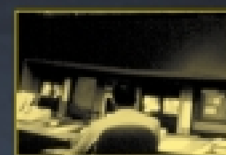

ITS

National Intelligent Transportation Systems Program Plan

Five-Year Horizon

August 2000

U.S. Department of Transportation ITS Joint Program Office

ITS

National Intelligent Transportation Systems Program Plan

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EXECUTIVE SUMMARY

Transportation is vital to the social and economic health of the nation. Surface transportation systems – the networks of highways, local streets, bus routes, and rail lines – are the ties that bind communities and facilitate commerce, connecting residents to work, homes, schools, services, and each other. Today, surface transportation in the United States faces a number of challenges. Despite the fact that the United States has one of the best roadway systems in the world, congestion is increasing and safety remains a serious problem. Congestion takes its toll in lost productivity, costing the nation an estimated $40 billion each year. Trucks and buses travel over 100 billion miles annually and face the same congestion, delays, and inherent lost productivity experienced by the daily commuter. Vehicle crashes represent another $150 billion in financial burden to the economy, and result in the loss of more than 40,000 lives annually. Inefficient movement of vehicles – whether by private cars, motor carriers, or public transit vehicles – wastes energy, increases emissions, and threatens the quality of life we enjoy. Thus, the efficiency, safety, and effectiveness of surface transportation have direct impacts on accessibility, national economic growth and competitiveness, and the environment.

Intelligent Transportation Systems, or ITS, offer promising solutions to these pressing challenges. ITS refers to the electronics, communications, hardware, and software that support various services and products to address transportation problems. When deployed in an integrated fashion, ITS allows the surface transportation system to be managed as an intermodal, multi-jurisdictional entity, appearing to the public as a seamless system.

With the passage of the Transportation Equity Act for the 21st Century (TEA-21) in 1998, Congress reaffirmed the role of the United States Department of Transportation (U.S. DOT) in advancing the development and integrated deployment of ITS technologies. This report presents U.S. DOT's goals, key activities, and milestones for the National ITS Program for fiscal years (FY) 1999 through 2003. This 5-year plan will be followed by a 10-year program plan that sets forth the next-generation research agenda for ITS. These two documents, coupled with the Intelligent Transportation Society of America's national deployment strategy, will fulfill TEA-21's directive to update the National ITS Program Plan, and will address ITS deployment and research challenges for stakeholders across all levels of government and industry. While these reports provide an updated vision of the National ITS Program, they do not supersede material contained in the first National ITS Program Plan, published in 1995.

TRANSITION FROM RESEARCH TO DEPLOYMENT

With the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, Congress established a new era for transportation, calling for more efficient and safer use of the existing highway and transit infrastructure, and emphasizing intermodalism – the seamless integration of multiple transportation modes. ISTEA charted a course toward achieving operational, safety, and efficiency improvements by infusing surface transportation systems with ITS. Under ISTEA, the National ITS Program focused primarily on research, technology development, and field-testing that advanced the state of technology, demonstrated substantial public benefits, and fostered new models of institutional cooperation. The Program began to lay the foundation for an information and communications infrastructure that would enable the nation to realize the vision set forth by Congress – to manage multiple transportation facilities as unified systems for greater efficiency, safety, customer service, and quality of life.

TEA-21 continues the legacy of ISTEA by building on the success of research and development to date. Today, many ITS technologies are available, and the National ITS Program will shift its emphasis accordingly to the deployment of proven ITS technologies in an integrated fashion, while continuing to advance ITS capabilities through further research.

INTELLIGENT INFRASTRUCTURE AND INTELLIGENT VEHICLES

The National ITS Program focuses on two main objectives: deployment of intelligent infrastructure, and testing and evaluation of intelligent vehicle technologies. Intelligent infrastructure and intelligent vehicles provide the information and control needed to better manage surface transportation facilities (highways, roads, transit, and rail), to improve the safety of vehicles operating on those facilities, and to help users of all modes make better decisions about travel. Intelligent infrastructure is the necessary network of technologies – a communications and information backbone – that supports and unites key ITS services for metropolitan, rural, statewide, and commercial vehicle application. Intelligent vehicle technologies improve safety and enhance mobility of the vehicles that operate on our roadways. Such technologies apply to four classes of vehicles: light vehicles (passenger cars, vans, and light trucks), transit vehicles (buses), commercial vehicles (trucks and interstate buses), and specialty vehicles (emergency response, enforcement, and highway maintenance vehicles). Since no single technology "fix" can address America's growing demand for and changing patterns of travel, to realize the promise of a truly national transportation system, ITS products and services must be seamlessly integrated and interoperable. Over time, intelligent vehicles will increasingly interact with intelligent infrastructure to yield even greater gains in mobility and traveler safety, as illustrated on Figure ES-1.

Intelligent infrastructure and intelligent vehicle objectives are addressed through four program areas: metropolitan ITS infrastructure, rural ITS infrastructure, commercial vehicle ITS infrastructure, and intelligent vehicles. Each program area targets a specific environment in which ITS capabilities are used. The metropolitan and rural ITS infrastructure program areas address network-based technologies deployed in those two settings. The commercial vehicle ITS infrastructure program area focuses on the integrated technologies needed specifically for safety and administrative regulation of interstate trucking. Finally, the intelligent vehicles program area targets in-vehicle safety systems for all users and geographic settings.

The National ITS Program includes intelligent infrastructure and intelligent vehicles. Over time, infrastructure and vehicles will work together for even greater benefits in mobility and traveler safety.

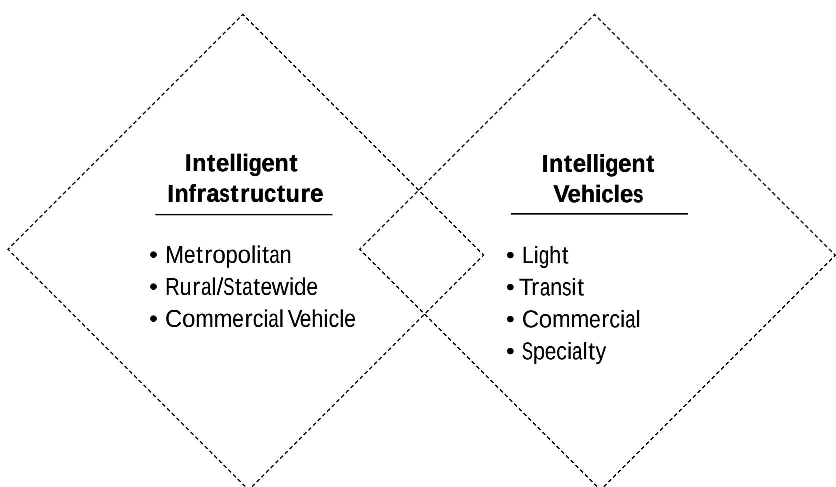


Figure ES-1: The National ITS Program Structure

ITS PROGRAM STRATEGIES

The National ITS Program utilizes eight program strategies that work cooperatively to advance the state of ITS across the country.

1. **Conducting Research** advances ITS infrastructure and vehicle capabilities by bringing technologies from visionary concepts to viable and attractive solutions to transportation problems. Continued research and development is necessary for increasing the real-time capabilities of ITS infrastructure components, improving intelligent vehicle capabilities, and for developing successive generations of ITS technologies.

2. **Accelerating the Development of Standards** allows communications, surveillance, monitoring, and computer processing systems to "speak" to each other, provides design guidance to manufacturers, and reassures purchasers that their systems will be compatible with other ITS elements.

3. **Building Professional Capacity** ensures that transportation professionals across the country have the skills necessary to design, deploy, operate, and maintain ITS systems. ITS requires new technical skills, such as systems engineering, electronics, and communications, as well as institutional skills which include coalition building.

4. **Creating Funding Incentives** encourages more widespread integration of ITS in metropolitan, rural, and commercial vehicle settings. The overall trend in ITS funding has shifted from dedicated special funds to the use of traditional transportation funding mechanisms such as the Highway Trust Fund (including the Mass Transit Account). However, temporary funding incentives are still necessary to foster integration and national interoperability, and to accelerate deployment.

5. **Providing Guidance and Technical Assistance** aids implementers seeking to deploy integrated ITS. U.S. DOT provides specialized technical support through its Federal field staff, through the publication of guidance documents on best practices for ITS deployment, and with the Peer-to-Peer Network, a resource composed of professionals from the private and public sectors who are on-call to provide short-term, no-cost technical assistance to transportation colleagues across the country.

6. **Ensuring Consistency[1] with the National ITS Architecture and Standards** helps in planning for ITS integration, reducing development time and cost, and laying the groundwork for a seamless national ITS network. U.S. DOT is working with stakeholders to develop Federal policy on consistency, and is actively training stakeholders on this issue.

7. **Evaluating the Program** is essential for understanding the value and effectiveness of ITS activities and for measuring progress toward deployment goals. Tracking and evaluation is consistent with the spirit of the Government Performance and Results Act, and allows for the continual refinement of the National ITS Program.

8. **Showcasing Benefits** communicates positive results realized through the use of ITS technologies to multiple decision makers. By understanding the benefits of ITS, decision makers can compare ITS to other transportation options when addressing local transportation issues. Showcasing benefits also encourages integration of ITS systems. For example, deployment sites demonstrate successful interjurisdictional working relationships and interagency coordination. By learning about the deployment sites, decision makers better understand the operation and management planning that is necessary to achieve integration in their area.

[1] TEA-21 calls for "conformity" with the National ITS Architecture and standards. U.S. DOT's incremental, phased approach to implementing this provision is better reflected by use of the term "consistency" with the National ITS Architecture. For the purposes of this report, these terms are deemed synonymous.

PROGRAM AREA GOALS, KEY ACTIVITIES, AND MILESTONES

These eight ITS program strategies are used to meet specific goals in each of the four ITS program areas: metropolitan, rural, and commercial vehicle infrastructure, and intelligent vehicles. In addition to the activities listed below, detailed roadmaps for each program area are included in Appendix A. The roadmaps, and the text in Chapter III, are guiding the National ITS Program under TEA-21.

Metropolitan ITS Infrastructure Program Area

The metropolitan ITS program has demonstrated proven technologies for metropolitan application. Model deployments in metropolitan settings have been successful and will continue to be showcases for other areas. However, while individual systems are being purchased and installed around the country, sites are just beginning to integrate systems across jurisdictions and modes. Since integration has been limited, communities are not yet reaping the full benefits of ITS.

The metropolitan component of the National ITS Program is focused on meeting the goals for integrated deployment laid out by former Secretary of Transportation Federico Peña in 1996 and reiterated by current Secretary of Transportation Rodney Slater. Known as "Operation TimeSaver," U.S. DOT's objective is to facilitate integrated deployment of basic ITS services in 75 metropolitan areas by 2006.[2] At present, 36 sites are considered to have some elements of integration, and additional sites show the clear beginnings of integrated systems.

Metropolitan ITS Infrastructure Program Area Goal:

By 2003, the metropolitan program aims to have 64 sites achieve the Operation TimeSaver goal for integrated deployment.

Key Activities and Milestones. The Operation TimeSaver goal will be met using all eight ITS program strategies, as follows:

- **Conducting Research.** Traffic management and transit management research will be advanced under TEA-21. New models for traffic management, such as the ITS Deployment Analysis System, have been developed that more accurately represent the impact of ITS, allowing transportation planners and designers to compare ITS with other transportation options more effectively. This model was made available to the ITS planning community in 1999. A more sophisticated planning model – the Transportation Analysis and Simulation System, or TRANSIMS – is under development and will be available for initial use in 2002. In transit management, research will focus on the application of integrated transit systems through operational tests in areas such as fleet management, electronic fare payments, and traveler information. From 1999 to 2003, this research will be guided by the Federal Transit Administration's (FTA) 5-year research and technology plan.
- **Accelerating the Development of Standards.** Development of standards, such as the National Transportation Communications for ITS Protocol (NTCIP) and the Transit Communications Interface Profiles (TCIP), will help facilitate integration in metropolitan areas. NTCIP will allow traffic management and operations personnel to better control, manage, and monitor virtually all the devices used on the roadway. TCIP will allow data to be shared among transit departments and other operating entities, such as emergency response services and regional traffic management centers. Because these standards are fundamental to metropolitan transportation operations, a training course on each standard is necessary. The course on NTCIP is already available, on a request basis, through the Institute of Traffic Engineers, and it will be available to stakeholders through 2003. A course on TCIP will be developed in 2000 with delivery expected to occur from 2001 to 2003.

[2] Since the announcement of the Operation TimeSaver goal, U.S. DOT has increased the number of metropolitan areas measured from 75 to 78. In this report, the Operation TimeSaver goal is referred to as both 75 and 78 areas.

- **Building Professional Capacity.** Training courses will continue to be offered on all aspects of metropolitan ITS deployment. Courses will be updated as new information is made available. Throughout 2000, the primary focus is to educate stakeholders on the use of the National ITS Architecture as a tool for integration. In FY 2001 and 2002, U.S. DOT will rely on traditional Federal Highway Administration (FHWA) and FTA training programs to deliver the metropolitan courses from the Professional Capacity Building Program.

- **Creating Funding Incentives.** TEA-21 funding incentives are being offered to metropolitan public-sector applicants to support technical integration and jurisdictional coordination of ITS infrastructure. Funding will be offered to both highway and transit projects, and U.S. DOT will work with Congress and the funding recipients to ensure that both the spirit and intent of TEA-21 funding criteria are met. U.S. DOT will allocate funding incentives annually based on programmatic goals and the criteria defined in TEA-21. Funding available for integration is set by TEA-21 at $75 million in 1999, $83 million in 2000, $83 million in 2001, $85 million in 2002, and $85 million in 2003. A maximum of 90 percent of this funding is available to metropolitan areas.[3]

- **Providing Guidance and Technical Assistance.** Special guidance and technical assistance is being offered to transportation officials through Federal field staff expertise, guidance documents, and the Peer-to-Peer Network to assist in the planning, design, operation, and maintenance of metropolitan ITS. In addition, Federal field staff will work with their state and local partners to develop "ITS service plans" that outline local technical guidance needs and plans for delivery. Development of "ITS service plans" began with a focus on the top 78 metropolitan areas, and has expanded over time to include statewide concerns that typically involve rural ITS applications. U.S. DOT currently has 62 service plans being implemented (49 from the top 78 metropolitan areas and 13 statewide plans). U.S. DOT expects to increase that number to 70 in FY 2001(55 from the top 78 metropolitan areas and 15 statewide plans), 80 in FY 2002 (60 from the top 78 metropolitan areas and 20 statewide plans), and to expand over time to include activities in other metropolitan areas beyond the top 78.

- **Ensuring Consistency with the National ITS Architecture and Standards.** The National ITS Architecture and standards will be instrumental in catalyzing integrated ITS deployment across the country, enabling areas to meet local needs while reducing development costs and risks, facilitating future expansion capability, and fostering interoperability. Interim policy guidance on consistency with the National ITS Architecture and standards was issued in 1999, and U.S. DOT expects to issue a final policy in 2001. The interim guidance is being implemented until release of the final policy; the final policy will be implemented through 2003 and beyond.

- **Evaluating the Program.** Program evaluations track levels of deployment and integration in the 75 metropolitan areas. Evaluations are being used to demonstrate ITS benefits and to measure progress toward the Operation TimeSaver goal. From 1999 through 2003, U.S. DOT will conduct annual tracking surveys, assemble the data received, and report findings. Using this information, the metropolitan program will be refined as appropriate. In addition, a final evaluation of the Metropolitan Model Deployment Initiative will be completed in 2000. The resulting report will provide further insight into the impacts of metropolitan ITS technologies.

- **Showcasing Benefits.** The four metropolitan model deployment sites funded under ISTEA – Phoenix, Arizona; Seattle, Washington; San Antonio, Texas; and the New York/New Jersey/Connecticut metropolitan area – will continue to showcase the benefits of metropolitan ITS technologies under TEA-21. These sites have brought together public and private sector partners to integrate existing infrastructure with new traveler information systems. In addition, metropolitan ITS technologies will be demonstrated to the public through the advanced transportation management truck scheduled to travel the country through 2000. In addition, results of deployment evaluations will be incorporated into publications to disseminate benefits information.

[3] TEA-21 requires a minimum of 10 percent of the available funding incentives be spent on rural integration. Exact amounts to be allocated to metropolitan and rural areas will be determined on an annual basis.

Through these eight strategies, the metropolitan ITS program will continue to pursue the deployment of integrated, intelligent transportation systems – including advanced traffic management, traveler information, and public transit systems – that will improve urban transportation management in the 75 largest urban areas. At the same time, there are 340 major metropolitan areas nationwide that could benefit from advanced technologies, and U.S. DOT's field staff is working actively with all interested communities.

Rural and Statewide ITS Infrastructure Program Area

Information technologies are currently being applied in rural settings to help improve the safety and mobility of rural travelers. However, rural and statewide ITS applications are not yet as well defined as metropolitan and commercial vehicle applications. Under TEA-21, the rural program will focus primarily on research and field operational testing to further develop rural infrastructure components. Through these tests, U.S. DOT will identify solutions that reduce the public sector costs of providing, operating, and maintaining rural ITS infrastructure. Lessons learned from the metropolitan program will be leveraged to the maximum possible extent, as will rural program resources. For example, U.S. DOT will cooperate with other organizations and other Federal departments involved in the mobility of people (such as Health and Human Services) in order to develop innovative ITS-supported services, such as mobility management. Systems such as multi-agency mobility management, automatic collision notification, tourist information, and weather information will be the primary focus in the early years of the program.

Rural and Statewide ITS Infrastructure Program Area Goal:

By 2003 the rural ITS program aims to have demonstrated a statewide information network that is multijurisdictional and multimodal within a state and able to share data across state lines, in 10 locations.

Key Activities and Milestones. To reach this goal, the rural ITS program will focus primarily on conducting research through operational tests. The other seven program strategies will be used to a more limited extent.

- **Conducting Research.** Seven areas have been identified for further research: surface transportation weather and winter mobility, emergency services, statewide/regional traveler information infrastructure, rural crash prevention, rural transit mobility, rural traffic management, and highway operations and maintenance. While activities are expected in all seven areas, U.S. DOT has worked with stakeholders to categorize and prioritize the list. Initial efforts will focus on multi-agency mobility management services, weather information, emergency services, and regional traveler information. Operational tests are currently underway for all four, and additional rounds of tests will be conducted through 2003.
- **Accelerating the Development of Standards.** U.S. DOT is just beginning to identify what standards may be necessary for rural-specific ITS applications. Standards are identified by assessing user needs, defining rural ITS infrastructure, and modifying the National ITS Architecture. The rural ITS program is actively seeking stakeholder participation in this process, and modifications to the National ITS Architecture are being made as rural ITS applications are defined. Once the National ITS Architecture is revised, ITS standards requirements can be identified. The result may be the development of new rural-specific standards and/or modification of existing ITS standards to apply to rural situations. U.S. DOT defined unique rural user services in 1999 and is currently developing them. These defined rural services are facilitating the refinement and update of the National ITS Architecture, and efforts to examine the need to modify existing, or develop new standards as deemed appropriate.
- **Building Professional Capacity.** Professional capacity building for rural practitioners involves modifying existing ITS courses to reflect the needs of rural ITS users and exploring distance learning opportunities. Practitioners with rural expertise will help tailor existing courses to a rural audience. Courses delivered in 1999 and 2000 will focus on educating Federal field staff and rural stakeholders in the use of the National ITS

Architecture for integration. Initiatives are underway to overcome barriers of limited time and travel funding experienced most acutely by rural partners. U.S. DOT is exploring methods to deliver training through satellite broadcast, CD-ROM, and on the Internet. As with other parts of the National ITS Program, U.S. DOT will transfer course delivery to the National Highway Institute and National Transit Institute beginning in 2001.

- **Creating Funding Incentives.** TEA-21 funding incentives are being offered to rural public sector applicants to support deployment of individual project components and the integration of existing ITS components. Funding will be offered to both highway and transit projects, and U.S. DOT will work with Congress and the funding recipients to ensure that both the spirit and intent of TEA-21 funding criteria are met. U.S. DOT will allocate funding annually based on programmatic goals and TEA-21 criteria. Funding levels are set by TEA-21 at $75 million in 1999, $83 million in 2000, $83 million in 2001, $85 million in 2002, and $85 million in 2003. A minimum of 10 percent of available funding will be used in rural areas.

- **Providing Guidance and Technical Assistance.** U.S. DOT will provide guidance and technical assistance primarily by disseminating the results of rural field operational tests to stakeholders. Materials, such as lessons learned and simple solutions compendia, technical toolboxes, and catalogs of available systems, will be compiled and packaged for stakeholders in an "Advanced Rural Transportation Systems toolbox." The first version of the toolbox will be developed in 2000 to 2001, and the second in 2003. Assistance also will be available to rural stakeholders through Federal field staff and the Peer-to-Peer Network.

- **Ensuring Consistency with the National ITS Architecture and Standards.** Interim policy guidance on consistency with the National ITS Architecture and standards was issued in October 1998. U.S. DOT expects to issue a final policy on consistency in FY 2001. This policy will be instrumental in catalyzing integrated ITS deployment across the country. In rural areas, stakeholders will be engaged in the policy development process to work through consistency issues at the statewide planning level. The interim guidance is being implemented until release of the final policy; the final policy will be implemented through 2003 and beyond.

- **Evaluating the Program.** Rural ITS infrastructure components must be defined before they can be tracked, so program evaluation activities are just beginning. Once the components are defined, quantifiable indicators will be identified, as they have been for metropolitan applications. U.S. DOT will define rural infrastructure in 1999 and 2000. Tracking for rural infrastructure is expected to begin in 2001.

- **Showcasing Benefits**. In these early stages of the rural ITS program, benefits of rural ITS applications are being showcased through field operational tests. These tests are not of the same scale as the metropolitan model deployments, but they still provide rural stakeholders the opportunity to see rural ITS technologies in operation and the benefits to rural America. Tests for automatic collision notification, traveler information, and weather information technologies will be completed in 2000. Additional tests are planned for 2001 through 2003 to address applications such as traveler information in a national park setting.

Commercial Vehicle ITS Infrastructure Program Area

The commercial vehicle ITS infrastructure program focuses on increasing safety for commercial drivers and vehicles while improving operating efficiencies for government agencies and motor carriers. At the center of the program is the deployment of Commercial Vehicle Information Systems and Networks (CVISN), which link existing information systems to enable the electronic exchange of information. The initial implementation of CVISN, known as "Level 1," addresses safety information exchange, credentials administration, and electronic screening; it is being prototyped in two states and piloted in eight states nationwide. U.S. DOT expects CVISN Level 1 capabilities to be achieved in Maryland, Virginia, Washington and Kentucky by late FY 2000, and in California, Colorado, Connecticut, Michigan, Minnesota, and Oregon by December 2001, depending on the availability of discretionary deployment incentive funding from Congress.

Commercial Vehicle ITS Infrastructure Program Area Goal:

U.S. DOT has set a goal of having 26 to 30 states deploy CVISN Level 1 capabilities by 2003. Achievement of this goal will depend on the extent to which funds authorized for CVISN in TEA-21 are appropriated for that use.

