center to provide comprehensive trauma care.

59 Post-secondary institutions include public and private two-year colleges, four-year colleges, community colleges, technical schools, and universities (offering advanced degree programs).

60 Employment data are for the Massachusetts and New Hampshire portions of the corridor only. Employment data by industry for the State of Vermont was unavailable.

61 Over Three-Fourths of U.S. Active Internet Users Connect Via Broadband At Home in November, According To Nielsen//NetRatings, December 12, 2006. URL: http://www.netratings.com/pr/pr_061212.pdf (accessed August 30, 2007).

62 Turner, S.D., Broadband Reality Check: The FCC Ignores America’s Digital Divide; Free Press with Consumers Union and Consumer Federation of America, August 2005.

63 OECD Broadband Statistics – latest report (to December 2006) available at http://www.oecd.org/sti/ict/broadband (accessed August 24, 2007).

64 Ford, George S., Thomas M. Koutsky, Lawrence J. Spiwak, The Broadband Performance Index: A Policy-Relevant Method of Assessing Broadband Adoption Among Countries, Phoenix Center Policy Paper No. 29, Phoenix Center for Advanced Legal & Economic Public Policy Studies, http://www.phoenix-center.org/pcpp/PCPP29Final.pdf (accessed August 24, 2007).

65 Letter, Ambassador David A. Gross, United States Coordinator, International Communications and Information Policy, U.S. Department of State, to Mr. Angel Gurria, Secretary General, Organisation of Economic Co-operation and Development, April 24, 2007 http://www.ntia.doc.gov/ntiahome/press/2007/State_OECD_042407.pdf (Accessed August 24, 2007).

66 “Broadband Deployment Is Extensive throughout the United States, but It Is Difficult to Assess the Extent of Deployment Gaps in Rural Areas.” GAO-06-426, United States Government Accountability Office, Washington, D.C., May 2006.

67 Sharon E. Gillett, Lehr, W.H., Osorio, C.A. Sirbu, M.A. Measuring the Economic Impact of Broadband Deployment, Final Report. National Technical Assistance, Training, Research, and Evaluation Project #99-07-13829, Submitted to the Economic Development Administration, U.S Department of Commerce, Washington, D.C.; February 28, 2006.

68 Ford, George S. and Koutsky, T.M., “Broadband and Economic Development: A Municipal Case Study from Florida.” Applied Economic Studies, April 2005. URL: http://www.freepress.net/docs/broadband_and_economic_development_aes.pdf (accessed August 30, 2007).

69 http://www.certla.org/vision.asp (accessed August 30, 2007).

70 http://www.clbi.org (accessed August 30, 2007).

71 Report on Building Out Broadband, Findings and Recommendations, The President’s Council of Advisors on Science and Technology, December 4, 2002. URL: http://www.ostp.gov/PCAST/FINAL%20Broadband%20Report%20With%20Letters.pdf (accessed August 30, 2007).

72 Ibid.

73 http://www.ohsep.louisiana.gov/commo/commoindex.htm (accessed August 30, 2007).

74 U.S. Department of Education. “Toward A New Golden Age In American Education: How the Internet, the Law, and Today’s Students are Revolutionizing Expectations.” National Education Technology Plan 2004, http://www.ed.gov/about/offices/list/os/technology/plan/2004/plan.pdf (accessed August 30, 2007).

75 FHWA Highway Statistics, 2005.

76 AASHTO and Transportation Construction Coalition, The Interstate Highway System Fifty Years and Looking Forward, June 28-29, 2006.

77 What is ITS? United States Department of Transportation (USDOT), Intelligent Transportation Systems (ITS), Joint Program Office (JPO). URL: http://www.its.dot.gov/its_overview.htm (accessed August 30, 2007).

78 ITS Benefits Database, “Evaluation Results of Three Prototype Automatic Truck Rollover Warning Systems,” Strickland, R.R. and H.W. McGee. URL: http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ID/22D73F749A10437285256961 0051E2DF?OpenDocument&Query=BApp (accessed August 30, 2007).

79 “Documentation and Assessment of Mn/DOT Gate Operations” Prepared for the Minnesota Department of Transportation by BRW, Inc. October 1999. URL: http://www.dot.state.mn.us/guidestar/pdf/gatereport.pdf (accessed August 30, 2007).