Key Activities and Milestones. All eight ITS program strategies are being used to meet the commercial vehicle program area goal, as follows:

- **Conducting Research.** Research efforts will continue the development, testing, and implementation of technologies necessary to support commercial vehicle safety enforcement and compliance goals. Under TEA-21, FHWA and the Federal Motor Carrier Safety Administration (FMCSA)[4] will undertake coordinated activities intended to reduce or eliminate transportation-related incidents and the resulting deaths, injuries, and property damage. These activities include demonstrating cost-effective technologies for achieving improvement in motor carrier enforcement, compliance, and safety, while keeping up with the latest technological advances. U.S. DOT will define CVISN Level 2 capabilities in FY 2000, and expects to demonstrate prototype technologies in two or three states from 2000 through 2003.
- **Accelerating the Development of Standards.** U.S. DOT will continue to update and maintain the CVISN architecture to ensure consistency and interoperability, to include lessons learned from deployments, and to keep current with changing technology. In addition, two standards – Electronic Data Interchange (EDI) and Dedicated Short-Range Communication (DSRC) – are essential to the demonstration of CVISN. EDI supports safety information and credential information exchange, and will be approved in 2000. By the end of 2000, the U.S. DOT will have completed a DSRC standard at 5.9 GHz, which is necessary for vehicle to roadside exchange of information. In 2000, U.S. DOT's emphasis will shift to developing guidelines for compatibility and certification testing of the DSRC standard. Ultimately, independent testing organizations will be responsible for certification testing of DSRC.
- **Building Professional Capacity**. Professional capacity building is critical to states, vendors, and FHWA and FMCSA project managers in order to implement CVISN. In addition to the current suite of commercial vehicle ITS awareness and deployment courses, training and technical assistance will be available to states in the areas of interoperability testing for conformance with the National ITS Architecture, systems integration issues and lessons learned, and commercial vehicle ITS project monitoring and maintenance. In 1999 and 2000, training will be delivered to 20 new states to prepare them for CVISN deployment. From 2001 through 2003, 5 to 15 new states will be reached.
- **Creating Funding Incentives.** TEA-21 authorized $184 million over 6 years to deploy CVISN in a majority of states. Funding will be allocated based on programmatic goals and TEA-21 criteria as follows: $27.2 million in 1999, $30.2 million in 2000, $32.2 million in 2001, $33.5 million in 2002, and $35.5 million in 2003. The funding will assist prototype and pilot states, as well as other interested states, in reaching CVISN Level 1 capabilities.
- **Providing Guidance and Technical Assistance.** U.S. DOT has developed an integrated strategy to support states through the deployment of CVISN. From 1999 through 2003, U.S. DOT will continue to provide support to states through tool kits, guides, the Peer-to-Peer Network, and outreach.
- **Ensuring Consistency with the National ITS Architecture and Standards.** The interim guidance issued in October 1998 and the final policy expected in 2001 apply equally to commercial vehicle ITS

[4] The FMCSA was created by the Motor Carrier Safety Improvement Act of 1999 and is the successor agency to the FHWA's Office of Motor Carrier Safety (OMCS).

applications. At the heart of CVISN is the need for interoperability among Federal, state, carrier, and other commercial vehicle systems and networks that allow the exchange of data. The development of a policy to ensure consistency with the National ITS Architecture and approved standards supports this interoperability. The final policy is expected in 2000, and Federal field staff will implement the policy through 2003 and beyond.

- **Evaluating the Program.** Deployment tracking surveys will be conducted for all 50 states at 2-year intervals from 1999 to 2003. In addition, field operational tests will be complete in 2000 and results will be incorporated into ITS costs and benefits databases.
- **Showcasing Benefits.** All eight pilot states serve as model deployments to showcase the benefits of CVISN. Benefits information will be collected from the sites and incorporated into brochures and materials for distribution to stakeholders in 1999 and 2000. CVISN technologies will also be showcased across the country in 1999 and 2000 with the commercial vehicle Technology Truck, a traveling classroom that contains commercial vehicle technologies and provides an interactive learning environment for stakeholders.

The Intelligent Vehicle Initiative Program Area

Under ISTEA, U.S. DOT research in crash avoidance, in-vehicle information systems, and automated highway systems pointed to new safety approaches and promising solutions that could significantly reduce motor vehicle crashes. Preliminary estimates by the National Highway Traffic Safety Administration showed that rear-end, lane change, and roadway departure crash avoidance systems have the potential, collectively, to reduce motor vehicle crashes by one-sixth, or about 1.2 million crashes annually. Such systems may take the form of warning drivers, recommending control actions, and introducing temporary or partial automated control of the vehicle in hazardous situations. These integrated technologies can be linked to in-vehicle driver displays that adhere to well-founded human factor requirements. U.S. DOT has harnessed these efforts into one program, the Intelligent Vehicle Initiative, or IVI.

Intelligent Vehicle Initiative Program Area Goal:

The IVI is focused on working with industry to advance the commercial availability of intelligent vehicle technologies and to ensure the safety of these systems within the vehicles.

Key Activities and Milestones. This program is solely a research effort; therefore, the other seven program strategies do not apply.

- **Conducting Research.** Intelligent vehicle research aims to identify in-vehicle technologies to counter a series of problems that are major causes of vehicle crashes. To help speed the development of solutions, the IVI has been organized into manageable tasks by dividing the spectrum of problems into eight “problem areas,” and segmenting vehicle types into four vehicle “platforms,” listed on Figure ES-2. Each problem area will be studied in the platform(s) where new technologies are most needed and can be readily adopted.

  Currently, the IVI program is moving forward through pilot research and testing projects within each platform. Projects range from defining safety needs for specialty vehicles to widespread initial trial deployment of automatic collision notification systems for light vehicles. In general, the light and commercial vehicle platforms are further along in the process because they benefited from prior research. However, the transit and specialty vehicle platforms will advance rapidly by adapting research conducted in the other platforms. In addition to the core in-vehicle technologies, the IVI program will also begin to explore possible vehicle-infrastructure cooperative technologies, as well as ways to help improve the ability of drivers to receive and process more information in the vehicle.

The Eight IVI Problem Areas	The Four IVI Platforms
• Rear-End Collision Avoidance • Lane Change and Merge Collision Avoidance • Road Departure Collision Avoidance • Intersection Collision Avoidance • Vision Enhancement • Vehicle Stability • Safety Impacting Services • Driver Condition Warning	• Light Vehicles • Commercial Vehicles • Transit Vehicles • Specialty Vehicles

Figure ES-2: IVI Problem Areas and Platforms

To accomplish programmatic objectives, the IVI is undertaking public/private partnerships with the motor vehicle industry and infrastructure providers. For transit, key partnerships with fleet operators will also be necessary, as transit vehicle designs are influenced not only by the vehicle manufacturers but also by transit agencies. Such partnerships are essential because private manufacturers ultimately "deploy" IVI technologies in new vehicles. U.S. DOT will also use multiple platforms to allow the program to focus initial research on the classes of vehicles where new technology will be adopted most quickly. Other vehicle types can then be equipped with the proven technology. U.S. DOT will also study linkages with intelligent infrastructure, multiple systems integration, generations of vehicles with increased capabilities, and human factors. Finally, peer review will be used to help keep the goals and objectives of the program on target. Under TEA-21, the intelligent vehicle program will form a public/private partnership in 2000 to mutually govern and conduct enabling research for intelligent vehicles, engage the Transportation Research Board in 1999 for a multi-year peer review, and complete initial operational tests on all platforms by 2001.

ADDITIONAL AREAS COVERED IN THE PLAN

In addition to program area goals and activities, this report also covers the National ITS Architecture and ITS standards, emerging program activities, and an update of ITS user services.

The National ITS Architecture and ITS Standards

The full benefits of ITS cannot be realized unless systems are integrated, rather than deployed as individual components. At the urging of public and private sector stakeholders, U.S. DOT is facilitating system integration and technical interoperability through the development of the National ITS Architecture and ITS standards.

The National ITS Architecture is a framework that defines the functions performed by ITS components and the ways in which components can be integrated into a single system. It can be used to help agencies plan and design both projects and deployment approaches that meet near-term needs while keeping options open for eventual system expansion and integration. U.S. DOT will ensure that the National ITS Architecture responds to changing needs of the National ITS Program and the ITS industry by keeping the architecture up to date and relevant as new ITS applications emerge.

Since the inception of the ITS Program under ISTEA, stakeholders have recognized that ITS standards are necessary to achieve technical interoperability. Without technical standards, state and local governments, as well as consumers, risk buying products that do not necessarily work together or consistently in different parts of the country. U.S. DOT is facilitating the creation of technical standards to minimize public sector risk in procuring these products. The overall goal of the ITS standards program is to have a comprehensive set of ITS standards developed and routinely used as states and localities deploy integrated, intermodal systems.

Over the past several years, U.S. DOT has funded standards development organizations in conjunction with industry volunteer support to accelerate the traditional standards development process. Under TEA-21, U.S. DOT expects that all ITS standards identified in the baseline National ITS Architecture will be developed, and that the ITS standards program will increasingly focus on implementation. A first step in this direction will include the testing of approved ITS standards under realistic transportation conditions.

Additionally, U.S. DOT worked with the ITS user community in FY 1999 to identify critical ITS standards. In a report to Congress, 17 standards were identified as critical for national interoperability or as foundation standards for the development of other critical standards. Development of critical standards will be actively monitored, and provisional standards may be established if development is not complete by January 1, 2001.

Emerging Program Activities

As the National ITS Program evolves, and transportation opportunities arise, it becomes apparent that new areas can benefit from ITS. Five such areas will be addressed under TEA-21: intermodal freight, ITS data archiving, rail transit, pedestrian and bicycle safety, and accessibility.

- The goal of the emerging **intermodal freight** program is to facilitate goods movement around congested areas, across multiple modes, and with international trading partners to the north and south. The application of advanced information and communications technologies to the intermodal system offers opportunities to strengthen the links between the separate modal systems that currently operate as competitors. Under TEA-21, the intermodal freight program will conduct field operational tests to identify benefits and opportunities for ITS applications for border and corridor safety clearance applications and for intermodal freight applications that enhance operational efficiency. By 2001, U.S. DOT expects to have enough information to develop an intermodal freight ITS user service that will be added to the National ITS Architecture.
- **ITS data archiving** addresses the collection, storage, and distribution of ITS data for transportation planning, administration, policy, operations, safety analyses, and research. The recently approved archived data user service, the 31st user service in the National ITS Architecture, addresses this new area and was integrated into the architecture in early FY 2000.
- **Rail transit** is an important transit mode that historically has used advanced technologies in its operations. However, little attention has been focused on how rail can benefit from system integration and ITS information. U.S. DOT aims to address rail transit as a part of identifying integrated transit systems across agencies, modes, or regions.
- **Pedestrian and bicycle safety** efforts focus on creating more pedestrian-friendly intersections through the use of adaptive crosswalk signals, inclusion of pedestrian and bicycle flows in traffic management models, and the promotion of in-vehicle technologies to detect and avert impending vehicle-pedestrian collisions.
- And **accessibility** can be improved, especially for rural Americans, with better information coordination and dispatching for ride-sharing, paratransit, and other public transit efforts. Moreover, efforts will be aimed at improving mobility and safety for two user groups underserved by current pedestrian crossings: the elderly and the disabled. U.S. DOT will support ITS solutions that meet the needs of these Americans.

Update of ITS User Services

The National ITS Program focuses on the development and deployment of a collection of interrelated user services. These are areas in which stakeholders have identified potential benefits from advanced technologies that improve surface transportation operations. The user services have guided the development of the National ITS Architecture and ITS standards, as well as research and development of ITS systems. When the 1995 National ITS Program Plan was published, 29 user services were identified. However, in keeping with the evolving nature of the National ITS Architecture, two new services have been identified: highway-rail intersection and the archived data user service.

ITS solutions for highway-rail intersections aim to avoid collisions between trains and vehicles at highway-rail grade crossings. Examples of intersection control technologies include advisories and alarms to train crews, roadside variable message signs, in-vehicle motorist advisories, warnings, automatic vehicle stopping, improved grade crossing gates and equipment, and automated collision notification.

Archived data services require ITS-related systems to have the capability to receive, collect, and archive ITS-generated operational data for historical purposes and for secondary users. ITS technologies generate massive amounts of operational data. These data offer great promise for application in areas such as transportation administration, policy, safety, planning, operations, safety analyses, and research. Intelligent transportation systems have the potential to provide data needed for planning performance monitoring, program assessment, policy evaluation, and other transportation activities useful to many modes and for intermodal applications.

Figure ES-3 lists all 31 ITS user services, including the two new ones. The user services have been grouped together in seven areas – travel and traffic management, public transportation management, electronic payment, commercial vehicle operations, emergency management, advanced vehicle safety systems, and information management.

ITS user services are defined not along lines of common technologies, but rather by how they meet the safety, mobility, comfort, and other needs of transportation users and providers. They represent essential, but not exclusive, ITS products and services.

Travel and Traffic Management

- Pre-Trip Travel Information
- En-Route Driver Information
- Route Guidance
- Ride Matching and Reservation
- Traveler Services Information
- Traffic Control
- Incident Management
- Travel Demand Management
- Emissions Testing and Mitigation
- Highway-Rail Intersection*

Public Transportation Management

- Public Transportation Management
- En-Route Transit Information
- Personalized Public Transit
- Public Travel Security

Electronic Payment

- Electronic Payment Services

Commercial Vehicle Operations

- Commercial Vehicle Electronic Clearance
- Automated Roadside Safety Inspection
- On-Board Safety Monitoring
- Commercial Vehicle Administrative Processes
- Hazardous Material Incident Response
- Commercial Fleet Management

Emergency Management

- Emergency Notification and Personal Security
- Emergency Vehicle Management

Advanced Vehicle Safety Systems

- Longitudinal Collision Avoidance
- Lateral Collision Avoidance
- Intersection Collision Avoidance
- Vision Enhancement for Crash Avoidance
- Safety Readiness
- Pre-Crash Restraint Deployment
- Automated Vehicle Operation

Information Management

- Archived Data User Service *

** Indicates user service added since the first edition of the National ITS Program Plan in 1995.*

Figure ES-3: The 31 ITS User Services

THE ROAD AHEAD

The National ITS Program is well on the way to achieving national ITS deployment and research goals by 2003. The Program stems from a strategic vision of how modern information and communications technologies can enhance the safety and efficiency of surface transportation systems and the quality of life of the American public. Under ISTEA, U.S. DOT partnered with a cross-section of representatives from diverse fields (transportation, electronics, and communications) and stakeholders from all sectors (public, private, and academic) to research, develop, and operationally field-test key ITS technologies. Under TEA-21, the challenge of continuing important research and deploying ITS infrastructure within the transportation planning process has begun. The actions and milestones outlined in the Five-Year National ITS Program Plan will achieve the National ITS Program's specific research and deployment goals, and will help U.S. DOT achieve the broader goal of a safer, more mobile, more productive, and more accessible transportation network.

I. INTRODUCTION

This report presents the goals, activities, and milestones for the National Intelligent Transportation Systems (ITS) Program from fiscal years (FY) 1999 through 2003. It sets forth a detailed account of the United States Department of Transportation's (U.S. DOT's) course of action under the Transportation Equity Act for the 21st Century (TEA-21), and updates the first National ITS Program Plan published in 1995. That original plan was instrumental in laying the foundation for the ITS research agenda pursued under the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Under TEA-21, research and development (R&D) is still an important component of the ITS program. However, the program has matured, and aiding deployment of ITS across the country has taken on a new urgency. Today, the National ITS Program is balanced between continuing important research and helping implementers deploy ITS technologies rapidly and with the best information for decision making. The "National ITS Program Plan: Five-Year Horizon" does not supersede the material contained in the 1995 plan. Information from the earlier plan – such as the definitions of the original 29 user services – is still valid today.

LEGISLATIVE REQUIREMENT

This plan is provided in accordance with section 5205 of TEA-21, which states: *"The Secretary shall maintain and update, as necessary, the National ITS Program Plan developed by the Department of Transportation and the Intelligent Transportation Society of America. The National ITS Program Plan shall –*

(A) specify the goals, objectives, and milestones for the research and deployment of intelligent transportation systems in the context of major metropolitan areas, smaller metropolitan and rural areas, and commercial vehicle operations;

(B) specify how specific programs and projects will achieve the goals, objectives, and milestones referred to in subparagraph (A), including consideration of the 5- and 10-year timeframes for the goals and objectives;

(C) identify activities that provide for the dynamic development of standards and protocols to promote and ensure interoperability in the implementation of intelligent transportation system technologies, including actions taken to establish critical standards; and

(D) establish a cooperative process with state and local governments for determining desired surface transportation system performance levels and developing plans for incorporation of specific intelligent transportation system capabilities into surface transportation systems.

In addition, the plan shall be transmitted and updated as part of the Surface Transportation Research and Development Strategic Plan developed under section 508 of title 23, United States Code."

APPROACH

To fulfill this legislative directive, U.S. DOT has broken down the requirement into three distinct parts – a 5-year plan, a 10-year plan, and a national deployment strategy as shown on Figure I-1.

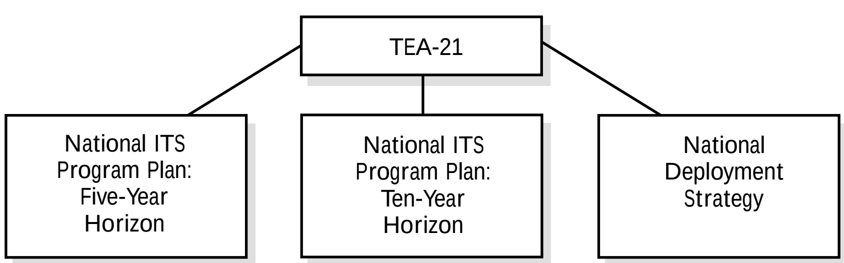


Figure I-1: U.S. DOT's Approach to Meeting the TEA-21 Program Plan Requirement

The **National ITS Program Plan: Five-Year Horizon** identifies the goals of the U.S. DOT under TEA-21, and shows how U.S. DOT will broadly guide all program, policy, and budget decisions over the next 5 years.

The **National ITS Program Plan: Ten-Year Horizon** will identify the longer-term, next-generation ITS research agenda. U.S. DOT will develop the plan in partnership with the larger ITS community through the Intelligent Transportation Society of America (ITS America). The 10-year plan will be started in 2000 and published in 2002.

The **National Deployment Strategy** will define the actions required by the broader ITS community to accomplish the deployment of an ITS infrastructure. ITS America is leading this effort and is actively engaging public and private sector partners across the country. The plan will focus on state and local governments in particular, and will define the broader strategic actions necessary – beyond U.S. DOT spending – to bring about widespread ITS deployment in the United States. The report will be completed in 2000.

ORGANIZATION OF THE PLAN

Chapter II provides a brief overview of the National ITS Program, its structure, and goals. The four program areas of the National ITS Program – metropolitan ITS infrastructure, rural and statewide ITS infrastructure, commercial vehicle ITS infrastructure, and the intelligent vehicle initiative – are presented, as are the eight ITS program strategies that U.S. DOT will use to move the National ITS Program forward.

Chapter III focuses on the four program areas in detail. It includes goals and objectives for each, and discusses how the eight program strategies will be used to meet those goals. TEA-21 requires U.S. DOT to describe the process providing for the dynamic development of ITS standards. Chapter IV provides an in-depth discussion of that process, as well as the critical relationship between ITS standards and the National ITS Architecture in providing the foundation for systems integration and interoperability.

Chapter V includes emerging program activities that point to places where the National ITS Program is just beginning to focus attention and will continue to explore over the next several years. Intermodal freight, ITS data archiving, rail transit, pedestrian and bicycle safety, and accessibility are discussed. Chapter VI concludes the main body of the report with a discussion of what the future holds.

Several appendices are included. Appendix A provides detailed roadmaps for the four program areas. Appendix B contains milestones for ITS standards currently under development. Appendix C includes full descriptions of the two new user services – highway-rail intersection and the archived data user service – that have been added to the National ITS Program since the first program plan was published in 1995. A list of acronyms and abbreviations and a list of references make up the final two appendices.

II. OVERVIEW OF THE NATIONAL ITS PROGRAM

In 1991, ISTEA launched a program of research and testing of intelligent transportation systems, with a charge to U.S. DOT to investigate their effectiveness in solving congestion and safety problems, in addressing operating inefficiencies, and in reducing the environmental impact of growing travel demand. By late 1995, early results had convinced U.S. DOT that a number of the technologies were technically feasible and highly cost-effective. Furthermore, when integrated, these technologies could provide a powerful platform for managing and operating the transportation network. In addition, ITS technologies seemed promising for the development of remarkable vehicular safety products. Thus, in January of 1996, former Secretary of Transportation Peña set a 10-year national goal of building an ITS infrastructure that would support metropolitan travel management and safety needs. U.S. DOT set similar objectives for rural and commercial vehicle ITS applications.

TEA-21 reaffirms the role of the U.S. DOT in advancing the development and integrated deployment of ITS technologies. The legislation launched an era of ITS infrastructure deployment by mainstreaming ITS funding eligibility under the National Highway System, Surface Transportation, and Congestion Mitigation and Air Quality programs, and by creating the ITS integration and commercial vehicle ITS infrastructure incentive programs. The need to maintain a strong research program that continued development and testing of new ITS technologies, particularly those for intelligent vehicles, was also recognized in TEA-21. Additionally, the legislation required that transportation planning include the efficient management and operation of the transportation system. In fact, operations and management are specifically identified as factors that metropolitan and statewide planners must consider when addressing transportation issues in their area. Thus, advanced technologies generally, and ITS infrastructure specifically, are now seen as fundamental to enabling the management and operation of the transportation system as a whole.

As set forth in TEA-21, the National ITS Program is focused on the integrated deployment of metropolitan, rural, and commercial vehicle ITS infrastructure and the continued evaluation and testing of intelligent vehicle technologies. This includes a strong emphasis on the research and technical support necessary to advance ITS capabilities in both infrastructure and vehicular applications.

ITS PROGRAM GOALS

Just as under ISTEA, the National ITS Program is focused on the interaction of intelligent infrastructure and intelligent vehicles to maximize mobility and safety. Over the next 5 years, U.S. DOT aims to push the envelope of infrastructure deployment and vehicular research. TEA-21 specifically directs U.S. DOT to:

- Expedite integrated ITS deployment in metropolitan and rural areas for both passenger and freight transportation;
- Ensure that Federal, state, and local transportation officials consider ITS in the transportation planning process and have adequate knowledge to do so;
- Improve regional cooperation and operations planning for effective ITS deployment;
- Promote the innovative use of private resources;
- Develop a workforce capable of deploying, operating, and maintaining intelligent transportation systems; and
- Complete deployment of the Commercial Vehicle Information Systems and Networks, or CVISN, in a majority of states by September 30, 2003.

ITS PROGRAM STRUCTURE

To meet these goals, the National ITS Program has been structured around the deployment of *intelligent infrastructure,* development and deployment of *intelligent vehicles,* and the use of several *program strategies* to support the advancement of both the infrastructure and vehicle programs.

Intelligent Infrastructure

Intelligent infrastructure refers to the electronics, communications, hardware, and software that enable the transportation system to be managed more efficiently and regulated more effectively. Appropriately linked, the technologies create a unified infrastructure that allows various modal and jurisdictional systems to be managed together as a single system.

The current intelligent infrastructure program has three parts: metropolitan, statewide or rural systems, and commercial vehicle applications. Deployment of ITS infrastructure in these areas provides an electronic infrastructure overlaid onto the existing physical infrastructure. This infrastructure enables the multi-modal systems management necessary to meet future travel demand in the United States, to serve as a platform for future applications, and to facilitate an unprecedented level of global commerce.

All of this will be made possible as systems are integrated at geographically appropriate scales, using common standards within a common architecture that allows for local flexibility and innovation. Implementing ITS infrastructure with common standards allows for the development of in-vehicle products that interact with the infrastructure, ultimately resulting in new levels of management capability, safety, and consumer convenience.

Intelligent Vehicles

The long-range safety potential of ITS cannot be fulfilled without smart vehicles, including light vehicles (passenger cars, vans, and light trucks), transit vehicles (buses), commercial vehicles (trucks and interstate buses), and specialty vehicles (emergency response, enforcement, and highway maintenance vehicles). Intelligent vehicles combine advanced safety, navigation, and communication technologies in a safe and human-centered fashion. Research under ISTEA helped move intelligent vehicle technologies from laboratory testing to field-testing. U.S. DOT created the Intelligent Vehicle Initiative (IVI) to bring vehicle-related safety research in the Department into one program to accelerate the development and commercial availability of intelligent vehicle technologies. Specifically, the IVI brings together research from the National Highway Traffic Safety Administration (NHTSA), Federal Motor Carrier Safety Administration (FMCSA), Federal Transit Administration (FTA), and Federal Highway Administration (FHWA).

Since no single technology "fix" can address America's growing demand for and changing patterns of travel, to realize the promise of a truly national transportation system, ITS products and services must be seamlessly integrated and interoperable. Over time, intelligent vehicles will increasingly interact with intelligent infrastructure to yield even greater gains in mobility and traveler safety, as illustrated on Figure II-1.

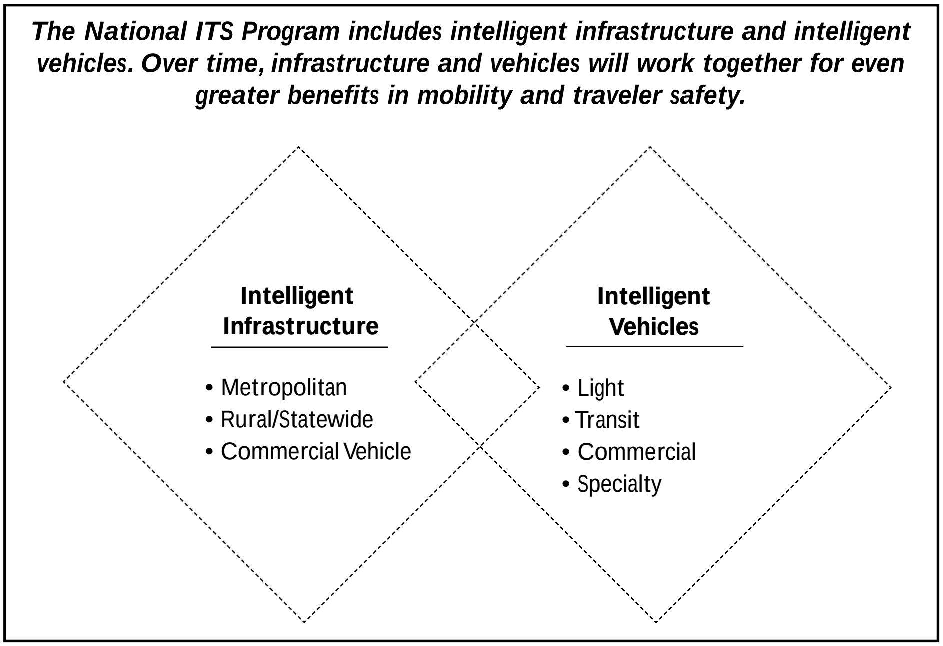


Figure II-1: The National ITS Program Structure

Program Strategies

The National ITS Program is guided by a set of eight program strategies that work together to advance the state of ITS across the country. They include:

1. Conducting research;
2. Accelerating the development of standards;
3. Building professional capacity;
4. Creating funding incentives;
5. Providing guidance and technical assistance;
6. Ensuring consistency with the National ITS Architecture and standards;
7. Evaluating the program; and
8. Showcasing benefits.

Together these strategies help meet overall goals of the National ITS Program. They push the boundaries of ITS capabilities, enable integrated and interoperable deployment of ITS components, and allow for the management and operations of the transportation system as a whole.

1. Conducting Research

An aggressive Federal research, development, and testing program has helped ITS evolve from a visionary concept to a viable and attractive solution to transportation problems. Continued research and development is essential for advancing the real-time capabilities of ITS infrastructure components and for developing successive generations of ITS technologies. Research is also critical for advancing the development of intelligent vehicle capabilities, without which the full potential of ITS will not be realized.

While the ITS program has transitioned under TEA-21 to focus more on deployment, research and development continues to be a major focus. Each of the program areas contains specific research and development plans for the next 5 years. As discussed in Chapter I, U.S. DOT will present a 10-year program plan that defines the next-generation ITS research agenda.

2. Accelerating the Development of Standards

When deploying ITS, transportation agencies expect that the systems they build will be able to exchange pertinent data with other systems. They also have reason to expect that ITS infrastructure can be upgraded and expanded over time. Similarly, the traveling public expects that the ITS products they purchase will function consistently and reliably anywhere in the country.

ITS standards are essential for achieving the interoperability and compatibility necessary to meet such expectations. Standards define how system components interconnect and interface within the overall framework of the National ITS Architecture. Standards also specify how various technologies, products, and components can be used together.

ITS standards will facilitate more widespread ITS deployment, creating a national market conducive to the efficiencies of mass production. This will allow agencies to deploy and upgrade components over time with products and services from multiple vendors, resulting in lower cost and higher quality. For these reasons, U.S. DOT has sponsored, and will continue to sponsor, the accelerated development of ITS standards through existing industry-based standards development organizations. U.S. DOT is now embarking on an aggressive testing and deployment effort to prove ITS standards in real-world transportation settings before requiring their use.

3. Building Professional Capacity

Successful deployment, operations, and management of intelligent transportation systems will require a new breed of transportation professionals. Just as the interstate highway construction program called for new skills in road building and civil engineering, ITS requires new technical skills in systems engineering, electronics, and communications, as well as institutional skills to build coalitions of stakeholders and streamline interagency projects. Many transportation professionals require education and retraining to develop and sustain the knowledge, skills, and abilities needed to design, deploy, operate, and maintain ITS.

In 1996, U.S. DOT's ITS Professional Capacity Building program was established to help meet this need. The program involves partnering with organizations to achieve its goals. Many stakeholders (including FHWA and FTA at the headquarters and field staff level, the National Highway Institute, the National Transit Institute, professional associations, the academic community, and the private sector) have worked together to develop education programs for future professionals, to provide hands-on training for current practitioners, and to disseminate information on ITS.

Since professional capacity building must be relevant, timely, and delivered in the most accessible manner to transportation practitioners, the Professional Capacity Building Program offers various content and delivery methods. New initiatives in distance learning are underway that will deliver training through satellite broadcast, CD-ROM, and the Internet to overcome the barriers of limited time and travel funding. Their web site address is *www.pcb.volpe.dot.gov.* A catalog entitled "U.S. DOT's Professional Capacity Building Program Courses and Seminars" describes the seminars, courses, and workshops currently available to stakeholders. These courses are primarily offered through partnerships with the National Highway Institute and the National Transit Institute. U.S. DOT has been working with these organizations to fully transfer leadership in capacity building out of U.S. DOT's ITS Joint Program Office and into traditional educating bodies.

4. Creating Funding Incentives

TEA-21 provides funding incentives for ITS deployment through two specific components: the ITS integration incentive program and the commercial vehicle ITS infrastructure incentive program. Together, these two programs help facilitate the integration of legacy systems, and hasten the mainstream deployment of integrated ITS technologies.

The ITS integration program encourages coordination of planned and existing ITS infrastructure into interoperable systems. Integration funding will be used to support the technical integration and jurisdictional coordination of metropolitan and rural ITS infrastructure through small, discretionary incentive awards to state and local public-sector applicants. The funding is primarily for integrating ITS components, rather than for the individual components themselves. The funding is also intended to support innovative financing and public/private partnerships.

The commercial vehicle ITS infrastructure program aims to develop and deploy information systems that support CVISN capabilities in three areas: safety information exchange, credentials administration, and electronic screening. CVISN capabilities are compatible with the National ITS Architecture and standards, and interoperable from state to state from a motor carrier's perspective. Incentive funding will be used to assist states in developing the necessary skill base and architecture to support CVISN capabilities. This funding not only speeds the development of a nation-wide commercial vehicle network, it also advances interoperability by creating state commercial vehicle architectures that are compliant with the National ITS Architecture.

During the 6 years of TEA-21 authorization, a total of $679 million is devoted to incentive funding. The annual breakdown is shown on Figure II-2.

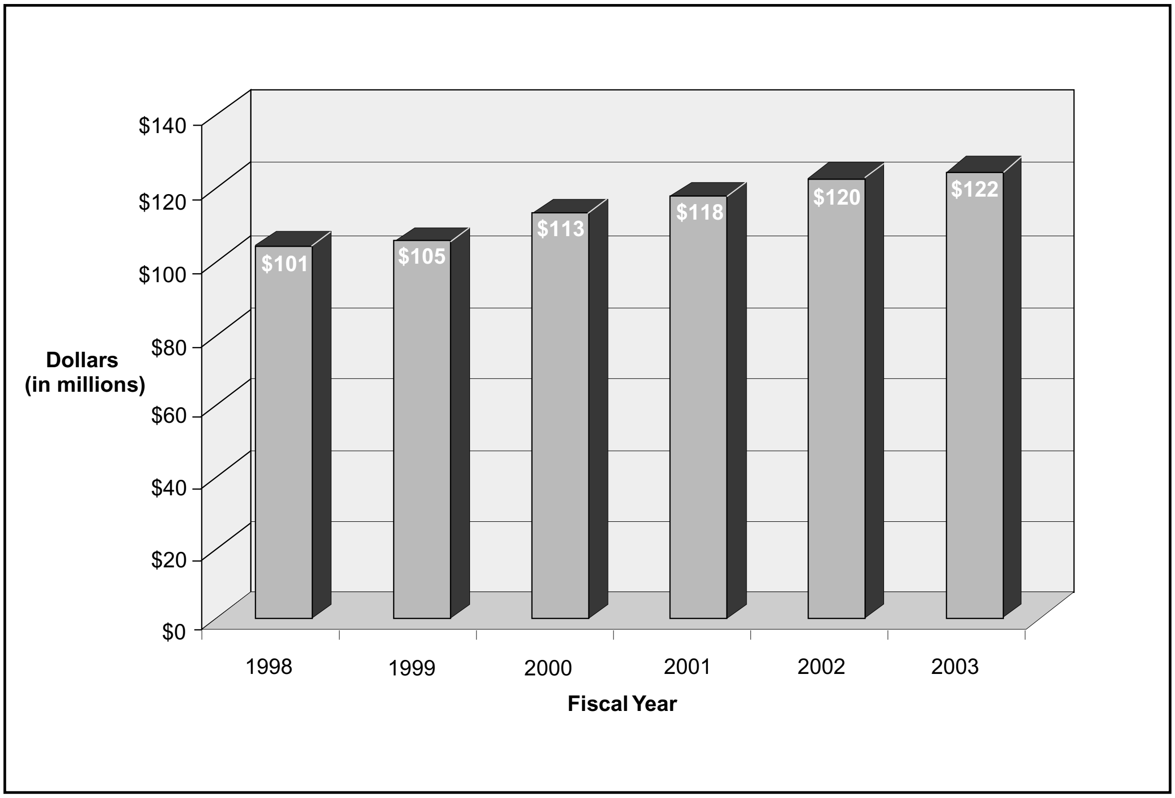


Figure II-2: ITS Incentive Funds Made Available Through TEA-21

5. Providing Guidance and Technical Assistance

While the Professional Capacity Building program is aimed at educating implementers, it is, by its very nature, a long-term process to add skills to an entire profession. State and local governments are taking advantage of the benefits ITS has to offer and deploying ITS technologies across the country today. To assist those areas in the near term, guidance documentation is being developed and distributed through Federal field staff.

Guidance documentation provides information on best practices and how ITS technologies can be implemented from both a technical and managerial perspective. Current subjects include how to use the National ITS Architecture in project planning and implementation, how to procure software, and options available within the Federal aid process to procure ITS technologies. Additional assistance is offered in areas such as telecommunications, innovative financing, public/private partnerships, and general implementation expertise.

Programs are also available that support peer exchange of technical assistance and documentation. Services such as telephone referrals, printed information, speakers' and facilitators' bureaus, at-desk reviews, and on-site consultations are available to transportation professionals. One of the most in-demand programs is the Peer-to-Peer Network, composed of professionals from the public and private sectors who are "on-call" to provide short-term, no-cost technical assistance to transportation colleagues across the country.

6. Ensuring Consistency with the National ITS Architecture and Standards

TEA-21 requires that all ITS projects that receive funding from the Highway Trust Fund (including the Mass Transit Account) conform to the National ITS Architecture and ITS standards. The National ITS Architecture is a tool that can help transportation professionals address ITS integration in their area, while standards can connect ITS components, facilitating interoperability. Use of the National ITS Architecture can lower cost, reduce development time, enable future expansion and evolutionary deployment, enhance system performance, and reduce risk. Use of standards allows for open interfaces, resulting in competition among interchangeable products. Standards prevent agencies from being limited to using a particular vendor for ITS upgrades and enhancements, and promote interstate interoperability and consistency.

In response to the TEA-21 conformity requirement, and to assist agencies currently planning and implementing ITS projects, U.S. DOT issued interim guidance on conformity with the National ITS Architecture and ITS standards in October 1998. Through this guidance, U.S. DOT seeks to foster the involvement of a wide range of stakeholders at the local level, support flexibility in using ITS to meet local needs, achieve integration of ITS systems and components, enable information sharing among stakeholders, and support future expansion. U.S. DOT is currently preparing a final policy that will go through a formal rulemaking process. Public comment will be sought on this policy through the release of a notice of proposed rulemaking. The final policy is anticipated in FY 2001.

U.S. DOT is proceeding along a policy course that allows standards to become mature, technically sound in real-world operations, and generally accepted by the user community before being considered for formal adoption through the rulemaking process. At this time, U.S. DOT has not formally adopted any standards. However, in some cases, standards have been published by standard development organizations and are available for initial use. In such instances, U.S. DOT will encourage areas to use the standards in deployment. A more detailed discussion of this issue is contained in Chapter IV, under "Standards Policy Support."

7. Evaluating the Program

Evaluations are a critical part of ensuring progress toward the vision of integrated intelligent transportation systems and achieving ITS deployment goals. Evaluations help to understand the value, effectiveness, and impacts of National ITS Program activities, and facilitate the Program's continual refinement.

The National ITS Program has undertaken assessment activities based on the Government Performance and Results Act (GPRA) to help ensure that the National ITS Program is effective in meeting U.S. DOT's high-level transportation goals. In keeping with GPRA, heavy emphasis is placed on tracking both program outputs and program outcomes. Program outputs are results-oriented measures that track the progress of a program, such as the number of toll plazas equipped with electronic toll collection capability. Program outcomes are results-oriented measures for which the benefits of a program are easily understood by the end-user, the taxpayer. An example would be a decrease in the number of minutes spent waiting to pay tolls. In addition, policy analysis activities are undertaken to evaluate the effectiveness of other program strategies, such as standards, architecture conformance policy, and professional capacity building.

Program outcomes are measured according to a few key measures derived from broad program goals contained in the 1992 ITS Strategic Plan, including safety, mobility, efficiency, productivity, and energy and the environment. Data bases have been compiled to track both the costs and benefits of deploying ITS technologies according to these categories. The data bases contain real-world working knowledge gained from the full range of research, operational tests, and deployments conducted under ISTEA, and will be expanded under TEA-21.

8. Showcasing Benefits

Showcasing benefits is a way of communicating to decision makers the positive results realized through the use of ITS technologies, and can be used to highlight the need for integration in ITS deployment. Three mechanisms are being used to showcase benefits. First, model deployment sites are used to demonstrate successful interjurisdictional working relationships. These sites also highlight the interagency coordination required for the operation and management planning necessary to achieve integration. The sites help to raise the awareness of the benefits of integrated ITS services and encourage public sector officials to build supporting infrastructure. Second, U.S. DOT has partnered with industry to conduct technology tours across the country to showcase state-of-the-art ITS technologies. Finally, benefits information from the program evaluation effort is being packaged into reports and brochures for dissemination to stakeholders.

III. PROGRAM AREA FIVE-YEAR PLANS

The four ITS program areas – metropolitan ITS infrastructure, rural and statewide ITS infrastructure, commercial vehicle ITS infrastructure, and the intelligent vehicle initiative – all have specific goals, objectives, and milestones to be achieved under TEA-21. Each program area is described below in detail, and the eight ITS program strategies are used to illustrate specific activities that will be undertaken to meet program area goals. Detailed roadmaps have been developed for each ITS program area and are included in Appendix A.

1. METROPOLITAN ITS INFRASTRUCTURE

Metropolitan areas in the United States are experiencing unprecedented challenges to mobility. In the past decade alone, metropolitan traffic has grown by 30 percent, resulting in chronic gridlock that shows no sign of subsiding. In the next 10 years, the number of cars on our roads and highways will increase by another 50 percent. Because Americans spend 2 billion hours stuck in traffic every year, the annual cost of congestion, measured in lost productivity, has skyrocketed to over $48 billion.

States, metropolitan planning organizations – the Federally designated forum for cooperative regional transportation planning – and local governments are struggling with resulting demands on our infrastructure, residents, and businesses. Traffic volumes in most areas are growing at a time when transportation budgets are shrinking. Furthermore, even if the money were available, the lack of space to expand or build new highways renders those alternatives infeasible. Transit providers are also contending with slashed budgets while straining to meet greater expectations from customers for improved service.

Metropolitan ITS offers some solutions. It points to a new paradigm of managing and operating the current transportation system as a whole with an intermodal, single-system view of regional mobility. Metropolitan ITS also can help ensure the long-term economic prosperity of our nation's urban and suburban areas. In January 1996, former Secretary of Transportation Peña set a goal of integrated ITS deployment in 75 of the largest metropolitan areas by 2006. He stated:

> *"I'm setting a national goal: to build an intelligent transportation infrastructure across the United States to save time and lives, and improve the quality of life for Americans. I believe that what we do, we must measure…Let us set a very tangible target that will focus our attention...I want 75 of our largest metropolitan areas outfitted with a complete intelligent transportation infrastructure in 10 years."* [5]

This goal is known as "Operation TimeSaver," and is being met by the metropolitan ITS program through the deployment of integrated intelligent transportation systems – including advanced traffic management, traveler information, and public transportation systems – to improve urban transportation management in the 75 urban areas. At the same time, all 340 major metropolitan areas nationwide could benefit from advanced technologies. U.S. DOT field staff is actively working with all interested areas.

Where We Are

Under ISTEA, the ITS program demonstrated the viability of metropolitan ITS technologies, such as traffic and transit management operations, traffic signal control, and traveler information. Today, metropolitan ITS applications are being deployed throughout the nation, but few of them in an integrated fashion. For example, areas where coordinated deployment is expected, such as incident management, show widely different levels of integration. Only 8 percent of the targeted 75 metropolitan areas have some level of integration between freeway management and traffic signal control systems. In addition, the majority of the 75 sites do not fully consider ITS in the planning

[5] Excerpt of a speech delivered by former Secretary of Transportation Federico Peña at the Transportation Research Board Annual Meeting in Washington, D.C. on January 10, 1996.

process. Even when metropolitan and statewide planning bodies include ITS projects in their plans, few have considered a concept of operations for their area. Although sites are beginning to use the National ITS Architecture to facilitate integration, more technical support is required.

The metropolitan ITS program has been actively tracking deployment and integration of ITS infrastructure in the 75 metropolitan areas. As a result, the sites have been classified as areas of low, medium, and high levels of integrated deployment:

- Low-level deployment areas are characterized by limited deployment and/or limited integration. This may be caused by a lack of awareness of ITS and the potential benefits to transportation agencies and the public.
- Medium-level deployment areas have an awareness of ITS and have deployed advanced technologies. However, individual systems have been bought and installed in a piecemeal fashion with little integration.
- High-level deployment areas are regions where a large number of varied ITS deployment activities are underway with significant integration. These areas tend to be the early adopters in the ITS field. They understand the benefits of ITS, have gained valuable experience in ITS design and procurement issues, and currently operate advanced transportation systems.

At present, 39 sites have low levels of integrated deployment, 25 have medium levels, and 11 have high levels. To advance integration of ITS, U.S. DOT has sponsored the development of "Early Deployment Plans" that identify current or future ITS projects in an area. Most of the 75 areas have initiated plans and many are complete, providing U.S. DOT with a foundation for helping areas integrate their ITS applications.

At the same time, research and development is being conducted in traffic management and transit management technologies to set the stage for the next generation of metropolitan ITS technologies. This research has resulted in significant advancements for ITS planning and operations.

Where We Are Going

To meet the Secretary's Operation TimeSaver goal, all 75 sites must have either a medium or high level of integration by 2006. As shown on Figure III-1, U.S. DOT expects that 64 metropolitan areas will meet this goal by FY 2003.

This total will include 39 sites at a high level and 25 sites at a medium level of integrated deployment. The 11 sites that remain in the low-level category will be the focus of support from 2003 to 2006. Figure III-2 shows the projected breakdown of high, medium, and low levels of integrated deployment for the 75 metropolitan areas over time.

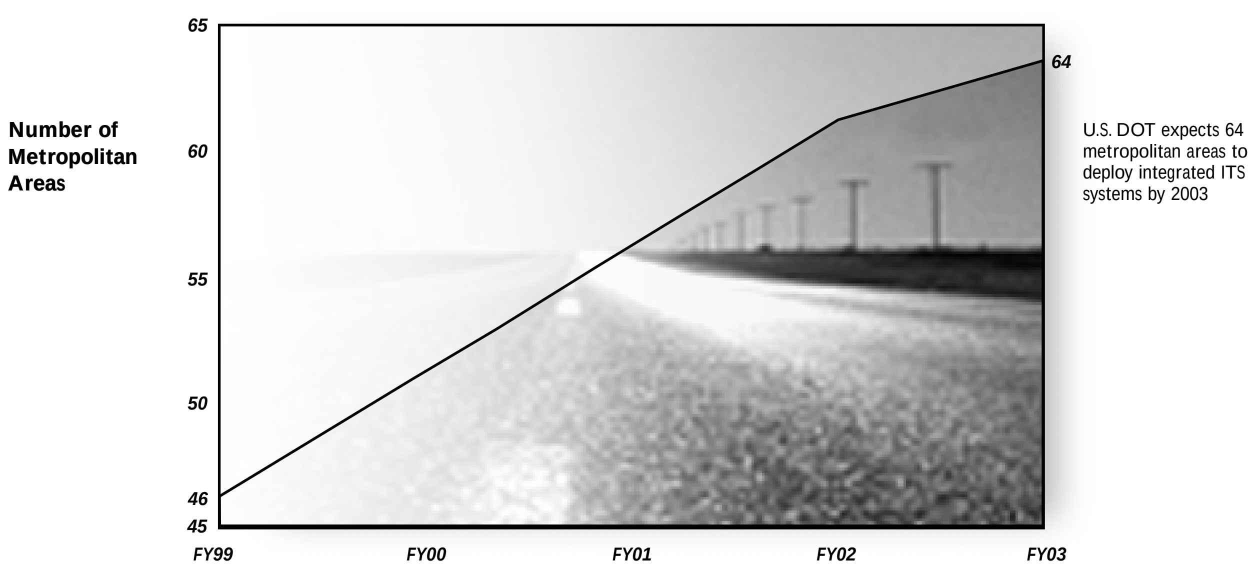


Figure III-1: Metropolitan Deployment Goal

Integration will be facilitated through use of the National ITS Architecture and related standards. As part of this process, regional stakeholder bases will be broadened to include nontraditional stakeholder groups, such as emergency management personnel and the travel and tourism industry. U.S. DOT also expects to see metropolitan areas begin to routinely consider ITS as part of the transportation planning process. U.S. DOT will encourage regions to start linking their metropolitan ITS development activities and architectures with statewide and regional plans and architectures. Under TEA-21, U.S. DOT also will work to define the next generation of ITS for traffic management, as well as advanced transit applications for traveler information, fleet management, and electronic payment in order to improve customer service and reduce system capital and operating costs.

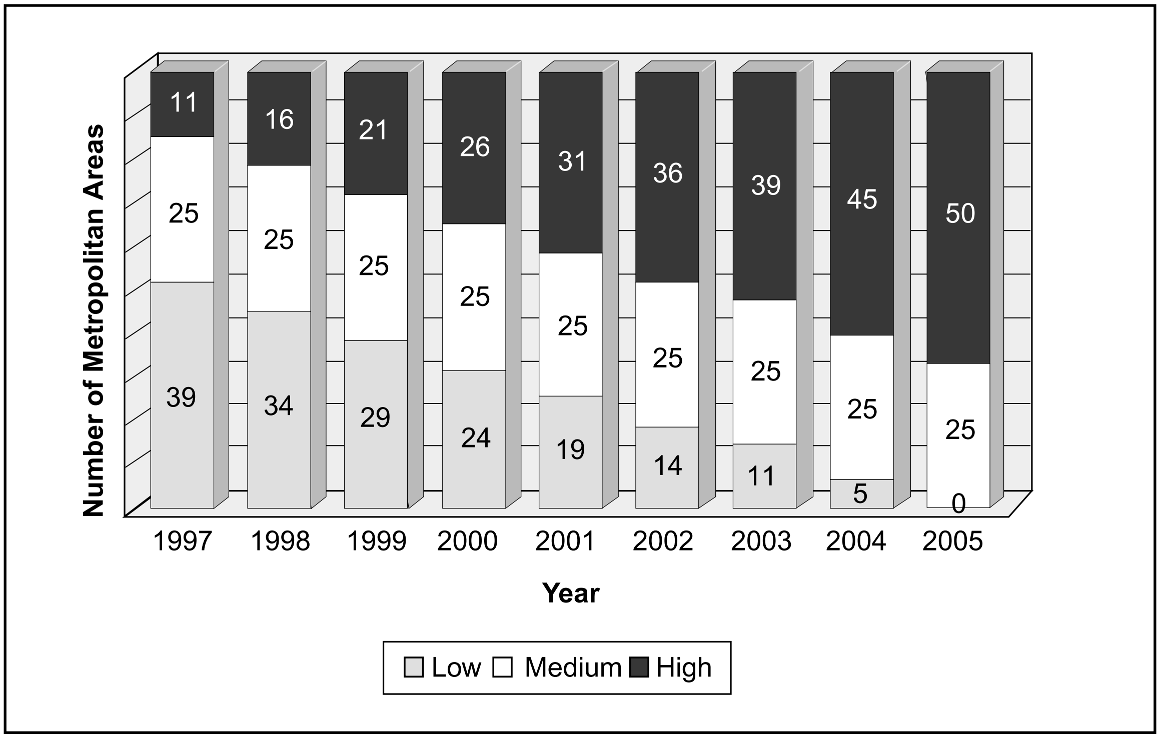


Figure III-2: Projected Levels of Metropolitan Integrated Deployment by Low, Medium, and High Sites from 1997 to 2005

How We Get There

The metropolitan program is a mature part of the National ITS Program. As such, all eight ITS program strategies are being used to meet the goal of integrated deployment in the 75 metropolitan areas.