80 USDOT, ITS JPO, ITS Benefits-Costs Database. URL: http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ID/A92C72A81C4C0D6185256B96004D63ED?OpenDocument&Query=BMeasure (accessed August 30, 2007).

81 Stephens, J. and J. Carson, “Follow-On Evaluation of the Montana Department of Transportation’s State Truck Activities Reporting System,” Montana State University, Bozeman, MT. URL: http://www.mdt.mt.gov/publications/docs/brochures/mcs_stars_final_report.pdf (accessed August 30, 2007).

Appendix A: Corridor Impacts Analysis – SWOT Analysis (by corridor)

The SWOT analysis examines and identifies the benefits and risks of providing broadband service (via a shared resource project) to the rural communities along the I-90, I-20, and I-91 corridors. It is important to note that the SWOT analysis focuses on the strengths, weaknesses, opportunities, and threats with regard to the attainability of the potential benefits identified for each of the corridors. This SWOT analysis considered both the private entity and public agency perspective. Therefore, within the matrix, the public agency perspective is denoted by bolded entries, while the private entity perspective is denoted by italicized entries. An entry also can be both bolded and italicized to denote a connection to both the private entity and public agency perspective.

SWOT Analysis for the I-91 Corridor

Issue	Strengths	Weaknesses	Opportunities	Threats
Overall Fiber Optic/ HST Deployment	*Fiber appears to be preferred backbone technology* *Many parts of corridor lack fiber with local connections ("on-ramps")* *Port of Montreal is expecting a five-fold increase in truck traffic along I-91 and I-93 in the near future*	***Cost, engineering, and legal/institutional considerations***	**State initiatives – Vermont, Massachusetts** **Link with local initiatives – northern Vermont, central Massachusetts, New Hampshire**	*Private sector alternatives*
Realizing Economic Development Benefits	**Many parts of corridor lack fiber with good local "off-ramps" – northern Massachusetts, southern Vermont/New Hampshire, northern Vermont/New Hampshire** *Demand is sufficient that public investment in trunk line fiber is likely to spur private investment in last-mile connections*	*Need to ensure that "off-ramps" are provided and that private ISPs can access* *Most larger communities already have good bandwidth/connectivity* *Fiber just along interstate highway does not provide enough coverage to serve all communities – need additional loops* *Some low-density areas will still not be economically serviceable*	***Support high-tech and medical-related growth in "Upper Valley" area of New Hampshire/Vermont and Five College Region of Massachusetts – expand geographic area of industry and housing options, increase telecommuting*** ***Support/increase population of remote workers throughout corridor*** ***Support local industries and entrepreneurs (e.g., woodcrafts, tourism, alternative energy)***	*Long-term decline of "traditional" employment base (e.g., manufacturing, forestry) in corridor* *High taxes (Vermont) – New Hampshire more competitive* *Lack of skilled workforce in many areas* *Verizon is leaving Vermont; (opportunity or threat), because several stakeholders expressed general displeasure with Verizon in delivering broadband service*
Realizing Health Care Benefits	*Many households do not have broadband access – would improve home-based telemedicine opportunities* *Some satellite health care providers and small rural practices need basic HST access or increased bandwidth – improve telemedicine and EMR opportunities*	*Many health care centers (e.g., Dartmouth-Hitchcock, other community hospitals) have adequate bandwidth/ connectivity for current needs*	***Nascent telemedicine and EMR programs based out of Hanover (Dartmouth-Hitchcock), Burlington (UMV-Fletcher), Boston (Tufts New England Medical Center, Joslin Vision Network)***	***Cost, technical, and institutional barriers to utilizing advanced technology (telemedicine and EMR) at smaller practices and at home***
Realizing Education Benefits	*Many households do not have broadband access – would improve distance learning opportunities, ability to research and apply to colleges on-line* **By encouraging last mile service provision, would allow more K-12 schools, libraries, etc. to access broadband**	**Higher education institutions already appear to have adequate connectivity** *One private college noted that home-based learning already is adequate without broadband* *Schools, libraries, etc. still need to be able to afford service, even if available*	***Higher education institutions are increasing on-line course offerings*** ***K-12 schools could benefit from sharing of teachers and resource materials***	

SWOT ANALYSIS FOR THE I-91 CORRIDOR (CONTINUED)

ISSUE	STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
Realizing Safety and Security Benefits	**Local security personnel identify the need for additional bandwidth along U.S.-Canadian border**	**DHS in Washington D.C. does not identify as need**	***Surveillance technology (e.g., constant video monitoring)*** *Cross-State/cross-border communications and coordination initiatives* ***Local fiber initiatives in northern Vermont/New Hampshire***	**Interagency/interjurisdictional cooperation required to leverage full benefits** ***Privacy, cost, personnel, technology issues***
Realizing ITS Benefits	**VAOT wants to install a DMS at every interchange (see threat)** **Vermont and New Hampshire have completed a Statewide ITS and Strategic Deployment Plan** **Public-Private Partnership (PPP) could be used to install WIM, RWIS and bridge de-icing projects** **Could be used to provide all three States with interagency communications** ***PPP language is being written into the Massachusetts Utility Accommodation Plan*** ***PPP is being written into Vermont Utility Accommodation Plan. The wireless is completed and wire line is under development*** ***NH has an accommodation manual***	*MassHighway has an RFP out to install conduit and fiber along State ROW* *MassHighway has control over how excess capacity is built out and access to the infrastructure* *Current market climate dictated MassHighway installing conduits versus letting private sector install conduits* **MassHighway cannot charge rent for ROW; must go through Division of Capital Asset Management** **Vermont and New Hampshire early stages of ITS programs** *Vermont is developing 30 plans for optical fiber alignment along its ROW (expected to bid 4Q 2007, 1Q 2008)* **New Hampshire has difficult time getting Office of Information Technology involved in ITS projects**	*In Massachusetts, current project to install empty conduit together with a to-be-developed statewide policy for accessing conduit will encourage private parties to offer high-speed telecom to communities along corridor* ***In Massachusetts, shared resource project will require separate vaults for each of the six conduits*** *Vermont has been approached by Canadian telecommunications long-haul service providers who want to install redundant optical fiber rings in Vermont*	*New Hampshire studied the private-public partnership concept five years ago and at that time there was no private sector interest.* ***Significant opposition to installation of DMS by Vermont citizens*** ***Vermont legislature has blocked all attempts at installing CCTV cameras – privacy concerns***

SWOT Analysis for the I-20 Corridor

Issue	Strengths	Weaknesses	Opportunities	Threats
Realizing Economic Development Benefits		***Inconsistent levels of fiber connectivity through corridor – good coverage throughout Louisiana section of corridor, Alabama and Mississippi is focused around urban areas***	**Rural development programs can offer good base for directing HST needs for economic development**	*Lack of high-tech sector may impede adoption of broadband technology in work sector*
Realizing Health Care Benefits	**Strong hub hospitals with HST technology in place** **University health care systems provide telemedicine with emphasis on rural areas**	*Low incomes = not a lot of potential for home health opportunities*	**Expanded access to rural areas in Alabama and Mississippi could increase opportunities for health care benefits to rural poor** **University of Mississippi Medical Center TelEmergency Program – Rural contracts** **Healthcare programs in rural schools** ***USDA Rural Development Program funding available for telemedicine programs not included in Public infrastructure***	
Realizing Education Benefits	**Educational institutions (K-12 and postsecondary) already are connected or are implementing HST connections to all institutions** **Medical educational institutions are a catalyst for postsecondary HST programs and continuing education**	*Link to individual households is weak at best*	**Some districts are providing access to educational opportunities for displaced K-12 students** ***USDA Rural Development Program funding available for education programs not included in Public infrastructure***	