Conducting Research

The metropolitan research program is focused on long-term and applied research for the next generation of traffic and transit management technologies. Examples include adaptive control systems that change signal timing in response to monitored traffic conditions, dynamic control systems that use historical data to predict traffic conditions and appropriate signaling, and travel modeling and analysis tools that help plan ITS enhancements to the transportation system. Human factors also are considered as part of traffic management research. Transit management includes research into areas such as fleet management systems, electronic fare payments, and traveler information for transit operations.

Traffic management research. The long-term traffic management research goal is to develop dynamic control systems by the year 2010 that predict traffic conditions in real time. These systems will help estimate and predict the status of a traffic network so that decision makers can make appropriate, proactive traffic management and traffic information choices that improve transportation operations in their area. Dynamic control systems will be an improvement over the currently available adaptive control systems, as dynamic systems aim to anticipate problems before they occur, rather than reacting to situations once they have become problems. Currently, research is underway to develop dynamic traffic assignment algorithms that will provide for better estimation and prediction of traffic over extensive street and freeway networks. These algorithms will serve as the basis for future dynamic control systems.

Adaptive control systems provide an interim solution. While dynamic systems are being developed, adaptive systems are being used to adjust signal timing in real time to accommodate traffic patterns. Adaptive control systems will continue to evolve in sophistication to serve the public until the full suite of dynamic control systems is ready. Previous computer simulation and limited-scale field trials in four cities demonstrated the ability of adaptive control systems to improve traffic flow in a variety of geographic situations and congestion levels. New functions will be added that provide priority for transit vehicles, connections to legacy systems, enhanced capacity, and automatic "switching" between control strategies.

To meet the needs of mid-sized and smaller areas where there may not be a need for frequent changes to signal timings, a "lite" version of adaptive control algorithms is being considered for development under the rural ITS program area. Such a version would be compatible with both legacy systems (such as closed-loop and small to mid-sized centralized systems) and ITS regional architectures. These "lite" applications are expected to be ready for use in 2003.

In the analysis arena, delivery of new modeling and analysis tools, such as the ITS Deployment Analysis System, provide prototype traffic analysis and planning tools that help metropolitan planning organizations when addressing ITS solutions in their long-range Transportation Plans. ITS Deployment Analysis System 2.0 was made available for use in 1999. While this software tool helps planners address the impacts of ITS, a more sophisticated model – the Transportation Analysis and Simulation System (TRANSIMS) – is recognized as the new generation of modeling for ITS transportation planning. TRANSIMS will ultimately be sensitive to operational factors. The model is under development, and will be available for initial use in 2002. Enhancements and improvements will continue to be made to the U.S. DOT family of traffic simulation models, such as the corridor simulation (CORSIM) and the Traffic Software Integrated Systems (TSIS). These models are used to validate designs and operational strategies, including algorithms used for adaptive and dynamic control systems.

The metropolitan program also focuses on human factors to support design and day-to-day operations of traffic management centers. Research in the field and with the human factors traffic management center simulator provides guidelines to enhance center design and management practices. Information is disseminated to stakeholders through products, such as the computer-aided design support system, and outreach efforts, including traffic management center workshops. Additional human factors research into driver response to new technologies and traveler information provides a reality check on the effectiveness of traffic control strategies.

Transit management research. Under TEA-21, transit R&D will move from examining and developing ITS within individual systems and transit modes to investigating integrated transit systems across agencies, modes (bus, rail, ferry boats, paratransit, highway), and regions. The "FTA Five-Year Research and Technology Plan" was developed with input from industry consultation, workshops, and the advanced public transportation systems stakeholders forum, and has helped shape metropolitan transit ITS R&D efforts. Research and operational tests are being carried out in a number of areas including impact analysis, fleet management, electronic fare payments, and traveler information. The potential of ITS within rail transit, bus rapid transit, and welfare-to-work is also shaping crosscutting initiatives such as the metropolitan transit ITS research program.

FTA's transit ITS vision is "integrated transportation technology producing high quality mobility into the 21st century." FTA's fleet operations program area is a key element in meeting this vision. The objectives of this program area include improving door-to-door travel times of transit patrons, reducing transit dwell times through the use of advanced technologies, promoting intermodal projects that improve connectivity through ITS, and implementing 15 integrated systems.

Transit agencies have a critical need for methods to assess the impacts and costs of ITS. In response, the "ITS Transit Benefits Matrix" is being developed. This document describes the benefits and costs of transit ITS in language and categories that transit professionals can understand, and is closely coordinated with efforts to evaluate the ITS program. In the longer term, transit ITS operational tests will continue to be evaluated and their results documented.

Fleet management systems developed over the next 5 years will seek to improve integration with subsystems as well as with multiple operator systems, and between transit and other modes. Industry consultation identified the need for development of the next generation of on-demand response algorithms to incorporate advances in computer and information technologies. Consultation also pointed to the need for expert systems to assist transportation center route supervisors and dispatchers in the timely analysis and response to automatic vehicle location and other real time system data. Consequently, the program includes research and operational tests on these two topics.

Electronic fare payment systems provide both operational benefits (by reducing dwell times) and system costs and benefits to the user in a simplified and seamless system. Through activities in this area, U.S. DOT continues to promote the vision of a single cashless payment system that may be used for any mode of transportation and, ultimately, for other applications as well. U.S. DOT research includes the development of multi-use smart card specifications and the provision and evaluation of a multi-use smart card field operational test. Results of this work are also important to integrated service provision, bus rapid transit, and support programs such as access-to-jobs.

In accordance with developing integrated systems, traveler information efforts will aim at bridging the gaps across multi-operator systems and between transit and other modes to provide real time information to transit passengers while addressing the Americans with Disabilities Act. As new technologies make feasible the concepts of personalized transit and traveler information, the potential for their use also will be examined. These systems have the potential to reduce passenger wait times, improve security, and increase customer satisfaction. Technical issues such as radio spectrum allocation and the potential for wireless technologies are additional research questions being addressed.

Other crosscutting initiatives are shaping the transit ITS R&D efforts, including the bus rapid transit program, rail ITS, and welfare-to-work initiatives. Transit ITS is a key component of the bus rapid transit program and its ability to eliminate the causes of delays and service unreliability for bus transit service on streets. Its components include electronic fare payment systems, signal priority treatments, automatic dispatching and automatic vehicle location systems, and en-route passenger information. Rail transit is an important transit mode that historically has incorporated advanced technologies in its operations. However, transit ITS has focused little attention on how it can learn from rail efforts, or on how rail can benefit from system integration and ITS information. The ITS rail initiative focuses on this transfer of ideas in order to develop truly integrated systems. Likewise, the welfare-to-work access-to-jobs initiative is a multi-million-dollar Federal effort. The transit ITS program is leveraging funds with the access-to-jobs program in order to use ITS to provide one-stop shopping for jobs and transportation, tailored services, and assistance in administration and accounting.

Analysis methods and tools are also being developed, including transit simulations integrating ITS into transit operations analysis (including special services such as bus rapid transit), incorporating transit ITS into the ITS Deployment Analysis System for use in planning ITS deployments, and adding ITS impacts to the Transit Capacity and Quality of Service Handbook. The goal is to provide the ability to assess the operations, impacts, and costs of integrated transit systems in the next 5 years.

Milestones for Conducting Research	
1999	Issue ITS Deployment Analysis System Version 2.0.
	Identify electronic smart card specifications.
2000	Issue Traffic Software Integrated Systems Version 5.0.
	Complete three prototypes for adaptive control systems software.
	Complete Phase 1 of Fleet Management Expert System.
	Publish Americans with Disabilities Act guidelines and research.
	Issue wireless technical transit guidelines.
2001	Complete Computer-Aided Design Support System.
	Develop demand responsive transit algorithm.
	Develop regional electronic fare payment system model.
2002-2003	Complete development and testing of dynamic traffic assignment algorithms.
	Deploy TRANSIMS and adaptive control systems.
	Develop and test dynamic control systems.

Accelerating the Development of Standards

Many standards apply to a metropolitan context; two are of particular importance – the National Transportation Communications for ITS Protocol (NTCIP) and the Transit Communications Interface Profiles (TCIP). NTCIP is a set of standards that allow traffic management and operations personnel to control, manage, and monitor virtually all the devices used on the roadway. Some examples are traffic signals, variable message signs, video cameras, loop detectors, and ramp meters. NTCIP standards also address communications between operations centers and field equipment. The standards allow electronic equipment from different manufacturers to operate with each other, thereby reducing the risks associated with relying on proprietary equipment vendors and customized one-of-a-kind software. NTCIP standards also make it easier for agencies to share information and to control roadside devices across jurisdictions. To support the NTCIP standards, U.S. DOT is supporting a course to educate stakeholders on the use of NTCIP, providing technical guidance and assistance, and encouraging the use of NTCIP in ITS procurements using Federal aid.

For transit, ITS standards efforts can be organized into five separate areas:

- **Continuation of TCIP development.** TCIP provides the interfaces among transit applications that allow data to be shared among transit agencies and other operating entities, such as emergency response services and regional traffic management centers. TCIP development and testing is ongoing in seven areas – fare collection, incident management, onboard/control center, passenger information, scheduling and run-cutting, spatial representation, and traffic management.[6] A course for stakeholders on the use of TCIP is currently under development. In the future, TCIP standards will be integrated with the NTCIP efforts for transportation management centers. Creating software for their implementation, and testing the standards through the TCIP dialog will be continued activities. TCIP elements not yet completed, such as the rail vehicle data objects, also will be undertaken.
- **International standards.** It is critical to the competitiveness of the U.S. transit industry that international standards also be addressed. Consequently, International Standards Organization efforts – such as the ITS Technical Committee 204 Working Group 8 – will continue to be supported.
- **Regional transportation payment system guidelines and specifications.** Based on the fare payment guidelines and specifications that have been created, the transit industry will lead the effort to develop transit payment guidelines for a regional payment infrastructure, encompassing transit, highway, paratransit, parking, and key local payment system partners.

[6] For more information on the seven areas of TCIP development and testing, visit the TCIP web site at *www.tcip.org.*

- **Communications standards.** Communications standards for rail control, data registry, DSRC, and geographical information systems will be developed.
- **Coordination with the Transit Standards Consortium.** The Transit Standards Consortium grew out of the TCIP development effort. Its goal is to take an overall look at the standards needs of the transit industry. As other efforts that use transit ITS as key components come to fruition, such as bus rapid transit, mixed rail corridor operations, and the Intelligent Vehicle Initiative, their specifications and standards will be addressed by the Transit Standards Consortium.

NTCIP and TCIP standards are not designed to replace existing interfaces, but to extend them. U.S. DOT will produce a series of technical assistance documents, and will provide policy support to assist sites migrating from legacy systems to new systems that incorporate new ITS standards. Other standards activities, such as testing, technical assistance, and development, are described in greater detail in the section devoted to ITS standards in Chapter IV.

Milestones for Accelerating the Development of Standards

1999	Initiate delivery of training on approved NTCIP standards.
	Complete testing and technical guidance for approved NTCIP ITS standards and encourage use on applicable ITS procurements using Federal aid funding.
	Complete TCIP development and initiate testing.
2000	Develop TCIP training course and initiate delivery.
	Facilitate specification of approved NTCIP ITS standards in all applicable ITS procurements using Federal aid.
2001-2003	Deliver NTCIP and TCIP training courses.
	Provide technical guidance and outreach materials.

Building Professional Capacity

The Professional Capacity Building program supports the metropolitan ITS program through the delivery of training on all aspects of ITS deployment to the widest possible audience. Courses have been delivered 250 times over the last 2 years, reaching almost 7,000 people. The catalog of "U.S. DOT's Professional Capacity Building Program Courses and Seminars" describes the many seminars, courses, and workshops currently available on topics related to metropolitan ITS deployment, such as ITS awareness, ITS and planning, ITS and transit, the National ITS Architecture, consistency with the National ITS Architecture and standards, procurement, telecommunications, public/private partnerships, and ITS deployment. To date, 15 metropolitan-oriented courses are available. Four new courses will be available from 1999 to 2000 – "Turbo Architecture," the CORSIM traffic simulation model, ITS software acquisition, and lessons learned in ITS procurement.

Under TEA-21, a major focus will be to deliver courses on the National ITS Architecture. FHWA resource centers and division offices and FTA regional offices will be targeted as priority audiences, as they will have responsibility for providing technical assistance to state and local agencies on this topic. All metropolitan courses will be updated over time as appropriate, and new courses will be developed based on a needs assessment study completed in 1998. For example, transit agency personnel have been underrepresented in past ITS training efforts, in part due to the lack of transit-oriented courses. The transit community has identified training needs in the areas of the National ITS Architecture, standards, telecommunications, and data management; in response, courses are being developed.

In FY 2001 and 2002, course delivery will transition from the Professional Capacity Building program to the National Highway Institute and National Transit Institute. In addition, educational linkages among urban, rural, and commercial vehicle programs will be established to leverage resources to the greatest extent possible.

Milestones for Building Professional Capacity

1999-2000	Educate stakeholders in use of the National ITS Architecture as a tool for integration.
	Update metropolitan-oriented courses; include transit information as appropriate.
	Release four new metropolitan-oriented courses.
	Develop new courses based on results of 1998 needs assessment.
2001-2002	Transfer course delivery to the National Highway Institute and National Transit Institute.

Creating Funding Incentives

TEA-21 funding incentives will be used to support both the planning for and deployment of integrated ITS in metropolitan areas. Discretionary incentive awards will be given to public-sector applicants to support technical integration and jurisdictional coordination of ITS infrastructure. Funding will be allocated based on programmatic goals and TEA-21 criteria. The money will apply to both highway and transit projects in metropolitan areas. In cases where discretionary money is directed by Congress, U.S. DOT will work with Congress and the funding recipients to ensure that both the spirit and intent of TEA-21 are followed.

Milestones for Creating Funding Incentives

Integration program funding will be allocated per programmatic goals and TEA-21 as follows:

(Dollars in millions)

Year	1998	1999	2000	2001	2002	2003	Total
ITS Integration Funds *	$74	$75	$80	$83	$85	$85	$482

* requires a minimum of 10 percent spent on rural integration

Providing Guidance and Technical Assistance

Transportation stakeholders need both technical and planning information to effectively deploy ITS. Federal field staff serves as the primary contacts for these stakeholders. Federal field staff requires adequate training to serve their customers, and transportation stakeholders need specific technical materials to support their deployment efforts. Information resources are needed on issues such as procurement, operations and management, and cost analysis. A variety of mechanisms will be used for delivering information resources, including the Professional Capacity Building program, the Peer-to-Peer Network, direct technical assistance by Federal field staff, deployment tracking inventory reports, the Internet (including U.S. DOT's Electronic Document Library), and professional transportation organizations such as the Institute of Transportation Engineers, the Association of Metropolitan Planning Organizations, the American Public Transportation Association, and the American Association of State Highway and Transportation Officials.

Federal field staff. U.S. DOT's goal is to transfer leadership to Federal field staff in order for them to implement U.S. DOT policies. For example, field leadership will be crucial to implementing key policy initiatives, such as consistency with the National ITS Architecture and standards. FHWA division staff will be provided with the assistance they need to work with local stakeholders on incorporating ITS projects into local and state transportation plans, and integrating ITS projects to enhance the local transportation system. FHWA resource centers will provide technical assistance to FHWA division offices by promoting technology deployment and best practices, developing and providing training, and assisting in intermodal and interagency coordination.

Since FTA does not have field staff in every state, transit-specific ITS guidance and assistance must come from other sources. For example, transit agencies will benefit from FHWA field assistance in conducting the planning process, since they are an integral part of metropolitan planning organizations. They will also benefit from FHWA resource center staff assistance. However, the majority of support to transit agencies comes from professional and industry associations – such as the American Public Transportation Association and the Institute of Transportation Engineers – that serve as key delivery mechanisms to stakeholders. In addition, the FTA outreach program includes awareness and industry consultation efforts such as scanning tours, the mobile showcase, and the advanced public transportation systems stakeholder forum. These forums meet a critical need to let the industry see and interact with actual technologies, and also to provide direct interaction with FTA staff. FTA will also use the Transit Standards Consortium and the Community Transportation Association of America to deliver outreach on ITS. Technical assistance through the Peer-to-Peer Network and consultant support will continue to be coordinated through FTA headquarters. Guidance and research dissemination also are key ingredients in providing information to transit agency staff that may not be able to go to training courses or conferences.

Federal field staff will continue to work with metropolitan areas to develop "ITS service plans" that assess local technical assistance needs. Each plan will describe the current state of ITS deployment in an area, identify the next steps for deployment, and determine applicable information resources and the most effective delivery methods. The final product will be a technical assistance strategy that links existing information resources and delivery mechanisms to address the area's unique needs. Since ITS service plans are oriented toward local agencies, the key to success will be creating a sustainable structure for meaningful input and exchange among Federal field staff and stakeholders. Initial service plans will be developed for metropolitan areas. Over time, service plans will be developed for areas with a rural or statewide focus. Specific target levels are included in the following milestone box.

Transportation stakeholders. For areas where integrated deployment is at a low-level, the key to advancing integrated deployment will be to deliver the right information to the right people. Since a respectable body of literature is available to support the needs of these areas, the focus will not be so much on developing new materials, as it will be on targeting materials to the appropriate audiences. However, some existing information resources may need tailoring to directly address pertinent issues in these metropolitan areas.

Maintaining a flow of information to areas with a low-level of integrated deployment is critical. Several key communication channels have already been established that serve as pipelines for information. These include the National Associations Working Group, the ITS Cooperative Deployment Network (an Internet-based tool that automatically distributes ITS information to subscribers via e-mail), and Public Technologies, Inc. (a nonprofit organization that develops and disseminates information on ITS geared to high-level local decision makers).

The needs of medium-level metropolitan areas are different in that they have an awareness of ITS and some deployment, but they need to go further in integrating their systems. Areas with a medium level of integrated deployment require more technical information on a just-in-time basis, including specific assistance on installation, operations, and evaluation. The keys to supporting these areas will be to develop resources that meet their needs and to deliver the information in a timely manner.

Technical assistance will continue to be critical to medium-level sites as they begin to integrate ITS. Basic materials on most technical topics exist and are available, but as ITS evolves, support material must evolve as well. Thus, technical assistance to these areas involves a continuous process of identifying user needs and supplying the information to meet those needs. Key areas of future support include analytical data and models for planning, procurement and contract management, systems engineering, standards, operations and management, architecture, and benefit and cost analysis. Materials will be delivered through a variety of channels, including training courses, technical documentation of case studies and lessons learned, the Peer-to-Peer Network, and through other organizations such as associations and universities.

U.S. DOT will encourage areas in the high-level category to push the boundaries in ITS. Future initiatives include expanding to a broader range of stakeholders, initiating standards testing and implementation, research testing, and sharing operations and control across jurisdictional boundaries. High-level deployment areas will focus on issues of changing technologies, integration, and evaluation of system effectiveness. In addition, their experience will be used to define the research and development agenda for the future.

U.S. DOT will learn from these high-level areas and share that information with both medium- and low-level deployment sites. The experiences of high-level areas provide the subject matter for lessons learned, case studies and peer exchange that will assist all sites in advancing ITS. Thus, the experiences of sites with a high level of integrated deployment will be incorporated into the information resources made available to implementers in other locations.

Milestones for Providing Guidance and Technical Assistance

1999	Work with top 78 metropolitan areas to develop and implement 35 ITS service plans.
	Issue funding incentives policy to Federal field staff.
	Deliver software training course.
	Provide guidance materials on procurement, and welfare-to-work best practices.
	Issue concept of operations implementation guide and planning benefit/cost aids.
2000	Continue with top 78 metropolitan areas and expand to statewide areas to develop and implement 62 ITS service plans.
	Deliver systems engineering materials.
2001	Continue with top 78 metropolitan areas and statewide areas, and expand beyond top 78 metropolitan areas to develop and implement 70 ITS service plans.
	Train field staff in architecture conformity policy.
	Provide case studies/guidance documents.
2002	Continue with top 78 metropolitan areas and statewide areas, and expand beyond top 78 metropolitan areas to develop and implement 80 ITS service plans.
	Deliver operations and management materials.
	Begin tailoring materials and assistance to medium-sized areas.
	Provide information on shared operations and control.
2003	Continue with top 78 metropolitan areas and statewide areas, and expand beyond top 78 metropolitan areas to develop and implement 90 ITS service plans.

Ensuring Consistency with the National ITS Architecture and Standards

The National ITS Architecture can help areas integrate new ITS components with existing deployments. By using the National ITS Architecture as a framework for deployment, areas can meet local needs while reducing development costs and risks, facilitating future expansion capability, and fostering interoperability. For these reasons, TEA-21 requires metropolitan ITS projects funded through the Highway Trust Fund, including the Mass Transit Account, to conform to the National ITS Architecture and standards.

Interim guidance on this issue was distributed in early FY 1999 to FHWA and FTA field offices. This guidance encourages identification of major ITS projects and assessment of integration opportunities. The guidance also suggests planning for ITS implementation through development of a local architecture or regional integration strategy. A Notice of Proposed Rulemaking is under development and will be published in the Federal Register for public comment. It will outline the proposed final policy to implement the TEA-21 conformance requirements. Final policy through formal rulemaking is expected in 2001.

Milestones for Ensuring Consistency with the National ITS Architecture & Standards

1999	Issue interim guidance on conformity with the National ITS Architecture and standards.
	Initiate final policy.
2000	Issue Notice of Proposed Rulemaking.
2001	Adopt final policy on consistency with the National ITS Architecture and standards.
2001-2003	Implement consistency policy.

Evaluating the Program

Program evaluations are being used to track deployment and the associated level of integration in the 75 metropolitan areas. These evaluations help meet programmatic goals and demonstrate the benefits and effectiveness of metropolitan ITS applications. The first round of surveys was conducted in 1997; a second round was conducted in 1999 to document changes. Additional surveys will be conducted on an annual basis under TEA-21 to measure progress toward the Operation TimeSaver goal.

To measure a metropolitan area's level of deployment (its "output"), a baseline was created as a starting point and surveys were distributed to county, city, and state Departments of Transportation (DOTs) in 1997. The program assessment team is now working with Federal, state, and local partners in metropolitan areas to develop local deployment goals. The 1999 survey results were compared against the 1997 baseline data to preliminarily characterize high, medium, or low levels of integrated deployment at each site. Results of the 1997 survey are available in a final report, "Tracking the Deployment of Integrated Metropolitan Intelligent Transportation Infrastructure in the U.S.A.: FY 1997 Results" (Electronic Document Library - #5883) and on the ITS Joint Program Office web site at *www.its.dot.gov.* These survey results show that deployment in many of the metropolitan areas does not reflect a coordinated regional focus.

With the 1999 deployment surveys, realistic deployment goals (what "should" be deployed) will be established with regional partners within the spirit of the Operation TimeSaver goal. This information will be used to predict what changes may result due to ITS projects that have been approved and funded, or planned to be funded as part of the metropolitan and statewide Transportation Improvement programs. This will be compared with estimates of what would need to be accomplished to reach the Operation TimeSaver goal (what "could" be deployed). Updates of progress against both what "could" and "should" be deployed will continue through 2005.

Dozens of metropolitan ITS field operational tests have been completed and their results entered into the ITS cost and benefit data bases. The few remaining tests will be completed by FY 2000; results will be entered into the ITS cost and benefit data bases once available.

Another source of information about the impacts of metropolitan ITS technologies will be the results of the Metropolitan Model Deployment Initiative evaluation; a final report is due to be published in 2000. In addition, most metropolitan ITS deployments receiving Federal ITS funding will be required to conduct a small-scale self-evaluation and a few metropolitan ITS deployment projects will be selected for a more comprehensive national evaluation.

Information on program output assists U.S. DOT in refining its efforts to help metropolitan areas meet local and national goals. Information on program outcomes shows interested areas the benefits of integrated ITS technologies in metropolitan settings around the nation.

Milestones for Evaluating the Program

1999-2003	Conduct annual tracking surveys.
	Assemble data and report findings.
	Conduct self-evaluations and national evaluations of metropolitan ITS deployments.
2000	Complete Metropolitan Model Deployment Initiative evaluation report.
	Enter results of remaining metropolitan field operational tests into cost and benefit data bases.

Showcasing Benefits

Under ISTEA, U.S. DOT financed model deployment sites in four metropolitan areas around the country to provide real-life examples of ITS potential and to demonstrate the benefits from integration. The four sites – Phoenix, Seattle, San Antonio, and the New York/New Jersey/Connecticut metropolitan area – will continue to showcase the benefits of metropolitan ITS technologies under TEA-21. These sites have brought together public and private sector partners to integrate existing infrastructure with new traveler information systems. They have deployed and integrated applications for managing traffic and transit, for integrating emergency services, and for providing real-time transportation information to travelers.

In addition to these sites, metropolitan ITS technologies will be demonstrated to the public through traveling demonstrations. The Advanced Transportation Management Truck tours the nation to showcase advanced technologies for managing transportation in urban areas. The truck is equipped with traffic, incident, and transit management technologies, coordinated and adaptive signal control technologies, and traffic simulation software. Demonstrations display the role of each technology in controlling congestion and improving mobility and safety. These technologies are presented in a mobile classroom that provides interactive hands-on demonstrations. Presentations are given to state DOTs and transit agency staff, emergency services personnel, public works officials, politicians, and major local and state decision makers. The truck will continue to operate until the summer of 2000.

Lastly, results from metropolitan program evaluation efforts will be incorporated into products to demonstrate the benefits of metropolitan ITS technologies. This includes an evaluation of the metropolitan deployment initiative that will be complete in 2000, ongoing self-evaluations, and national evaluations of congressionally designated ITS deployments.

Milestones for Showcasing Benefits

1999-2000	Incorporate evaluation information into written materials to showcase benefits to metropolitan stakeholders.
	Demonstrate technologies with the Advanced Transportation Management Truck.
1999-2003	Use metropolitan model deployment sites to showcase benefits of metropolitan ITS and the benefits of integration.

2. RURAL AND STATEWIDE ITS INFRASTRUCTURE

Rural America comprises a small and dispersed portion of our nation's population, but requires significantly greater travel distances to satisfy basic day-to-day needs. In addition to long distances, rural travel involves low traffic volumes, relatively rare congestion, visitors unfamiliar with their surroundings, and rugged terrain in remote areas. Furthermore, the rural community is quite diverse, involving interurban/interstate travel, small communities, rural counties, two-lane rural roads, and statewide and regional systems.

For those dependent upon others and on public transportation for travel, available and reliable transportation in rural areas is even more critical than in urban areas. An estimated 90 million rural residents live in the United States, of which an estimated 30 million are elderly, working poor, or people with disabilities. Over 1,200 rural transit organizations currently provide travel opportunities to this group of people, using a variety of techniques and technologies.

The rural ITS program is aimed at meeting the needs of this diverse set of users and operators through flexible options. Rural ITS infrastructure can improve the quality of life for rural residents and travelers by facilitating safer, more secure, more accessible, and more efficient movement of people and goods in rural America. The challenges to developing these services include the wide variety of conditions found in rural travel, the many different types of travelers in rural or statewide settings, and the costs of maintaining the rural transportation system.

Where We Are

In 1995, a strategic plan was developed that defined seven critical program areas for the rural ITS program. Since then, the rural program has evolved to be structured in terms of development tracks as a way to organize research, development, and testing activities. U.S. DOT expects to refine these concepts until rural ITS infrastructure is more fully defined, is more widely deployed, and can ultimately be tracked. The technical development tracks cover the diversity of the rural transportation system, and the breadth of the rural ITS program. They are:

- Surface Transportation Weather and Winter Mobility;
- Emergency Services;
- Statewide/Regional Traveler Information Infrastructure;
- Rural Crash Prevention;
- Rural Transit Mobility;
- Rural Traffic Management; and
- Highway Operations and Maintenance.

To date, operational tests have been conducted for emergency services, statewide/regional traveler information infrastructure, rural transit mobility, and surface transportation weather and winter mobility applications. Several more rounds of tests will follow under TEA-21.

U.S. DOT also has been active in providing information and technical support to stakeholders interested in deploying rural ITS. For example, the publication "Simple Solutions" describes proven and effective "low-tech" solutions that have worked in rural communities throughout the United States. These real-world solutions assist rural transportation professionals by introducing them to ITS and helping them apply technologies that can work in the open and often rugged spaces of rural America.

Many rural ITS initiatives also have been undertaken by state, county, and regional transportation agencies and organizations. One critical contribution derived from these efforts is the inclusion of nontraditional transportation stakeholders in rural-related workshops and conferences. Involvement of stakeholders such as the travel and tourism industry, health and human service agencies, employment agencies, economic development groups, and emergency medical services will be critical as rural decision makers work to find low-cost solutions that improve transportation operations for their area.

Where We Are Going

The rural ITS program is focused on encouraging widespread integrated deployment of rural ITS technologies that assist in reducing fatalities and crashes, and in increasing the accessibility and efficiency of transportation in rural areas. Just as in metropolitan areas, rural ITS deployments are already occurring around the country. However, more work needs to be done to understand which rural ITS services are most useful, how best to integrate them, and how to consider rural applications in concert with nearby metropolitan deployments.

To achieve these objectives, U.S. DOT will carry out an aggressive program of research and field operational testing. This research will furnish a better understanding of ITS technologies in rural settings, and will provide input for the modification of the National ITS Architecture. Following modification of the Architecture, standards requirements for rural applications will be identified. TEA-21 provides support for rural deployments and U.S. DOT expects that, by 2003, 10 states will have installed statewide platforms that integrate rural intermodal ITS services in their region (as shown on Figure III-3).

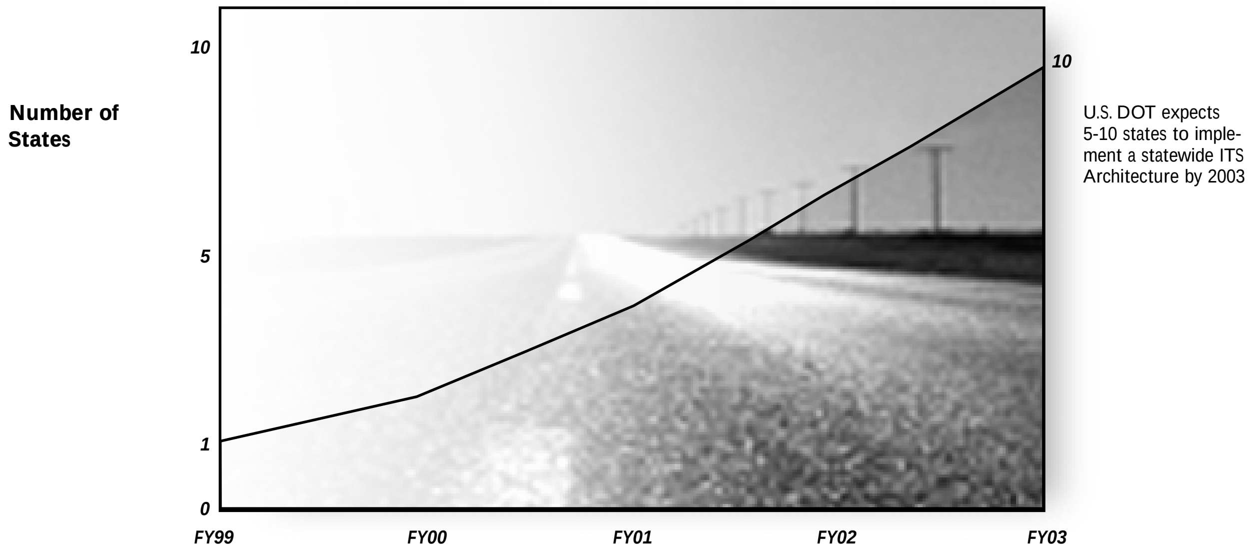


Figure III-3: Rural/Statewide Deployment Goal

How We Get There

The rural program will focus on research through operational tests. However, all eight ITS program strategies will be used, to varying degrees, to support the rural program under TEA-21.

Conducting Research

Research will be conducted along the lines of the seven rural development tracks. U.S. DOT will focus primarily on conducting field operational tests (FOTs) for surface transportation weather and winter mobility, emergency services, and statewide/regional traveler information infrastructure. Each track is described below.

- **Surface Transportation Weather and Winter Mobility** applications will improve the availability of weather information to help decision makers improve transportation operations impacted by the weather. U.S. DOT will conduct research focused on providing more detailed weather information to travelers and winter maintenance operators. Weather information needs to be more specific than what is currently available, and it must be filtered, processed, and presented in ways that are more tailored to surface transportation. To meet these needs, U.S. DOT will promote improved observation, processing, and dissemination of weather information. Observation involves the collection of more accurate data. U.S. DOT is working to identify the appropriate sensor network needed to collect the weather data required for ITS applications. Better processing will be achieved through higher-resolution weather models, and other road weather models such as heat balance models. In addition, surface transportation decision makers need weather information disseminated in easily understood formats. U.S. DOT plans to develop a prototype route-specific, road surface and weather information system that will help identify user requirements for weather-related applications. Specific activities are shown on Figure III-4.

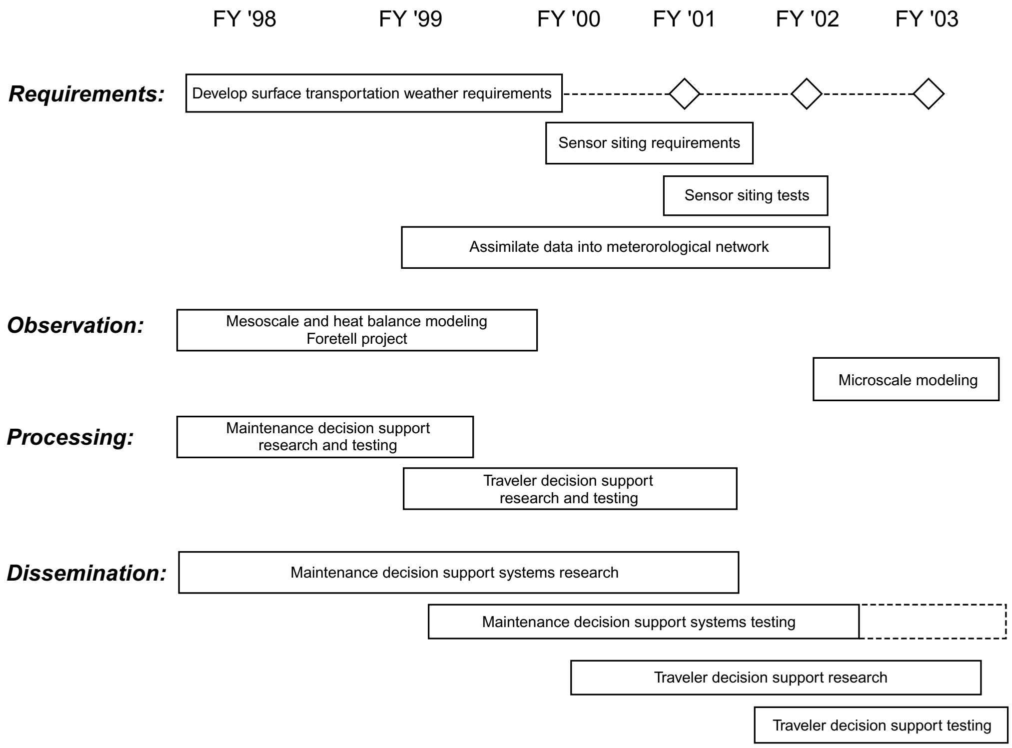


Figure III-4: Surface Transportation Weather and Winter Mobility Research Activities

- **Emergency services** applications help to coordinate the response to incidents and other activities in order to reduce medical response times in critical traffic accidents, thereby saving lives. Such technology is vital in rural areas, where many accidents are not immediately discovered, and people injured might have to wait helplessly for medical aid. Research in this area will focus on reducing crash notification time and providing quick and appropriate care. The challenge to developing appropriate rural ITS applications is that systems must be low cost and suitable for remote areas and rugged terrain.

  A variety of responding organizations (fire, police, Emergency Management Services, or EMS, and service dispatchers) must better coordinate to address the wide range of rural emergencies from isolated incidents to large-scale natural disasters. An information-sharing mechanism to locate an incident is a priority for emergency service providers. Initial research will focus on the use of enhanced cellular 911 services and automatic collision notification systems. Field tests of automatic collision notification systems are demonstrating the technical feasibility of systems that automatically and immediately report an accident and its location to an emergency medical service, significantly reducing the time required to assist crash victims. Field operational testing was conducted in FY 1999, and focused on the development of a statewide model for wireless EMS. Working with the EMS community in Buffalo, New York, U.S. DOT identified the organizational and institutional challenges to deploying enhanced wireless 911 and automatic collision notification systems, and will develop solutions to these problems. This model will be tested and modified as appropriate to apply to other states, with the goal of establishing the institutional structure to deploy integrated emergency services in several states by FY 2003. Specific activities for this area are indicated on Figure III-5.

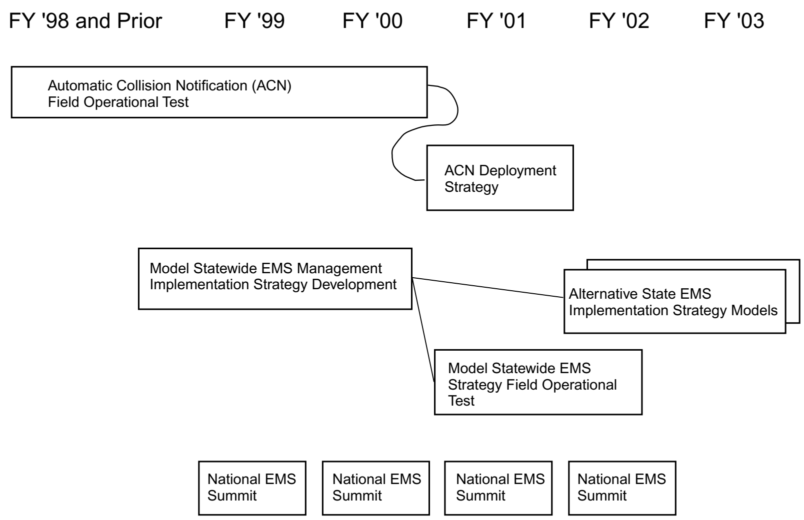


Figure III-5: Emergency Services Research Activities

- The **Statewide/Regional Traveler Information Infrastructure** development track focuses on the core infrastructure and standards needed to support data sharing that meets the needs of users and operators in all rural areas. Statewide/regional traveler information can consist of a wide range of information, including pre-trip advisories such as scheduled pickup and drop-off times, road closures, weather, and special events; en-route data such as tourist services; and real-time dynamic traffic information. Organizations that provide transportation services will share information with each other (within a state and across state boundaries) such as scheduled pick-up and drop-off times, road conditions, roadside services, transit and paratransit services, and tourism opportunities. These data must be integrated so travelers are not required to access multiple sources to receive all the information they need. The concept of mobility management services incorporates a "one-stop shopping" approach to public transportation travel. This concept uses ITS technologies by allowing a single telephone call to be made to gather information on various public travel options and then to schedule a trip. This will require not only the involvement of state DOTs, but also the tourism industry, national parks, private sector traveler information providers, and others. U.S. DOT's targets in this area include widespread use of multi-modal statewide/regional pre-trip information (several neighboring states operating traveler information/road closure systems); integrated, cost effective, regional system deployments; and commercial availability of en-route tour guide/navigation systems (including en-route updating). Building on current operational tests and actual deployments of rural multi-modal traveler information systems, the program will focus on developing formal requirements for statewide or rural multi-modal traveler information systems, developing decision support systems to support various users such as tourists or transportation system operators, and field operational tests of statewide and multi-state integrated systems. Specific activities for this area are indicated on Figure III-6.
- The **Rural Crash Prevention** development track focuses on the prevention of crashes before they occur, as well as on reducing crash severity. Rural areas are recognized for their unique environmental characteristics and rugged terrain. They present additional hazards for drivers such as defects in road geometry/structure, hazards leading to road departure, adverse climatic conditions, and unexpected encounters (rock falls, animals, and other vehicles). By examining the needs of rural travelers, crash prevention measures and advanced technologies can be implemented to assist in crash avoidance, hazard warning, work-zone and highway-rail crossing alerts, and dynamic speed zones. Research in this area will target the development and testing of variable speed limit systems and spot warning systems. Current practices will be reviewed, candidate systems for further development will be identified, and prototypes will be developed and field-tested.

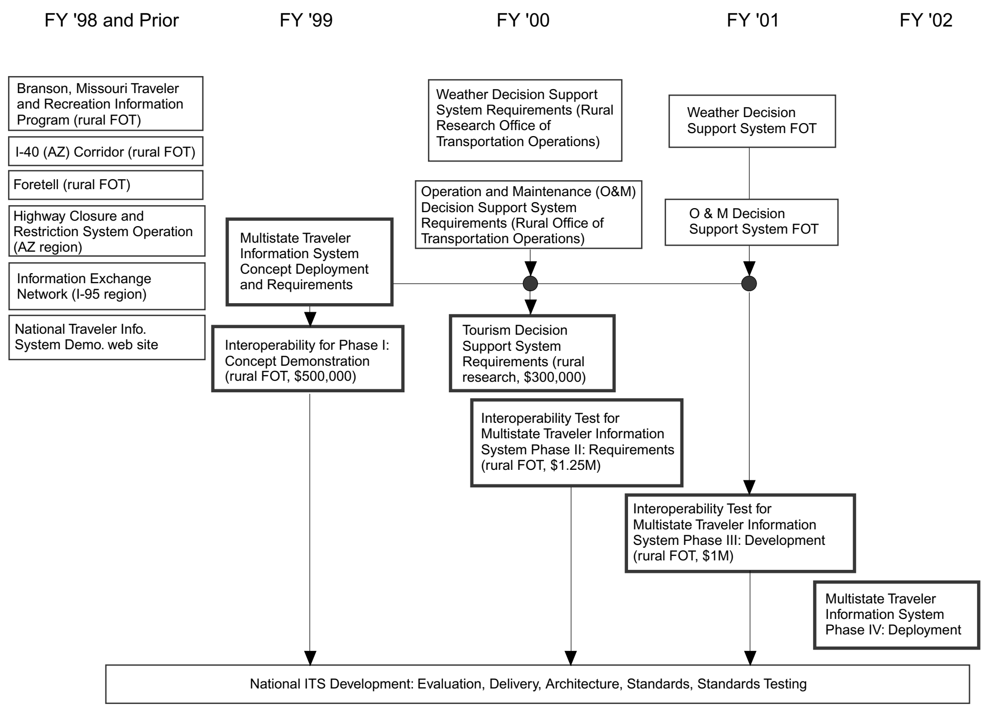


Figure III-6: Statewide/Regional Traveler Information Research Activities

- **Rural Transit Mobility** will increase the availability of transportation and the accessibility to services for those who are mobility-impaired by using transit/paratransit system management and by referring mobility-impaired people to appropriate transportation services. Rural transit mobility stakeholders have identified the following needs for rural mobility: better utilization of resources, reducing the isolation of users, providing advisory information, and improving the timeliness of trips. Research in this area is focused on the development and testing of systems that allow better coordination of various subsidized transportation services, such as improved dispatching algorithms and electronic payment and billing systems. The various subsidizing agencies, including the U.S. Department of Health and Human Services and the Department of Labor will be critical partners in the development of an interagency coordination model that will allow and encourage the use of these systems. It is expected that model dispatch/brokerage systems will be deployed in FY 2003.

- **Rural Traffic Management** is exercised at many levels: in small community traffic signalization for localized special events; for seasonal traffic peaks in recreational areas and parks (for example, over alternative routes when one is blocked); and over regional networks in cases of severe weather or other disasters. These cases are all significantly different from daily urban traffic congestion. In rural areas, traffic management can be viewed as the need for multijurisdictional coordination, mobile facilities, simple solutions for small communities, and operation in areas where utilities may not be available. Research in rural traffic management will focus on the appropriate strategies and equipment to perform surveillance, control, and communication that meet rural needs. Research will be initiated in FY 2001 to develop and fieldtest an adaptive signal control system (ACS) for small communities, known as "ACS-lite," that builds on the adaptive signal control systems currently being tested for heavily congested metropolitan areas. The ACS-lite system is intended to be a low-cost option available in FY 2003. Research also will be conducted to assess current portable traffic control systems and other systems and strategies suitable for seasonal and episodic traffic control. Based on this assessment, prototype portable traffic control systems may be developed and fieldtested.

- The **Highway Operations and Maintenance** development track focuses on improving the efficiency and capabilities of services to maintain and operate the transportation system. Highway operation and maintenance organizations are typically responsible for monitoring and maintaining roads, along with improving the physical condition of the infrastructure. They maintain the condition of public vehicle fleets and ensure safe operation of the system, especially under adverse travel conditions, such as winter weather or during construction and other work zone activities. They also ensure the efficient operation of the system, including the use and maintenance of various traffic management and traffic control devices. Stakeholders have identified the following needs: infrastructure management, safety monitoring, improved weather and surface condition information monitoring, and public fleet management through advanced vehicle tracking and on-board equipment monitoring systems. Under TEA-21, U.S. DOT will evaluate current practices; develop, test, deploy, and evaluate several safety technologies; and work to improve procedures and coordination of resources, thereby reducing cost and increasing efficiency of maintenance operations.

Milestones for Conducting Research

1999-2001	Finalize rural needs and user service requirements.
	Prototype a route-specific, road surface, and weather information system for winter maintenance and traveler information.
	Deploy comprehensive pre-trip traveler information networks in three states.
	Conduct a field operational test of automatic collision notification.
2001	Conduct a traveler information field operational test in a national park site.
	Develop an adaptive traffic control system for small communities.
2003	Deploy several multistate/regional traveler information networks.
	Establish the institutional structure to deploy integrated emergency services in several states.
	Complete development of several rural safety/traffic control systems such as variable speed limit systems, portable traffic control systems, advanced work zone systems, and spot warning systems.
	Deploy model dispatch/brokerage systems for coordinating paratransit and subsidized transit services.

Accelerating the Development of Standards

U.S. DOT is just beginning to identify what standards may be necessary for rural-specific ITS applications. Standards are identified through a process of assessing user needs (also known as user services), defining rural ITS infrastructure, and modifying the National ITS Architecture. The rural ITS program is actively seeking stakeholder participation in this process. U.S. DOT is looking at this issue from the top down, by reviewing the National ITS Architecture, and from the bottom up, by keeping track of how rural ITS is being deployed at the local level. Operational tests provide an additional input to this process as they show how rural applications work in real-world settings.

As the National ITS Architecture is refined and updated, U.S. DOT may find that ITS standards need to be developed to support the rural ITS infrastructure. New standards may be required, or existing ITS standards may need modification to apply to rural technologies. For example, it is anticipated that new message sets may be needed for weather applications, and several traveler information service standards will need to be modified to meet rural needs.

Milestones for Accelerating the Development of Standards	
1999	Define user services for rural ITS applications.
2000	Refine and update the National ITS Architecture as appropriate.
2001	Initiate development of new standards or modification of existing standards as appropriate.

Building Professional Capacity

Professional capacity building for rural practitioners will be accomplished primarily through the modification of existing ITS courses to reflect the needs of rural ITS users. Practitioners with rural expertise will help tailor individual courses to a rural audience. As research into rural applications continues, more specific training requirements for rural ITS may be identified in the future. In the short term, course delivery will focus on educating Federal field staff and their rural partners in the use of the National ITS Architecture as a tool for integration and on architecture consistency policy.