SWOT Analysis for the I-20 Corridor (continued)				
Issue	**Strengths**	**Weaknesses**	**Opportunities**	**Threats**
Realizing ITS Benefits	**Alabama already has city and State ITS programs (DMS, CCTV, fog warning system, variable speed limit signs,) and leased communications lines** **ALDOT wants to communicate road closures with neighboring States** **All fiber in the MDOT ROW is owned by State** *MDOT currently leases lines from Bell South* **MDOT sees broadband role in addressing homeland security/military communications integration needs** ***Mississippi coastline planning for broadband wireless infrastructure (post-Katrina)*** **LaDOTD IT section managed DOTD business network and use leased lines** **LaDOTD has access to a private optical fiber provider and four access points along I-20 between Shreveport and Monroe** ***LaDOTD permits longitudinal installation of fiber in the ROW*** ***LaDOTD has eight microwave towers on I-20 and permits private telecommunications provider access by permit*** ***LaDOTD permits fiber (not pipelines or electric utilities) in Interstate highway ROW*** ***LaDOTD permits fiber installations in rest areas and welcome centers*** **LaDOTD and State Police each have radio networks** **Mississippi is interested in CCTV, RWIS and DMS on bridges** **Portable DMSs could provide directions and information during an emergency** **Provide traveler information across State lines.** **Could be used to implement 511 in Mississippi**	*Mississippi long-range plan is to install optical fiber along I-55* *There is an extensive optical fiber installation in Baton Rouge along I-12 between Hammond and south on I-55 to New Orleans* *LaDOTD needs to know a company before it allows a private carrier to install infrastructure in the ROW* *If MDOT were to enter a public-private partnership for optical fiber installation, MDOT would require completely separate conduits and manholes* *Mississippi and Louisiana need optical fiber in North/South corridors more so than along I-20* *MDOT is developing a Statewide two-way radio network to be shared by all agencies* **LaDOTD can only recover administrative costs associated with optical fiber/tower permitting process**	***In Mississippi, optical fiber for DOT use is installed along I-20 at Jackson*** **Mississippi partners with Arkansas for Mississippi River Bridges to monitor homeland security risks and Mississippi wants to partner with Louisiana** ***All three States want better center to center communications***	***Need to confirm that ALDOT only permits crossing (not longitudinal installations) along access controlled highways*** **Lack of cooperative planning between MDOT and LaDOTD and State Information Technology Services** ***Alabama prohibits shared resource projects and installation along controlled access highways*** **LaDOTD could use optical fiber backbone for State agency uses, but probably could not sell to a private company** *MDOT does not allow attachments to structures for telecommunications installations* *Mississippi has an information technology services agency that will want to get involved if the network is not traffic related*

SWOT Analysis for the I-90 Corridor

Issue	Strengths	Weaknesses	Opportunities	Threats
Overall Fiber Optic/ HST Deployment	*Fiber appears to be corridor preference for backbone technology*	**Technology choice may limit development in some areas**	***Existing infrastructure and institutional knowledge provides a good base for developing other areas of the corridor***	
Realizing Economic Benefits	**States have made significant investments in fiber available for government use**	**Current focus on economic development appears to be in on urban areas, not rural communities with greater distances from highway ROW**	*Increased ability for remote workers throughout corridor*	*South Dakota: does not have a high percentage of white collar workers*
Realizing Health Care Benefits	*Increased potential for home health care opportunities* *Hospitals providing infrastructure assistance to small community facilities* ***Strong government investment in public facility infrastructure, including medical facilities***	*Privacy concerns may limit infrastructure access to non-network hospitals*	***Existing private sector offerings may spur growth of other sectors*** ***USDA Rural Development Program funding available for telemedicine programs not included in Public infrastructure***	
Realizing Education Benefits	*Could help improved household access to broadband/HST, which would improve individual access to educational opportunities via distance learning*	*Educational institutions (all levels) across the corridor seem to have adequate connectivity*	***USDA Rural Development Program funding available for education programs not included in Public infrastructure***	
Realizing ITS Benefits	***Wisconsin – State Patrol houses telecomm equipment. Regeneration facilities housed in prefabricated buildings located on State ROW*** ***Iowa allows private telecommunications companies to place facilities in the ROW for a fee*** **South Dakota shares DMS information with Iowa and Minnesota** ***South Dakota has 22 DMS along I-90. Currently lease backbone. Also have 12 maintenance shops along I-90. Currently lease backbone*** ***Minnesota had deployed several ITS devices (automated gate closures, RWIS, DMS, and CCTV). Minnesota uses wireless and leased communications***	*I-94 in Wisconsin already has ITS and optical fiber infrastructure with at least 12 strands of fiber. Separate handholes for WisDOT and private carrier and there is a portion of that infrastructure that overlaps I-90* *Wisconsin DOA already provides bandwidth to schools and other State government agencies* **Iowa DOT does not have assets on I-90, but does have fiber in Des Moines, Iowa City, and the Quad Cities** *ICN exists throughout Iowa* *South Dakota does not have significant amount of optical fiber* *Minnesota implementing digital microwave and 800 MHz backbones* **MnDOT considers I-90 to be in poor material condition (high water table). They prefer to delay ITS deployments until this is addressed**	***Wisconsin studied PPP in1994 and determined restrictions too rigid. Passed legislation, but still cannot lease fiber (on State ROW) to private companies*** ***Wisconsin has been using dark fiber as a match for FHWA ITS earmark funds. Wisconsin leases 8-12 fibers and has a self-sustaining system*** ***Minnesota advertises to colocate on DOT-owned towers. DOT allows other public agencies on its towers to make agreements with private entities to swap tower usage*** ***MnDOT sells tower colocation space yearly on first-come, first-served basis*** ***Connect Minnesota legacy*** ***The Minnesota $100K barter limit does not apply to wireless communications or other State agencies***	***Unknown if South Dakota allows private telecommunications facilities on ROW*** ***Minnesota State optical fiber can only be used by public agencies*** ***In Minnesota, I-35 much higher priority than I-90*** ***Minnesota legislature bars barter agreements over $100K*** ***Minnesota does not have common carrier status so restricted in what partnerships they can take*** ***Minnesota can install optical fiber in ROW at any time, but it must be all State and Federal funds (barter not allowed)*** ***In Wisconsin, all ITS projects (and feasibility studies) must be associated with a specific road construction project***