Rural stakeholders are widely distributed geographically, making both distance and cost a challenge to delivering training to rural constituents. Currently, U.S. DOT has worked to reach the rural audience through conferences, publications, courses, seminars, and workshops. A major effort is now underway to develop distance-learning capabilities that provide rural stakeholders with easy and timely access to the training they require.

Over time, all courses, including those with rural components, will be incorporated into FHWA and FTA training programs offered by the National Highway Institute and National Transit Institute. Courses will eventually be delivered entirely through these channels.

Milestones for Building Professional Capacity	
1999-2000	Modify existing courses to include rural subjects as appropriate.
	Train Federal field staff and rural stakeholders in using the National ITS Architecture as a tool for integration.
	Explore virtual learning delivery methods including video-conferencing and web-based training.
2002	Transfer course delivery to the National Highway Institute and National Transit Institute.

Creating Funding Incentives

TEA-21 provides funding incentives to be used for the integration of ITS. Localities will be encouraged to support technical integration, political cooperation, and jurisdictional coordination of ITS in their area. For rural areas, this funding may be used either to deploy individual project components or to integrate existing rural systems. This approach differs from that used in metropolitan areas, where funds are to be used for integration only. The difference is appropriate because rural areas have fewer systems deployed that can be integrated with one another. Funding to rural areas will be allocated based on programmatic goals and TEA-21 criteria. A minimum of 10 percent of integration funding will be used for rural applications and will be available for both highway and transit projects.

Milestones for Creating Funding Incentives

Integration program funding will be allocated per programmatic goals and TEA-21 criteria as follows:

(Dollars in millions)

Year	1998	1999	2000	2001	2002	2003	Total
ITS Integration Funds *	$74	$75	$80	$83	$85	$85	$482
* requires a minimum of 10 percent spent on rural integration							

Providing Guidance and Technical Assistance

At this early stage in the rural ITS program, guidance and technical assistance will focus mainly on disseminating testing results to stakeholders. U.S. DOT will develop a communication plan to disseminate the results of research projects currently underway or planned in the immediate future. Guidance materials consist of lessons learned and simple solutions compendia, technical toolboxes, and catalogs of available systems. Many of these materials will be packaged together for rural stakeholders as the "Advanced Rural Transportation System (ARTS) toolbox," the first version of which will be developed in 2000 to 2001, and the second in 2003. In addition, FTA intends to develop and deliver results of transit information system integration efforts. Delivery will be via FTA web sites, FTA regional offices, the technology-sharing program of the Research and Special Programs Administration, and the rural transit assistance program. The rural transit assistance program and regional offices will provide limited technical assistance on specific operational problems, while FTA grants and local operating agency resources will continue to fund technical planning contracts that will include transit ITS solutions. Other venues for technical assistance to rural stakeholders include the Peer-to-Peer Network and various Internet resources.

Another key aspect of providing guidance will be to bring organizations together to resolve rural issues. In addition to the multiple jurisdictions within states (county law enforcement, state highway departments, Indian tribal leadership, regional hospitals/trauma centers, etc.), various Federal departments and agencies need to work together and combine their expertise to help resolve rural issues. Depending on the rural location, major players in addition to U.S. DOT might include the Departments of Agriculture, Interior, Commerce, Defense, Education, Justice, Health and Human Services, and Labor. U.S. DOT will deliver guidance such as models of interagency coordination to help stakeholders learn to coordinate more effectively with other organizations in their area.

Milestones for Providing Guidance and Technical Assistance

1999-2001	Develop a communication plan to disseminate the results of research projects currently underway or planned in the immediate future.
	Distribute to rural stakeholders the first version of the ARTS toolbox, building upon the "simple solutions" approach to solving rural problems with low-cost, low-tech alternatives.
	Deliver coordinated models of interagency cooperation to deal with issues such as mobility to work sites and medical facilities, transit management in national parks or tourist attractions, weather integration, or communications spectrum issues.
2003	Begin to develop a second version of the ARTS toolbox for rural stakeholders, incorporating lessons learned from the additional research and operational tests.

Ensuring Consistency with the National ITS Architecture and Standards

Policy is under development by U.S. DOT to ensure consistency with the National ITS Architecture and standards, and applies to ITS deployments using Federal funding in both metropolitan and rural settings. Discussions with stakeholders have revealed a major difference in application of the policy at a statewide level. U.S. DOT has proposed using the statewide planning process as part of ensuring conformity, but the statewide level requires less detailed plans than those necessary at the metropolitan level. For this reason, the statewide arena poses a unique challenge that will need to be addressed as policy development moves forward. A final policy is expected through rulemaking in FY 2000. The formal rulemaking process provides ample opportunity for stakeholder comment, and U.S. DOT will use this process to help determine the most appropriate actions for ensuring consistency at the statewide level. Once the final policy is approved through rulemaking, Federal field staff will implement the policy through FY 2003 and beyond.

Milestones for Ensuring Consistency with the National ITS Architecture and Standards

1999	Issue interim guidance.
2000	Issue notice of proposed rulemaking.
	Final policy adopted through rulemaking process.
2001-2003	Implement consistency policy.

Evaluating the Program

Program evaluation activities are just beginning to emerge for the rural ITS program. Since rural ITS infrastructure components must be defined before they can be tracked, program assessment cannot be done until the infrastructure has been identified. Once defined, quantifiable indicators will be developed for rural ITS components, as they have been developed for metropolitan applications. In addition, geographic boundaries of rural regions (most likely state boundaries) will be defined and a subset of rural regions across the U.S. will be selected as the survey population, if appropriate. After completing this definition task, baseline surveys of rural ITS deployments will commence. Finally, survey personnel will work cooperatively with local decision makers to develop local deployment goals (what "should" be deployed) for each rural region. Tracking for rural infrastructure is expected to begin in 2001. Until that time, rural areas have access to the "Simple Solutions" document, which showcases the benefits of rural applications.

The main source of information about the impacts of rural ITS technologies is the set of field operational tests currently underway. These tests are scheduled for completion by the end of 2000, and their results will be entered into the costs and benefits data bases when they become available.

Milestones for Evaluating the Program

1999-2000	Identify rural infrastructure.
2000	Complete first round of field operational tests.
2001	Conduct baseline survey for rural ITS infrastructure.
	Enter results of rural field operational tests into cost and benefits data bases.
2002-2003	Track rural infrastructure on an annual basis.

Showcasing Benefits

Benefits of rural ITS applications are being showcased through field operational tests. Tests are currently being conducted for automatic collision notification, traveler information, and weather technologies, and more are planned for applications such as traveler information in a national park setting. These tests are not of the same scale as the metropolitan model deployments, but they do provide rural stakeholders the opportunity to see rural ITS technologies in operation and the benefits to rural America.

Milestones for Showcasing Benefits

1999-2000	Use first round of field operational tests to showcase benefits of rural ITS technologies.
2001-2003	Use additional field operational tests to showcase benefits.

3. COMMERCIAL VEHICLE ITS INFRASTRUCTURE

The interstate commercial motor vehicle industry includes approximately 500,000 motor carriers. It is a complex mix of businesses ranging from one-truck operations to fleets with thousands of vehicles and drivers that transport both goods and passengers. Among the carriers, there are 42,000 registered hazardous materials carriers and 13,000 bus and motor coach operators. The number of drivers holding commercial driver's licenses now exceeds 9 million.

On the average, interstate motor carriers may deal with five or six public agencies in each of the states in which they operate. They are legally required to obtain numerous credentials and clearances that require extensive information. Approximately 375,000 of these carriers operate without a safety rating because of the limited number of inspectors available to monitor new and established carriers.

In addition, regulatory compliance involves inefficient administrative procedures and redundant, often manual, data entry. As a result, neither states nor agencies within a state can share information easily, and the information that is shared is often inadequate. The administrative burden associated with regulatory compliance also increases labor costs for the motor carrier industry. Compliance costs for the industry (including record keeping, safety programs, and tax filing) have been estimated to be as high as $5 billion annually. The public sector's costs are even greater because of the paperwork associated with inspecting vehicles, issuing credentials, and collecting taxes.

The vision of the commercial vehicle ITS program is to increase safety for both drivers and vehicles while improving operating efficiencies for government agencies and motor carriers. In turn, savings of time, resources, and cost of doing business can be realized. At the center of this program is the deployment of Commercial Vehicle Information Systems and Networks, or CVISN. CVISN will link existing disparate and cumbersome information systems and data bases (currently used by regulators to obtain compliance information) and enable the electronic exchange of information.

CVISN consists of four components: safety information exchange, credentials administration, electronic screening, and freight and fleet management. The first three components, along with interoperability testing, are included in the development of a CVISN Level 1 capability within a state. The specific actions that a state must perform in order to achieve CVISN Level 1 capabilities are presented in Figure III-7. In completing CVISN Level 1 capabilities, states will benefit from operating efficiencies through streamlined credentialing, inspection, and enforcement processes, while increasing highway safety. FMCSA also is supporting CVISN by engaging the private sector in discussions on freight and fleet management practices. This is to ensure that private sector products are deployed in accordance with CVISN systems at the state and national levels. In FY 2000, FMCSA expects to define CVISN Level 2, the next stage in the evolution of CVISN.

1. Establish an organizational framework for cooperative systems development among state agencies and motor carriers;
2. Establish a state CVISN system design that conforms to the CVISN architecture and can evolve to include new technologies and capabilities (the CVISN architecture is part of, and consistent with, the National ITS Architecture); and
3. Demonstrate the following elements of the three main components of CVISN:
   - *Safety Information Exchange* – ASPEN (a roadside inspection tool) or equivalent at major inspection sites; connection to the Safety and Fitness Electronic Records system (SAFER), which provides interstate carrier and vehicle safety snapshots; and the Commercial Vehicle Information Exchange Window (CVIEW) (or equivalent) for exchanging interstate and intrastate carrier, vehicle, and driver safety snapshots within and among states.
   - *Credentials Administration* – end-to-end processing (i.e., carrier application, jurisdiction application processing, and credential issuance) of the International Registration Plan (IRP) and International Fuel Tax Agreement (IFTA) credentials; ready to extend to other credentials (intrastate, titling, oversize/overweight, electronic payment, carrier registration, hazardous materials); connection to IRP and IFTA clearinghouses; and have at least 10 percent of the transaction volume handled electronically, and are ready to bring on more carriers as they sign up and to extend to branch offices where applicable.
   - *Electronic Screening* – implemented at a minimum of one fixed or mobile inspection site and ready to replicate at other sites.
   - *Interoperability Testing* – complete interoperability tests to demonstrate conformance with the architecture and standards.

Figure III-7: Actions States Must Take to Achieve CVISN Level 1 Capabilities

Where We Are

CVISN is being prototyped and piloted in a total of 10 states nationwide. The two initial states that began testing CVISN Level 1 systems and capabilities – Maryland and Virginia – are referred to as "prototype" states. Both are in the final stage of testing. The eight states that began deployment of CVISN are referred to as "pilot" states. These are California, Colorado, Connecticut, Kentucky, Michigan, Minnesota, Oregon, and Washington. The pilot states have achieved varying degrees of progress in deploying Level 1 capabilities, with Kentucky approaching the level found in the two prototype states. A total of 40 states have expressed interest in deploying CVISN Level 1 capabilities, with a majority participating in pre-deployment activities such as developing commercial vehicle ITS state business plans and attending U.S. DOT CVISN training courses and deployment workshops.

A detailed architecture for CVISN and draft standards has been defined to promote interoperability and efficiency. In addition, the International Registration Plan and International Fuel Tax Agreement clearinghouses are in operation, facilitating the electronic exchange and reconciliation of registrations, fuel taxes, and fees among jurisdictions.

The commercial vehicle mainstreaming program is focused on outreach activities to get states started with CVISN. In addition to developing commercial vehicle ITS state business plans, regional coordination forums are being conducted to describe CVISN benefits, share lessons learned, and begin the CVISN development process. FMCSA has developed three training courses to increase awareness and understanding of commercial vehicle ITS among key stakeholder groups and to provide background before states attend a series of CVISN deployment workshops.

U.S. DOT has a strategic goal to promote public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage. For FMCSA, this translates into the continuous improvement of highway safety. A major opportunity to improve highway safety is to increase targeted enforcement of high-risk commercial vehicle carriers and drivers. Through CVISN, FMCSA has developed, and is now implementing, Electronic Data Interchange standards; set up communication networks; and piloted software for the electronic transfer of safety performance information between Federal and state enforcement agencies. FMCSA has also developed computer hardware and software to allow broader access to safety information by safety inspection, law enforcement, and FMCSA personnel. Key components of these systems include the SAFER system, the Unified Carrier Register, and the use of laptop computers, all of which provide enforcement personnel (particularly those at the roadside) access to previously unavailable information systems. These programs systematically improve data on the carrier, vehicle, and driver performance; analyze it; and identify high-risk carriers and drivers. The information is being used to screen and target high-risk carriers for on-site review and inspection, both at the roadside and at motor vehicle administration offices when carriers apply for permits or register their vehicles. The continued development and deployment of safety information systems will play a crucial role in protecting and enhancing the health and safety of the American public.

Where We Are Going

U.S. DOT has set a goal to deploy CVISN Level 1 capabilities in 26 to 30 states by 2003, depending on congressional funding. U.S. DOT and the participating states remain committed to completing CVISN Level 1 in the prototype states and in Kentucky by early FY 2000, and in the remaining pilot states by December 2001, pending availability of deployment incentive funding from Congress. TEA-21 established a goal "to complete deployment of CVISN in a majority of states by September 30, 2003." (See Figure III-8.) In the legislation, Congress also authorized $184 million from FY 1998 to 2003 to deploy CVISN. However, subsequent designations by Congress through the appropriations process have considerably reduced U.S. DOT's ability to completely fund the CVISN pilot states while providing funding to other interested states.

U.S. DOT is working with states that received designated appropriations to promote the use of all or a portion of their funds to advance to the next phase of CVISN activities. This ensures that these states are taking the appropriate steps in support of the national deployment goal for CVISN. U.S. DOT is committed to providing all interested remaining states with the CVISN architecture and available standards, tools (including training and deployment workshops), and guidance necessary to achieve this goal.

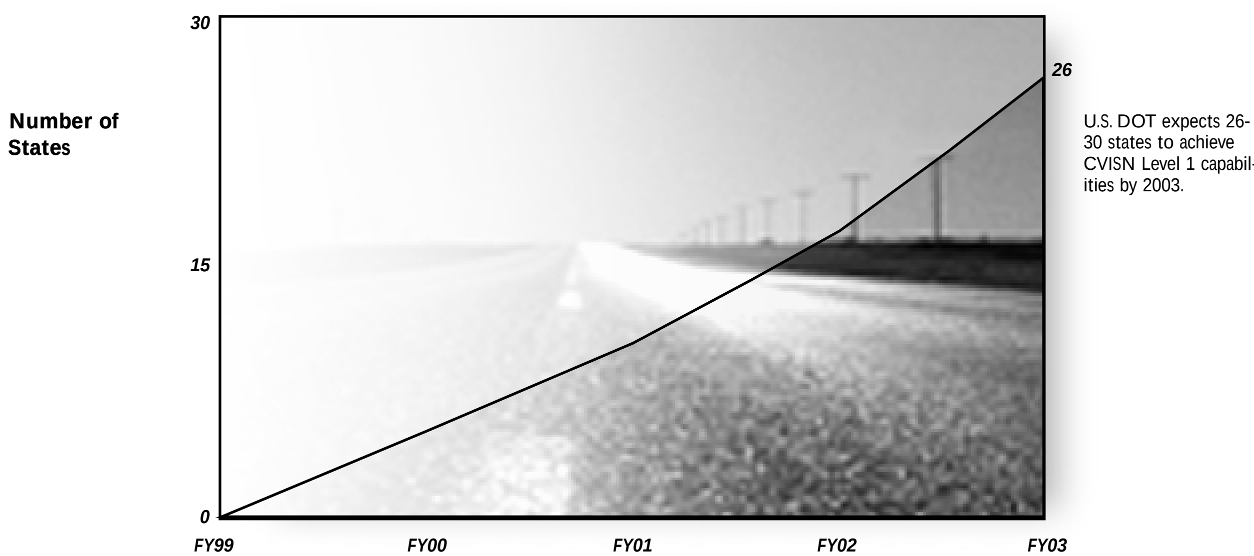


Figure III-8: CVISN Deployment Goal

A major component of CVISN is the safety information systems that support the exchange of motor carrier, vehicle, and driver safety and credentials information to roadside enforcement personnel and other authorized users. Motor carrier safety information systems provide the means to maintain an accurate carrier census and target unsafe carriers, prioritize carriers for audits, establish a motor carrier safety fitness rating and profile, manage program resources effectively, analyze programs and regulations, and track industry statistics and trends. Intelligent safety decisions will support the future expansion of Federal and state motor carrier safety information systems through the collection of safety information from numerous sources. Future development and deployment will emphasize unified information systems, including: a complete motor carrier register that integrates the former Interstate Commerce Commission and DOT systems; online, roadside access of motor carrier safety information to guide the selection of vehicles and drivers for inspection based on prior safety history; and the expansion of national resources to include intrastate carriers. Once this information has been made available, it will be analyzed for real-time operations and to support Federal and state policy decisions. This information will be made widely available to all authorized users over the Internet, with restricted information being provided only to enforcement officers through secure field systems.

Since technology is rapidly changing, it is critical to be able to assess both new and existing technologies for achieving improvements in motor carrier enforcement, compliance, and safety. The development and testing of new technologies at the roadside for evaluating safety performance, and for improving Federal and state compliance and enforcement operations, will be crucial to meeting the vision of the commercial vehicle ITS program.

How We Get There

Similar to the metropolitan ITS program, the commercial vehicle program is relatively mature. Therefore, all eight ITS program strategies will be used, to varying degrees, to meet the commercial vehicle deployment goal.

Conducting Research

In the commercial vehicle ITS research program, FMCSA will undertake coordinated activities intended to reduce or eliminate transportation-related incidents and their resulting deaths, injuries, and property damage. These activities include demonstrating cost-effective technologies for achieving improvement in motor carrier enforcement, compliance, and safety, while keeping up with the latest technological advances.

The commercial vehicle ITS research and development program includes continued development, testing, and implementation of technologies (e.g., software, networks, data bases, sensors) necessary to support improvement in safety, enforcement, and compliance. As part of this effort, U.S. DOT will assess new and existing technologies that reduce crashes and improve: 1) the identification of high-risk motor carriers, vehicles, and drivers; 2) the enforcement of and compliance with performance-based regulations; and 3) the efficiency and accuracy of safety data collection and access at the roadside. This will support the development and testing of new technologies at the roadside for evaluating safety performance and for improving Federal and state compliance and enforcement operations. Areas to be addressed include:

- Defining, prototyping, and deploying CVISN Level 2 capabilities, which may include use of on-board monitoring devices to support safety inspections, and the automated collection and exchange of citation data;
- Investigating and testing various motor carrier identification and enforcement technologies that support roadside screening of carriers, vehicles, and drivers;
- Developing Intelligent Safety Decisions, including safety data warehousing for improving crash analysis and resource allocation;
- Developing a Unified Carrier Register system that will support carrier DOT registration, licensing and insurance, as well as provide carrier census data needed to normalize crash data for use in targeting high risk carriers;

- Ensuring the SAFER system is fully operational by extending it to include additional interfaces to sources of data and channels for distribution of data, and modifying the system to reduce operating and maintenance costs;
- Establishing Dedicated Short Range Communication (DSRC) standards at the 5.9 gigahertz (GHz) frequency band;
- Researching the use of the web-based standard extensible markup language, or XML, as a supplement to Electronic Data Interchange (EDI); and
- Automating the interoperability test process to allow states and motor carriers to execute these tests more efficiently and with less outside technical support.

Milestones for Conducting Research

2000	Define CVISN Level 2 capabilities.
2000-2001	Achieve over 2,500 users of ASPEN, the standard formatted roadside system for safety inspections used to target high-risk carriers.
	Integrate new technological developments into ASPEN system, such as voice recognition, transponder interfaces, and secure Internet connections.
2000-2003	Assessment of brake testing technologies (i.e., infrared) for use in a compliance and enforcement environment.
	Test visual imaging technologies (i.e., license plate readers, optical character recognition systems) and integrated roadside performance evaluation systems that can identify motor carriers, improve the productivity of roadside inspectors, and support performance-based roadside enforcement.
	Prototype Level 2 capabilities with two or three states and with motor carriers.
2001-2003	Initiate real world testing of CVISN Level 2 capabilities.
	Ensure SAFER is fully operational and integrated with FMCSA systems (including external system interfaces) and permanently maintained as an integral part of FMCSA operations.
	Develop Intelligent Safety Decisions, including adding intrastate motor carriers, integrating the Unified Carrier Register with all CVISN operations, integrating driver traffic citations to identify high-risk operations, and creating a data warehouse.

Accelerating the Development of Standards

U.S. DOT will continue to update and maintain the commercial vehicle ITS architecture to ensure consistency and interoperability, include lessons learned from deployments, and continue to keep up and evolve with changing technology. In 2000, U.S. DOT will finalize the Level 1 interoperability suite, and identify any architecture and standards changes necessary to support CVISN Level 2 capabilities.

In addition, two key standards are required for the demonstration of CVISN Level 1 capabilities – standards for Electronic Data Interchange and for Dedicated Short Range Communication. It is expected that the EDI standards for safety information and credential information exchange will be approved in 2000. Maintenance of the standard will be an ongoing activity. If needed, new implementation guides will be produced for the CVISN Level 2 items that rely on the EDI standards. With an increasing number of business transactions conducted on the Internet, a shift to the web-based standard XML is expected in 2001 and 2002. The web-based standard will be a co-existing alternative to EDI, allowing states to offer motor carriers the ability to register, license, and pay fees using a standard web browser.

In 1999, support continued for the development of a DSRC standard, including the 915 megahertz (MHz) American Society for Testing and Materials 17.51 and the Institute for Electrical and Electronic Engineers P1455 standards. A DSRC certification plan also will be developed. In 2000, the emphasis shifted to compatibility and certification testing at 915 MHz. In 2001, certification testing efforts (of state CVISN or of individual technologies) will begin transitioning to permanent testing organizations. An overall shift in DSRC technologies is expected to use 5.9 GHz for DSRC equipment, requiring development of associated standards. The goal is to achieve a certification testing mechanism that can be financially self-sustaining.

Milestones for Accelerating Standards Development

1999	Support development of DSRC 915 MHz standard.
	Develop DSRC certification plan.
2000	Finalize Level 1 interoperability test suite.
	Conduct DSRC standard certification and compatibility testing.
	Draft DSRC standards for the 5.9 GHz frequency band.
	Approve EDI standards for safety information and credential information exchange.
	Develop appropriate architectural and design standards, and identify any necessary changes to existing architecture and standards for CVISN Level 2 capabilities.
	Research the use of XML as a supplement to EDI.
2001	Begin transitioning DSRC certification testing efforts to permanent testing organizations.
	Complete testing of CVISN standards for safety and credentialing and obtain final approval by standards development organizations.
	Review and, if necessary, revise the architecture and standards to support CVISN Level 2.
2002	Develop a suite of interoperability tests to support CVISN Level 2.
	Approve use of web-based XML standard as supplement to EDI.

Building Professional Capacity

Professional capacity building is critical to states, vendors, and FHWA and FMCSA project managers to implement CVISN. CVISN implementation requires building new stakeholder coalitions as well as knowledge of systems engineering and electrical engineering. The FHWA and FMCSA suite of professional capacity building courses assists CVISN project members in the implementation of their projects. Courses include lessons learned from prototype and pilot states to further prepare CVISN team members for the real-world challenges they may face.

The deployment strategy for CVISN Level 1 consists of three key phases: planning, design, and deployment. Planning includes participation in two commercial vehicle ITS training courses and the development of a commercial vehicle ITS state business plan. These courses promote commercial vehicle ITS awareness and are essential to effective coalition building among the state agencies involved in commercial vehicle operations and with industry. The design phase supports the state in establishing its CVISN project team, including at a minimum a CVISN project manager and a system architect. Once individuals have been selected, a state can participate in CVISN architecture training and then in three CVISN deployment workshops. These activities will assist the state in developing its CVISN project plan and top-level design.

The deployment phase includes implementing systems and/or system modifications that support CVISN Level 1 capabilities (safety information exchange, electronic credentialing, and electronic screening). To support the states' commercial vehicle ITS deployments, training and technical assistance will be available to them in the areas of interoperability testing for conformance with the National ITS Architecture, systems integration issues and lessons learned, and commercial vehicle ITS project monitoring, maintenance, and operation.