Appendix B: Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ALDOT	Alabama Department of Transportation
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
BOR	Bureau of Reclamation
BPL	Broadband over Power Lines
CCTV	closed circuit television
CERT	Consortium for Education, Research, and Technology
CFR	Code of Federal Regulation
CLBI	Central Louisiana Business Incubator
CLEC	Competitive Local Exchange Carriers
COTM	Contracting Officer Task Order Manager
DCAM	Division of Capital Asset Management
DHS	Department of Homeland Security
DMS	dynamic message signs
DOT	department of transportation
DSL	Digital subscriber line
DSRC	dedicated short-range communications
DTN	data transmission network
EHIS	electronic health information systems
EMR	Electronic medical record
EOC	Emergency Operations Centers
ESP	Emergency Service Provider
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FLHP	Federal Lands Highway Program
FWS	Fish and Wildlife Service
GAO	Government Accountability Office
GHz	Giga Hertz
GIS	geographic information system
HAR	highway advisory radio
HST	high speed telecommunications
ICN	Iowa Communications Network
IEEE	Institute for Electrical and Electronics Engineers
ILEC	Incumbent Local Exchange Carriers
ITS	intelligent transportation systems
IXC	interexchange carrier
Kbps	kilobits per second
LaDOTD	Louisiana Department of Transportation and Development
LAN	local area network
LSU	Louisiana State University

Mbps	megabits per second
MDOT	Mississippi Department of Transportation
MHz	Mega Hertz
MRI	Magnetic Resonance Imaging
MSDDC	Military Surface Deployment and Distribution Command
NPS	National Park Service
NTIA	National Telecommunications and Information Administration
OECD	Organization for Economic Cooperation and Development
POP	point of presence
PPP	Public-Private Partnership
PSTN	public switched telephone networks
RFP	request for proposal
ROADM	Reconfigurable Optical Add Drop Multiplexing Technology
ROW	rights-of-way
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SWOT	strength, weaknesses, opportunity, and threats
TCA	The Telecommunications Act
TDM	time division multiplexing
TMC	Transportation Management Center
TOC	traffic operations centers
tPA	tissue palsminogen activator
TTI	Texas Transportation Institute
U.S. DOT	United States Department of Transportation
UAP	utility accommodation policy
UMC	Mississippi Medical Center
USAC	Universal Service Administrative Company
USACOE	United States Army Corps of Engineers
USD	University of South Dakota
USDA	United States Department of Agriculture
USF	Universal Service Fund
USFS	United States Forest Service
UTOPIA	Utah Telecommunication Open Infrastructure Agency
UZA	urbanized area
VII	vehicle infrastructure integration
VMT	vehicle miles traveled
VoIP	Voice over Internet Protocol
WAN	wide area network
Wi-Fi	Wireless Fidelity
WIM	weigh-in-motion
WiMAX	Worldwide Interoperability for Microwave Access

U.S. Department of Transportation
Research and Innovative Technology Administration
Federal Highway Administration