The FMCSA's National Training Center will continue its function to increase the ITS technical capacity of Federal, state, motor carrier, and private sector transportation professionals and serve as an information clearinghouse on commercial vehicle ITS training. From 1999 through 2000, U.S. DOT expects to reach 20 new states, and 5 to 15 more from 2001 through 2003. In FY 1999 through 2000, FHWA and FMCSA field staff will be trained to provide instruction to state implementers, as well as oversight and management, to ensure that Federal Highway Trust Fund dollars invested in commercial vehicle ITS conform fully to the CVISN architecture and applicable standards. Other delivery methods, such as web-based training and video conferencing, will be explored in FY 1999 and 2000. These methods may be used to capture a larger audience of participants at a lower cost than traditional classroom training.

Milestones for Building Professional Capacity

1999-2000	Conduct commercial vehicle ITS technical training to prepare 20 new states for CVISN workshops as well as maintain momentum in future CVISN states.
	Explore virtual learning delivery methods including video conferencing and web-based training.
	Increase the skills and knowledge base in commercial vehicle ITS within FHWA and FMCSA headquarters and field staff.
2001-2003	Complete a series of CVISN deployment workshops for 5 to 15 new CVISN states.

Creating Funding Incentives

ITS deployment funding incentives for commercial vehicles will be used to help implement CVISN at the state level. CVISN deployment is focused on achieving CVISN Level 1 capabilities in the prototype and pilot states, and expanding to other interested states. Working with states and motor carriers, U.S. DOT will continue to provide technical and peer-to-peer assistance, training, and lessons learned to the prototype and pilot states, as well as to other states.

In addition to the 10 prototype and pilot states, many other states have shown interest in pursuing CVISN. U.S. DOT is committed to helping them demonstrate CVISN Level 1 capabilities. Currently, 36 additional states have business plans that have been accepted by FHWA and FMCSA. Nine additional states are working on their business plans. Also, 32 states submitted "pre-applications" to participate in the CVISN component of the FY 2000 ITS deployment program. TEA-21 authorized $184 million over 6 years to deploy CVISN in a majority of states by September 30, 2003. With these funds, U.S. DOT expects 30 states to complete CVISN project plans with top-level system designs by 2001. Full funding will be provided to states to develop project plans and deploy CVISN Level 1 per funding availability.

Milestones for Creating Funding Incentives

CVISN program funding will be allocated per programmatic goals and TEA-21 as follows:

(Dollars in millions)

Year	1998	1999	2000	2001	2002	2003	Total
CVISN Funds	$25.5	$27.2	$30.2	$32.2	$33.5	$35.5	$184

Providing Guidance and Technical Assistance

FHWA and FMCSA have worked with several partners over the past few years to develop resources to support states planning to deploy CVISN. These resources include commercial vehicle ITS training classes; CVISN deployment workshops; the CVISN tool kit; CVISN technical and management guides; commercial vehicle ITS Internet sites, including the Electronic Document Library; FHWA and FMCSA outreach and the Technology Truck; technical and institutional support (FMCSA and FHWA field staff, and contractor support such as CVISN state advisors and CVISN subject matter experts); and the CVISN interoperability test facility.

Collectively, these materials comprise an integrated strategy for providing support to the deployment process. Federal field staff will use these resources to actively provide guidance and technical assistance to interested states.

Interoperability testing requirements are necessary to help ensure national interoperability. These tests, including pair-wise and end-to-end tests, determine if the developed systems conform to the architecture. Pair-wise tests verify that interfaces between selected pairs of products or systems meet the applicable standards. End-to-end tests verify data flow and data usage among all required products or systems, from initial input through final outcome. Standardized interoperability test suites are being developed to test selected, critical aspects of interoperability in the areas of safety information exchange, credentials administration, and electronic screening.

In addition, FHWA and FMCSA have expanded the ITS Peer-to-Peer Network to include commercial vehicle ITS. The Peer-to-Peer Network will provide deployment support on an as-needed basis to state personnel implementing commercial vehicle ITS. Experienced FMCSA commercial vehicle ITS staff, FHWA Resource Center staff, and state and consultant CVISN implementers will provide this support. States will be able to request assistance from experienced peers, who would provide assistance remotely or via site visits, depending on need and availability. Also, states needing assistance could use the program to visit CVISN sites. The goal of this program is to facilitate technology transfer and provide lessons learned to mitigate deployment risks facing new state implementers and minimize deployment costs.

Milestones for Providing Guidance and Technical Assistance

2000	Provide technical assistance to states performing interoperability tests.
2002	Develop tools to automate the testing process to allow states and motor carriers to execute interoperability tests more efficiently with less outside support, and make the interoperability test effort more self-sustaining.

Ensuring Consistency with the National ITS Architecture and Standards

Interoperability of Federal, state, carrier, and other commercial vehicle systems and networks that allow the exchange of data is at the heart of CVISN. The development of a policy to ensure consistency with the National ITS Architecture and approved standards supports this interoperability. Policy is currently under development by U.S. DOT and will apply to all ITS deployments using Federal funding. As previously discussed, interim guidance was issued in 1999, and the final policy is expected in 2000. This policy guidance applies to CVISN projects. As part of the policy development process, three items specifically supporting interoperability, and therefore CVISN, have been identified, and draft requirements have been defined.

First, coordination is required between state motor carrier planning processes and statewide Federal aid planning processes for the successful inclusion of commercial vehicle ITS projects in an integration plan. Commercial vehicle ITS projects originating from a Motor Carrier Safety Assistance Program Commercial Vehicle Safety Plan would be coordinated with Federal aid staff to develop an ITS integration and implementation plan. Commercial vehicle ITS projects originating from the Federal aid planning process would be coordinated with the FMCSA staff, as would oversight for the project.

Second, the elements for national interoperability must be addressed. These include the standardization of hardware and software, uniformity and compatibility of functions and procedures, and the commonality of business agreements. All are being addressed by states, but achieving business agreements may be the most difficult. FHWA and FMCSA are actively pursuing strategies to achieve nationwide interoperability among electronic screening systems.

Third, testing requirements are necessary to help ensure national interoperability. Work is being completed in this area and documented in the CVISN operational and architectural compatibility handbook, and in a CVISN interoperability test suite. These documents contain operational, management, and system checklists; interface specifications; and interoperability test criteria, including test specifications, test cases and procedures, test tool descriptions, and test data.

Milestones for Ensuring Consistency with the National ITS Architecture & Standards

1999	Issue interim guidance; initiate final policy development.
2000	Adopt final policy through rulemaking process.
2001-2003	Implement consistency policy.
1999-2003	Develop ITS integration and implementation plans in coordination with FHWA staff.
	Define, develop, and maintain interoperability test scenarios, cases, and procedures, including test tools and data pertaining to CVISN Level 1 deployment in safety information exchange, credentials administration, and electronic screening.
	Develop and distribute CVISN operational and architectural compatibility handbook and CVISN interoperability test suite packages.

Evaluating the Program

Program evaluations are being used to track deployment of commercial vehicle ITS technologies. Deployment indicators for the CVISN infrastructure have been defined and baselined. Tracking is done at the statewide level and includes all 50 states. Because determining the baseline was dependent on outputs from legacy reporting systems, the data are less current (1996) than for the metropolitan infrastructure (1997). A report, entitled "Tracking State Deployments of Commercial Vehicle Information Systems and Networks" (Electronic Document Library - #7303), contains the results of the baseline survey. The deployment tracking methodology will continue to be applied in the CVISN infrastructure area. For CVISN, deployment-tracking surveys will be conducted at 2-year intervals to determine progress with ITS deployments in all 50 states. In addition, survey personnel will work cooperatively with local decision makers to determine the appropriate level of ITS deployment for each state. Planning for the tracking of freight and intermodal applications of ITS is also anticipated to begin at the end of this 5-year planning cycle.

About a dozen commercial vehicle ITS field operational tests have been completed, and their results have been entered into the ITS cost and benefit data bases. The remaining tests will be completed by the end of 2000. Results of these tests will be entered into the ITS cost and benefit data bases when they become available.

Another source of information about the impacts of commercial vehicle ITS technologies will be the results of the CVISN model deployment evaluation. A final report for the CVISN evaluation is due to be published in 2000. This will be the first systematic attempt at performing benefit-cost analyses of CVISN ITS deployments across multiple states. A Phase II CVISN evaluation will update benefit and cost data bases according to lessons learned from more mature and integrated CVISN deployments. In addition, most CVISN deployments receiving Federal ITS funding will be required to conduct a small-scale self-evaluation, and a few CVISN deployment projects will be selected for more comprehensive national evaluation.

Milestones for Evaluating the Program

1999-2003	Conduct CVISN deployment tracking surveys for all 50 states at 2-year intervals.
	Conduct self-evaluations and national evaluations of CVISN deployments.
2000	Complete remaining field operational tests.
	Incorporate results into ITS cost and benefit data bases.
	Complete Phase I CVISN model deployment evaluation.
2002	Complete Phase II CVISN model deployment evaluation.

Showcasing Benefits

The eight CVISN pilot states serve as model deployments to showcase the benefits of CVISN. These sites will be evaluated under TEA-21 to demonstrate CVISN benefits and provide lessons learned for other CVISN states. The ITS commercial vehicle "Technology Truck" is touring the nation, highlighting the benefits of CVISN to the motor carrier community. The truck houses portable advanced technologies for commercial vehicle operations activities and was constructed with classroom-type facilities, information kiosks, and computer demonstration workstations to offer an interactive learning environment. It will continue to travel to sites such as professional organization conferences, state government meetings, and motor carrier conferences until May 2000.

Milestones for Showcasing the Benefits

1999-2000	Showcase CVISN technologies across the nation with the Technology Truck.
	Incorporate CVISN benefits into brochures and materials for distribution to stakeholders.

4. THE INTELLIGENT VEHICLE INITIATIVE

Each year, more than 6 million crashes occur on our nation's highways. They kill more than 41,000 people, injure approximately 5.2 million others, and cost more than $150 billion per year. Over the last several decades, driving has become safer through public information and education campaigns, advanced safety features as standard equipment, and improved vehicle crashworthiness and highway design. Driver error, however, remains the leading factor in highway crashes.

Under ISTEA, U.S. DOT conducted research in crash avoidance, in-vehicle information systems, and automated highway systems that pointed to new safety approaches and promising solutions with the ability to significantly reduce motor vehicle crashes. Such systems may take the form of warning drivers, recommending control actions, or introducing temporary or partial automated control of the vehicle in hazardous situations. U.S. DOT has harnessed these diverse efforts into one program, the Intelligent Vehicle Initiative, or IVI.

IVI can be effective only if products, both in-vehicle and infrastructure components, achieve widespread deployment – something U.S. DOT wishes to accelerate. The motor vehicle industry and local transportation agencies will develop and deploy IVI services, while U.S. DOT will facilitate and encourage the installation and use of effective systems. Working together with industry and other stakeholders, U.S. DOT will develop performance guidelines, specifications, architectures, and standards, and will test and evaluate the most promising configurations for real-world use.

U.S. DOT will research and evaluate the benefits of IVI driver assistance systems, including the integration of driver information systems. Then, through the combined efforts of U.S. DOT's modal administrations, in partnership with the motor vehicle, trucking, and bus industries, state and local governments, and other stakeholders, U.S. DOT will work to facilitate the release of both vehicle-based and infrastructure-cooperative driver assistance systems.

Where We Are

The Intelligent Vehicle Initiative builds on an extensive resource of historical crash data that documents the most common types of crashes, as well as the most frequent causes of these accidents. Therefore, organization of the IVI is focused on both crash causes and collision types that have a statistically high rate of occurrence, and thus, the greatest potential to reduce accidents. In addition, these “problem areas” are first dealt with for the particular class of vehicle where the need is most urgent and there are the fewest barriers to deployment. By targeting these optimum “platforms” first, U.S. DOT hopes to expedite the deployment process and help manufacturers bring products to users faster. The four platforms include four classes of vehicles: light, commercial, transit, and specialty vehicles. Light vehicles are passenger vehicles, light trucks, vans, and sport utility vehicles. Commercial vehicles are heavy trucks and interstate buses. Transit vehicles include all non-rail vehicles operated by transit agencies. Specialty vehicles include emergency response, enforcement, and highway maintenance vehicles. The problem areas described below first will be applied to platforms with the most urgent need, or the greatest probability of acceptance. Later, insights gained from these initial deployments will be used to streamline development on all platforms that can benefit from the technology. Classifying vehicles into these four platforms allows U.S. DOT to focus on the unique problems posed by each and will expedite the commercial availability of driver-assistance systems across all platforms. IVI relies on the planned coordination and cooperation among the platforms. Each platform will be conducive to particular services that can then be applied to the other platforms. While the vast majority of crashes occur in the light vehicle platform, other platforms will permit field tests of particular systems sooner, before they are ready to be tested on light vehicles.

Problem areas have been identified based on the analysis of crash data, causal factors, and user needs, and include:

- Rear-End Collision Avoidance;
- Lane Change and Merge Collision Avoidance;
- Road Departure Collision Avoidance;
- Intersection Collision Avoidance;
- Vision Enhancement;
- Vehicle Stability;
- Driver Condition Warning; and
- Safety Impacting Services.

Each problem area is described below. A timeline for each problem area is also provided to show major support tasks that U.S. DOT will undertake for each technology development effort – problem definition and selection, system performance description, operational tests, deployment, and deployment support.

1. Rear-End Collision Avoidance

Rear-end collisions account for one in four crashes or over 1.7 million crashes a year. Technologies to avoid these collisions sense the presence and speed of vehicles ahead and provide warnings and limited speed control (e.g., coasting, downshifting, or braking) to avoid collisions. Early versions of this technology will use adaptive cruise control capabilities to detect and classify stationary objects and to determine lane shape and threat from vehicles in front. Later versions may include complementary lateral control and automatic braking in the event of an impending crash. Figure III-9 presents the timeline for rear-end collision avoidance tasks.

NHTSA estimates that driver warning systems alone would be effective in preventing 49 percent of rear-end crashes, or 759,000 crashes each year. Several projects have been completed and others are in progress, including a major operational test of a rear-end crash warning system, which would be particularly helpful for transit buses. Performance of these systems may be enhanced in the future by combining them with route guidance and highway infrastructure systems.

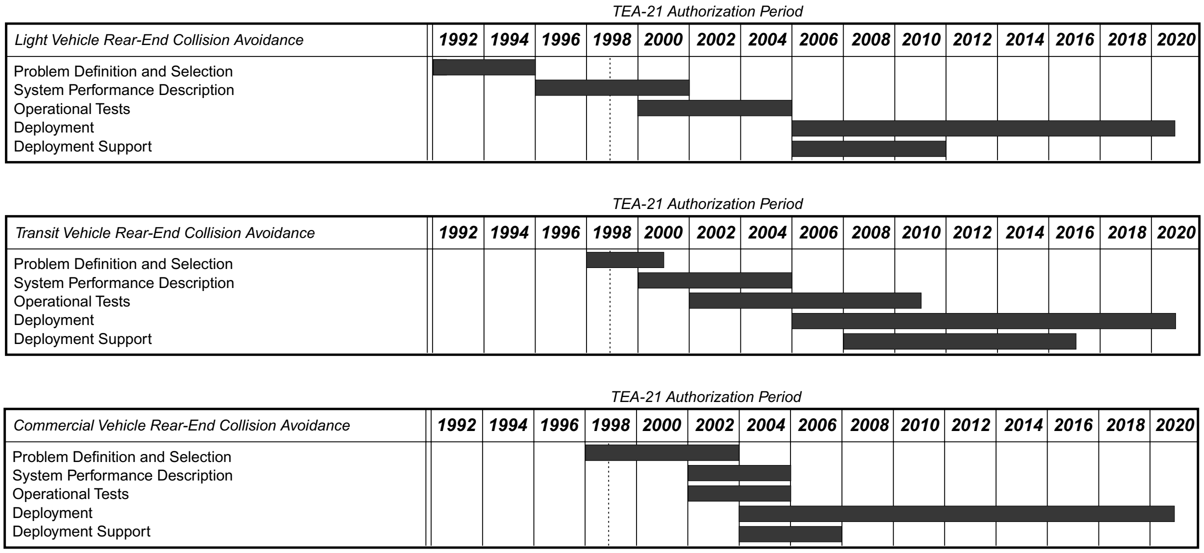


Figure III-9: Rear-End Collision Avoidance Timeline

2. Lane Change and Merge Collision Avoidance

Collisions during lane changes and merges also represent a major problem area, accounting for one in 25 of all crashes, with 90 percent caused by lane changes and 10 percent by merges. Primarily angle or sideswipe impacts, this problem area requires in-vehicle technology to help detect and warn drivers of vehicles in adjacent lanes. These systems monitor the lane position and relative speed of other vehicles beside and behind the equipped car, and advise drivers of the potential for collision. Figure III-10 presents the timeline for lane change and merge collision avoidance tasks.

It is estimated that these systems could apply to 192,000 of the approximately 600,000 lane change/merge crashes each year. A project currently underway involves transit buses.

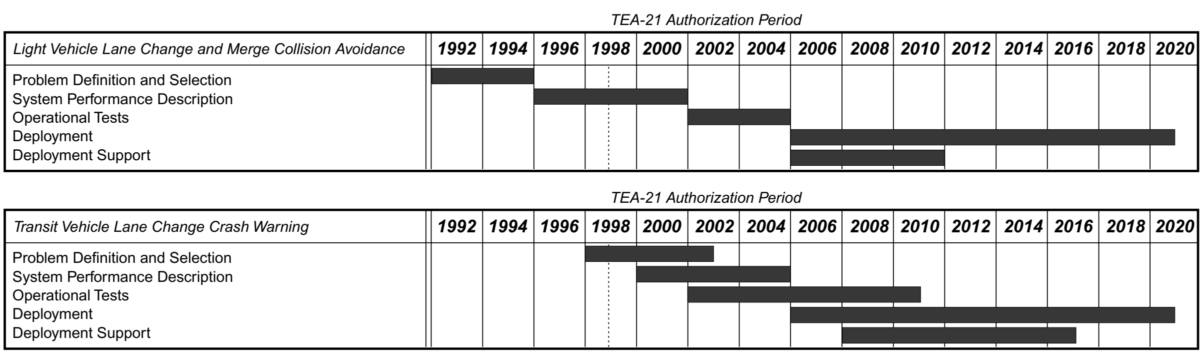


Figure III-10: Lane Change and Merge Collision Avoidance Timeline

3. Road Departure Collision Avoidance

The road departure collision category is dominated by the single-vehicle incident – where the vehicle leaves the road, but not because of a collision. In fact, one in five crashes are reported as a single-vehicle roadway departure. These crashes are the type most likely to occur at night, on high-speed roads, and with alcohol involved. NHTSA estimates that road departure collision avoidance systems could avert about 458,000 of the 1.2 million crashes each year. Figure III-11 presents the timeline for road departure collision avoidance tasks.

Systems to avoid road departure collisions will warn the driver when his or her vehicle is likely to deviate from the lane of travel. These systems track the lane or road edge and suggest safe speeds for the road ahead, and may offer a corrective steering or braking response. More advanced capabilities integrate an adaptive cruise control function to adjust vehicle speed for the shape of the road, based on input from a map data base and navigation system. Eventual cooperative communication with the highway infrastructure or use of in-vehicle sensors to assess road surface conditions (e.g., wet, icy, etc.) could also serve to adjust vehicle speed. Drowsy-driver advisory systems may be incorporated as another enhancement.

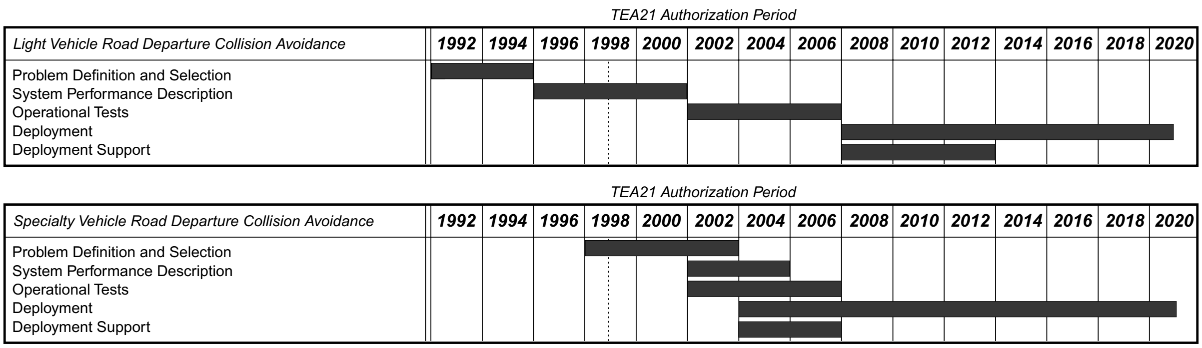


Figure III-11: Road Departure Collision Avoidance Timeline

4. Intersection Collision Avoidance

The problem of intersection collisions requires services to warn the driver when the potential for such a collision exists. These systems monitor a vehicle's speed and position relative to the intersection, along with the speed and position of other vehicles in the vicinity, advising the driver of appropriate actions to avoid a right-of-way violation or impending collision. This technology could be especially helpful to emergency vehicles.

The intersection collision problem is complex and must have infrastructure cooperation to work. While this service will be implemented first through in-vehicle systems, it will be augmented with information from map data bases and cooperative communication with the highway infrastructure. Technologies would sense the position and motion of other vehicles at intersections and determine whether they are slowing, turning, or violating right-of-way laws or traffic control devices. Figure III-12 presents the timeline for intersection collision avoidance tasks.

An analysis of 1993 General Estimates System data concluded that 29.6 percent of all crashes, or 1.8 million, were intersection/crossing path crashes. This problem area affects each of the IVI vehicle platforms. Light and specialty vehicle projects include specific attention to this problem.

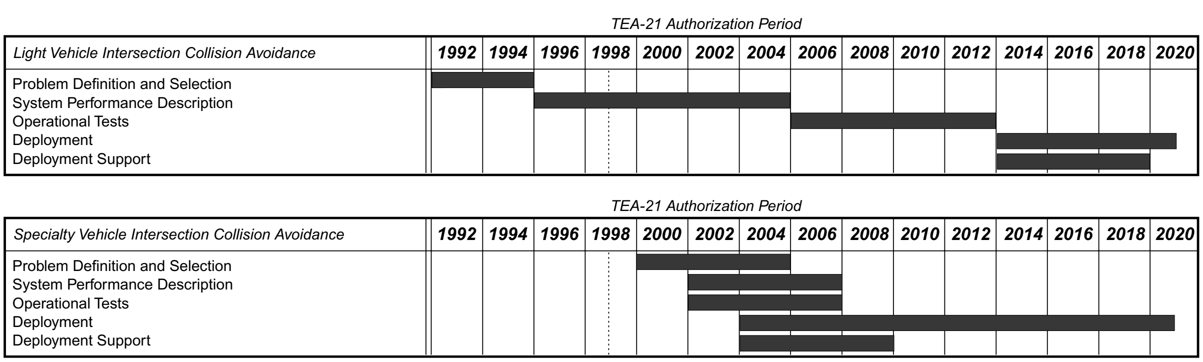


Figure III-12: Intersection Collision Avoidance Timeline

5. Vision Enhancement

Reduced visibility is a significant factor in 42 percent of all vehicle crashes and contributes to the danger inherent in any maneuver requiring a fast and accurate visual response. Reduced visibility can be caused by lighting and weather conditions such as glare, dawn, dusk, dark, artificial light, rain, sleet, snow, and fog. Figure III-13 presents the timeline for vision enhancement tasks.

Analyses suggest that of incidents having reduced visibility as a cause, one-third involve single-vehicle roadway departure crashes and one-fifth are rear-end collisions. Further, more than one-half of pedestrian incidents occur at night and include reduced visibility as a significant factor. Vision-enhancement services will likely be introduced through in-vehicle systems that use infrared radiation from pedestrians, animals, and roadside features to give drivers an enhanced view of what's ahead. Future versions may include information from highway infrastructure improvements such as infrared reflective lane-edge markings. Night vision enhancement products are already being introduced by manufacturers.

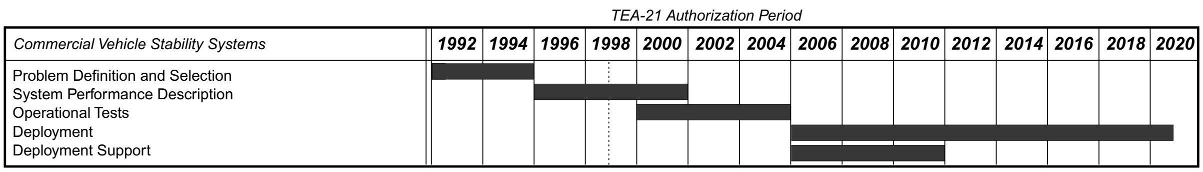


Figure III-13: Vision Enhancement Timeline

6. Vehicle Stability

This problem area requires that vehicles be equipped with systems to enhance their stability on the road. Current efforts are focused on commercial motor vehicles, as their higher centers of gravity and coupling points make them more prone to jackknifing and rolling over. Most incidents of heavy vehicle instability are triggered either by braking or rapid steering movements. Because heavy vehicle instability often results in rollover, this problem is particularly serious in terms of its potential to cause loss of life, injuries, property damage, and traffic congestion. Figure III-14 presents the timeline for vehicle stability tasks.

Two technologies are promising. The first is an in-cab device that shows the rollover threshold of the rig and advises the driver to avoid reaching or exceeding it. The second is a system for multiple-trailer combinations that will stabilize the rig by selectively applying braking at individual wheels. This system is intended to defy a phenomenon called rearward amplification, where each successive trailer has a more severe reaction to an initial steering move by the driver. For this system to work, the entire combination must be equipped with electronically controlled braking systems. Although these braking systems are now a production option from one tractor manufacturer, they are not yet offered on production trailers in the United States.

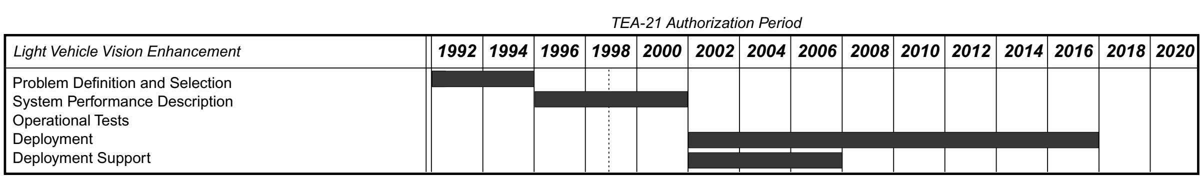


Figure III-14: Vehicle Stability Timeline

7. Driver Condition Warning

Truck driver fatigue is a factor in 3 to 6 percent of fatal crashes involving large trucks. Fatigue is also a factor in 18 percent of single-vehicle, large-truck fatal crashes, which tend to occur more frequently in the late-night, predawn hours. Commercial drivers themselves recognize fatigue and inattention as significant risk factors, having identified these conditions as priority safety issues at a 1995 Truck and Bus Safety Summit. Figure III-15 presents the timeline for driver condition warning tasks.

Driver condition warning systems alert drivers to conditions such as drowsiness. U.S. DOT is currently developing a real-time, on-board monitor that measures the degree to which eyelids cover the pupils over time, the best-known predictor of the onset of sleep. Technologies are also being used to provide overall alertness/drowsiness status through feedback mechanisms, allowing the driver to formulate better sleep habits. This service will probably be introduced first on commercial vehicles.

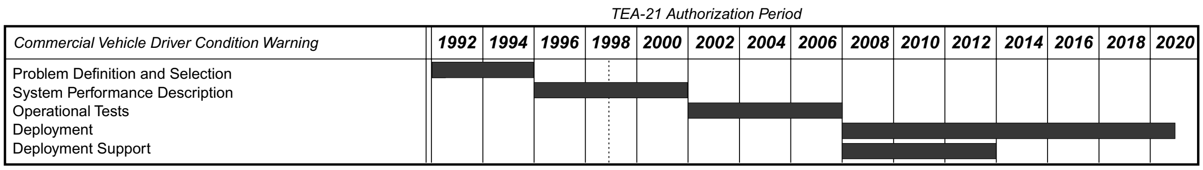


Figure III-15: Driver Condition Warning Timeline

8. Safety Impacting Services

More than 90 percent of crashes are the result of driver error. This statistic raises a concern over the effect of all the in-vehicle information systems being introduced. Of particular interest for IVI is the integration of these and other driver assistance systems and the resulting impact on the driver. These technologies can be considered safety-impacting services, in that they stand to further compound driver distraction. Examples of safety impacting services include:

- Route guidance and navigation;
- Adaptive cruise control;
- Automatic collision notification;
- Cellular telephone;
- In-vehicle computing;
- Control assistance for transit buses; and
- Vehicle diagnostics/prognostics for commercial and transit vehicles.

Where We Are Going

The ultimate objective of the IVI program is to work cooperatively with industry to advance the development and deployment of safety-enhancing intelligent vehicle technologies that address each of the identified problem areas for all vehicle platforms. Over the next 5 years, this work will be done primarily through research focused on developing in-vehicle and infrastructure-cooperative solutions.

For in-vehicle research, IVI technologies have the potential to dramatically reduce roadway crashes. However, care must be taken to ensure that the vehicle operator can safely and efficiently interact with these systems. For example, the introduction of cellular telephones and traveler information systems into the vehicle could further increase the driver's workload and may increase distraction. The IVI program address issues such as this as well as the impacts of driver assistance systems that the IVI program may introduce into the vehicle.

The program will further explore the linkages with intelligent infrastructure technologies, as research in this area promises to yield further vehicle safety enhancements. An example would be the exploration of roadway-based enhancements to crash avoidance technologies. Results from the early crash avoidance and the Automated Highway System programs indicate that in some problem areas, the necessary system performance can be achieved more effectively with cooperative vehicle-infrastructure and cooperative vehicle-vehicle systems. For example, the intersection collision problem probably cannot be completely addressed without an infrastructure-cooperative component. For this reason the role of infrastructure will be addressed in the individual problem areas, as well as from a crosscutting perspective.

How We Get There

U.S. DOT's mission is to provide leadership, expertise, resources, and information through the IVI program to continuously improve the quality of our nation's roads and the vehicles on them. U.S. DOT undertakes this mission together with all its partners to reduce crashes and the resulting injuries and fatalities. Appendix A contains a high-level roadmap for the IVI program. It illustrates the broad IVI program elements and the sequence in which these program elements will be accomplished. Under TEA-21, the following initiatives will be undertaken by U.S. DOT to meet the objectives of the IVI program.

Strengthening Public-Private Partnerships. The main goal of IVI is to improve driver safety through the development, introduction, and commercialization of driver assistance products that can reduce crashes and incidents. To achieve this goal, U.S. DOT must work cooperatively with the organizations that can help get these systems to the marketplace. In FY 1999, U.S. DOT formed a partnership with industry to mutually govern and conduct enabling research for intelligent vehicles, and will continue to foster such partnering opportunities as they arise. ITS America, serving as a Federal advisory committee, will also provide stakeholder advice. For transit vehicles, key partnerships with fleet operators will be necessary as well.

Multiple Platforms. The inclusion of the four individual platforms will allow U.S. DOT to expedite the commercial availability of driver assistance systems across all platform types. Although the largest problem area is in light vehicles, U.S. DOT will be able to conduct field tests and quantify the benefits of some systems in the other platform areas before they are ready to be tested on light vehicles. This will provide U.S. DOT a better understanding of the benefits and give guidance on where best to conduct future research.

Encouraging Cooperative Infrastructure. To date, research on crash avoidance systems has focused almost exclusively on in-vehicle systems. Although autonomous in-vehicle systems are easy to deploy, the required system performance for some problem areas can only be achieved through cooperative systems. For this reason, the IVI program will address the role of infrastructure from an individual problem area viewpoint as well as from a cross-cutting perspective.

Evaluating Multiple System Integration. The IVI will address the potential impact, both positive and negative, of integrating multiple systems that provide IVI services. The impact on driver workload from multiple systems competing for the driver's attention will be studied. The potential benefits from combining multiple services also will be studied. For example, a digital map data base could be designed to perform the necessary functions for a roadway departure system as well as an intersection collision avoidance system.

Developing Generations of Vehicles. The IVI will focus on developing generations of vehicles with increasing capabilities. In a single generation, each platform will have different levels of capabilities based on its unique operating environment. Over time, each vehicle platform will increase its capabilities to higher levels. As generations advance, the role of vehicle-to-infrastructure cooperation is expected to increase in importance, as is that of system capability. The focus in each generation will be to evaluate the benefits, technical capabilities, and user acceptance of in-vehicle and cooperative systems. Thus, the generation process provides most of the important IVI milestones, where each vehicle generation will serve as a benchmark from which to measure the progress of U.S. DOT's research investment and the qualifying factors for achieving the next generation of vehicles. To support this effort, U.S. DOT will develop standard measures and objective test procedures, and incorporate ongoing peer review into the IVI program.

In 1999, "Generation Zero" operational tests will be initiated across all four platforms to assess the technical performance, determine user acceptance, and measure the benefits of driver assistance systems that are expected to enter production preparation between 2000 and 2003. U.S. DOT expects to generate preliminary performance specifications in FY 2000 that define key elements of Generation Zero technologies. Generation Zero products will begin to be delivered in FY 2000, and development of Generation One technologies will begin. Generations One and Two are expected to address systems with more advanced capabilities, higher levels of integration, and increased infrastructure cooperation. Each generation will culminate in multi-platform field tests, which will objectively evaluate improvements in safety and driver performance resulting from the introduction of intelligent vehicle systems. Generation One technologies will begin to be tested in 2001, and are expected to be ready for use beginning in 2003.

Addressing Human Factors. Recognizing the importance of human factors to the success of IVI, U.S. DOT will initiate research to ensure that individual services provide drivers with appropriate information that they can efficiently process and to which they can safely react. Human factors research will help to flag potentially troublesome issues related to making warning systems commercially available. Critical human factors research issues include how IVI services relate either to one another or to equipment already on the vehicle, in terms of the driver's ability to handle the new services. Once services become commercially available, human factors research is needed to examine driver response and adaptation, as well as unintended safety consequences.

Facilitating Peer Review. In FY 1999, U.S. DOT engaged the Transportation Research Board to conduct an ongoing, multiyear review of the IVI. A standing committee was established to annually review the goals, program design and operation, strategic plan, and individual program elements of the IVI program. Eventually, the focus will shift to review of individual partnerships, evaluation of program operations, and progress on achieving program goals. The committee is composed of subject experts in public and private sector R&D, motor vehicles, and sensing, computer, and telecommunications technologies.

The IVI program will operate under the guidance of a public and private sector working group, and will be jointly managed within U.S. DOT by FHWA, FMCSA, FTA, and NHTSA. Guidance and direction also will be sought from all stakeholders not represented in the working group.

A product of common goals and shared best interests, the IVI program will help U.S. DOT fulfill its mission of improving our nation's transportation system by offering near-term benefits of crash reduction and transport efficiency. By facilitating the deployment of vehicle-related safety and mobility-enhancing products and systems to accelerate their market availability, IVI is creating a safer and more efficient transportation system for all.

Milestones for Conducting Research

1999	Initiate peer review by the Transportation Research Board.
	Form a public/private partnership with industry to mutually govern and conduct enabling research for intelligent vehicles.
	Initiate Generation Zero operational tests in four platforms.
2000	Complete Generation Zero preliminary performance specifications.
	Begin delivery of Generation Zero technologies.
	Initiate development of Generation One technologies.
2001	Complete Generation Zero operational tests.
	Initiate Generation One operational tests in four platforms.
2002	Conduct Generation One operational tests in four platforms.
2003	Begin delivery of Generation One technologies.

IV. THE NATIONAL ITS ARCHITECTURE AND ITS STANDARDS

Transportation professionals must take a "systems approach" to planning, implementation, and operations in order to ensure that the full effectiveness of ITS technologies will be realized, with individual deployments connected to a meaningful network. This approach emphasizes collaboration among affected parties and compatibility across jurisdictions. Systems must be compatible, or interoperable, at many levels to operate effectively. Systems interoperability can be achieved at three levels – technical, institutional, and procedural. However, national, regional, and local users must determine the appropriate level of interoperability for any application. ITS America has recently formed an interoperability subcommittee within its standards and protocols committee to address these issues. U.S. DOT will ensure a close link with the ITS America subcommittee to identify areas where interoperability is key, to help understand the multiple issues involved in achieving that interoperability, and to ensure that the user community is aware of the issues involved.

U.S. DOT's National ITS Architecture and ITS standards are aimed at facilitating *technical interoperability*, the capability of the hardware and software elements to communicate. The National ITS Architecture provides the framework, supporting analysis, implementation strategy, and detailed requirements essential to guide the standards development process. It also provides state and local transportation officials with a tool to facilitate ITS integration in their area. ITS standards, in conjunction with the National ITS Architecture, ensure that the framework interfaces enable nationally compatible intelligent transportation systems.

Institutional interoperability involves the resolution of a variety of institutional issues that will assure the administrative interoperability of ITS services. For example, suppose that all electronic toll collection activities used identical technologies. Even so, a motorist could not use a toll tag issued by one agency to pay tolls to another agency unless the agencies agreed to serve as each other's collection agents and to transfer funds to one another. Thus, agreements would need to be negotiated among organizations to overcome these issues to achieve institutional interoperability.

Procedural interoperability is the adoption of common procedures to allow the meaningful exchange of information. These serve to define the expected quality characteristics for data, devices, and systems. While the general need for such performance measures is clear, it is too early to be able to define or create them at present. Performance requirements such as speed, accuracy, and reliability will be revealed in future years as real-world experience with ITS products and services grows.

THE NATIONAL ITS ARCHITECTURE

The full potential of ITS is realized through a "systems architecture" which guides the coordinated deployment of ITS by public agencies and private organizations alike and ensures their integration. The National ITS Architecture is a framework that defines the functions performed by ITS components and the various ways in which components can be interconnected. The National ITS Architecture does not represent a particular design or ITS construction. Rather, it provides a starting point from which stakeholders can work together to make the vision of a unified, integrated ITS for their region a reality. Although the architecture is national in scope, it benefits state and local agencies by helping them to save planning time, save implementation costs, and achieve maximum benefits through the implementation of an integrated intelligent transportation system.

The National ITS Architecture is technically sound, flexible enough to be adapted by jurisdictions of all sizes, and has been broadly received across the country. It helps public agencies identify potential ITS applications and deployment opportunities for addressing local needs in the context of institutional constraints. For example, it helps stakeholders become aware of options to consider when making ITS choices. In some cases, the architecture tools provide insights into potential synergies between systems. The National ITS Architecture is also a source of information for creating and enhancing institutional relationships within a region. It identifies institutional linkages and emphasizes potential information exchange and activity coordination that can improve efficiency and performance.

Thus, the National ITS Architecture is a useful tool in supporting planning and project development activities, particularly where integration is the objective. It has been developed to enable and guide – not mandate – consistency among investors, purchasers, producers, and users in order to reduce the risk of incompatibility. The specific technologies and institutional arrangements used in any particular deployment are left to the discretion of the individual agencies and organizations involved. The National ITS Architecture allows agencies to design projects and deployment approaches for meeting near-term needs while keeping options open for eventual system expansion and integration.

Where We Are

The National ITS Architecture now covers 31 user services, and is being kept up-to-date through the incorporation of input from deployment programs throughout the country, as well as from emerging ITS standards. The architecture is available on both the Internet and CD-ROM for broad distribution. Version 2.0, incorporating approximately 100 changes and significant usability improvements, was released in September 1998. Two training courses, one focused on the private sector and one on the public sector, were developed and delivered to more than 1,800 stakeholders around the country by September 1999. The training pace has quickened as the transportation community addresses the TEA-21 requirement for conformity with the National ITS Architecture. This educational process has been vital to enabling planners to use the architecture as a tool and in facilitating its acceptance within the community.

The National ITS Architecture played a key role in the Metropolitan Model Deployment Initiative sites funded under ISTEA. The four sites used the National ITS Architecture to develop their regional architectures that link new deployments and legacy systems. These sites are demonstrating the benefits of integrated applications for managing traffic and transit, coordinating emergency services, and providing real-time transportation information to travelers, while showing the flexibility of the Architecture in being tailored to meet local needs. The sites are serving as models for other metropolitan areas to use in developing integrated ITS programs.

Where We Are Going

The goal of the National ITS Architecture program is to provide a framework that will enable a seamless, nationwide transportation system that can meet local stakeholder needs. Over the next 5 years, the National ITS Architecture will continue to be the cornerstone for integrated ITS deployments. Linkages with other program areas must be maintained to ensure consistency, continuity, and a clear message to industry and public sector partners. U.S. DOT will continue to ensure that the National ITS Architecture responds to the changing needs of the National ITS Program and the ITS industry by keeping it robust, up-to-date, and relevant. Infrastructure deployment support is essential and will remain a significant element of the U.S. DOT program.

How We Get There

Over the next 5 years, the National ITS Architecture will continue to be expanded and refined. ITS applications will continue to emerge as advances in data processing and data communications open up new possibilities for system integration; the National ITS Architecture needs to respond to these advances. For example, a new archived data user service was recently approved and was integrated into the National ITS Architecture in September 1999, bringing the number of user services covered to a total of 31. (Full descriptions of this user service and the previously added highway-rail intersection user service are included in Appendix C.) User services and user service requirements also are being examined to ensure rural ITS applications are fully addressed, which may lead to the identification of additional user services and/or requirements in FY 2000. Intermodal freight, weather, and emergency and incident management are other areas where stakeholders see a possible need for architecture modifications or enhancements. In addition, the Intelligent Vehicle Initiative will likely require an open interface to the ITS infrastructure, implying corresponding changes to the National ITS Architecture. As changes are added to the Architecture, U.S. DOT will make changes available quickly to users over the Internet, and will periodically release versions on CD-ROM. In December 1999, Version 3.0 of the Architecture was released. In FY 2000, Version 4.0 will be released; it will contain new rural services and requirements as well as any other changes. Additional CD-ROMs will be released in later years as appropriate.

As ITS deployment support for metropolitan, rural, and statewide infrastructures has become more of a focus of the National ITS Program, U.S. DOT is continuing to conduct Architecture training courses in FY 1999 and 2000, focused on both the public and private sector, and taught in nearly every state in the country. A software tool called "Turbo Architecture" has been developed by U.S. DOT and is available. Intended principally for public-sector transportation professionals at state, region, and metropolitan planning organization levels, it will find use within the private sector, and is planned to be a user-friendly tool to assist in the development of regional ITS architectures that are consistent with the National ITS Architecture. U.S. DOT will maintain this tool in FY 2000 and beyond. Finally, U.S. DOT has developed a program of training workshops targeted first at the Federal field staff, but migrating to states, regions, and metropolitan planning organizations to facilitate their regional and project architecture and deployment efforts. This detailed deployment support was initiated in FY 1999 and will continue through 2003.

Thus, over the next 5 years, U.S. DOT will use the National ITS Architecture to support integrated ITS deployment, will incorporate integrating new user services and requirements into the National ITS Architecture, will train transportation professionals in the use of the Architecture, and will support the development of ITS standards.

Milestones for the National ITS Architecture

1999	Release Version 3.0 of the National ITS Architecture.
	Provide detailed deployment support to regional, state, or metropolitan planning organization efforts.
	Continue intensive public and private sector architecture training courses targeted to include representatives from all 52 FHWA divisions, the four resource centers, 10 FTA regions, state DOTs, and U.S. DOT headquarters.
	Develop the "Turbo Architecture" software tool.
2000	Integrate new rural service(s) into the National ITS Architecture.
	Release version 4.0 of the National ITS Architecture with new rural service(s) and requirements as well as other Architecture refinements and modifications.
	Provide detailed deployment support to an increasing number of region, state, or metropolitan planning organization efforts.
	Maintain the "Turbo Architecture" software tool and distribute to all FTA regions and FHWA divisions.
	Continue public and private sector architecture training courses based on demand. Include the "Turbo Architecture" software tool in the architecture training course curriculum.
2001-2003	Provide detailed deployment support to an increasing number of region, state, or metropolitan planning organization efforts.
	Maintain the "Turbo Architecture" software tool and distribute to Federal field staff.
	Release updated versions of the National ITS Architecture with refinements as necessary.
	Integrate new user services addressing weather and intermodal freight, if desired by stakeholders, into the National ITS Architecture.

ITS STANDARDS

Since the inception of the ITS Program under ISTEA, stakeholders have recognized the need for ITS standards to achieve technical interoperability. Without technical standards, state and local governments, as well as consumers, risk buying products that do not necessarily work together or work consistently in different parts of the country. U.S. DOT is facilitating the creation of technical standards to minimize public sector risk in procuring these products.

Standards and protocols define how system components interconnect and interact within an overall framework known as an architecture. Standards specify how various technologies, products, and components must perform when used in combination or interchanged. For example, standards enable telephone systems in various countries to transmit and receive voice signals. Protocols define how data are to be exchanged, and cover specific data issues such as which messages have priority over each other.

Standards are "open" if published for use on a nondiscriminatory, competitively neutral basis, thereby enabling open competition among interchangeable products. Use of open standards prevents agencies from being limited to using a particular vendor for upgrades and enhancements. Open television standards, for example, allow television sets with different capabilities, made by many different manufacturers over the last 50 years, to use common broadcast signals. In the ITS industry, adherence to ITS standards will enable travelers to access ITS services, such as travel conditions, as they travel by car or transit between cities or across borders, without requiring separate devices as they travel. Such compatibility and interoperability among agencies, jurisdictions, and states is key to promoting an effective ITS market.

Highlighting a need for technical compatibility, TEA-21 requires U.S. DOT to "identify activities that provide for the dynamic development of standards and protocols to promote and ensure interoperability in the implementation of intelligent transportation system technologies, including actions taken to establish critical standards." Because standards are so important, the ITS standards program is described in great detail in this chapter. However, ITS standards are inextricably linked with the National ITS Architecture. When employed together, the National ITS Architecture and ITS standards are powerful tools that facilitate integration and assist areas in achieving systems interoperability.

Where We Are

Over the past several years, U.S. DOT has funded existing standards development organizations[7] (SDOs), in conjunction with industry volunteer support, to accelerate the traditional consensus-based process used to develop standards. This process has been successful; ITS standards development has proceeded faster than normal. Approved standards are entering a process of testing and, as more standards emerge from the SDO process, testing efforts will increase. Thus, the ITS standards program has begun to shift in focus under TEA-21 from development to deployment of ITS standards.

In 1996, standards development organizations were charged with accelerating the development of ITS standards based on interfaces defined in the National ITS Architecture. These standards, known as "Phase I" standards, are needed to support implementation of the 29 ITS user services that formed the original basis of the National ITS Architecture. At the beginning of this effort, the ITS community deemed 80 standards to be of most immediate need and encouraged accelerated development, while other standards were deferred for development at a later date. At present, 20 of the initial group of standards have been published, 6 are endorsed, 24 are currently being balloted, and the remaining 30 are under development and progressing quickly to ballot by the responsible SDOs.

[7] Standards development organizations coordinate the development of ITS standards through individual consensus-based procedures for designing, internally assessing, adopting, and publishing standards for use. Several standards development organizations have been involved in the development of ITS standards to date – American Association of State Highway and Transportation Officials, Institute of Transportation Engineers, American National Standards Institute, American Society for Testing and Materials, Consumer Electronics Manufacturers Association, National Electrical Manufacturers Association, Institute for Electrical and Electronic Engineers, and Society of Automotive Engineers. Additional standards development organizations may be used in the future, as appropriate.

Milestone charts for all Phase I standards currently under development are included in Appendix B; this information is updated regularly and can be found on U.S. DOT's ITS web site at *www.its.dot.gov.* Development of the remainder of the standards identified with the baseline architecture in 1996 began in 1999. This includes those standards that were deferred, as well as any necessary expansions to Phase I standards that have already been developed.

Where We Are Going

The overall goal of the ITS standards program is to have a comprehensive set of ITS standards developed and routinely used by states and localities to deploy integrated, intermodal systems. Over the next 5 years, U.S. DOT expects that all ITS standards initially identified in the National ITS Architecture will be developed, and that the ITS standards program will include increased attention to the issues associated with implementation. Critical standards for ITS have been identified, and their development will be actively monitored.

How We Get There

U.S. DOT will focus its efforts in five program tracks: development, testing, outreach and education, technical assistance, and policy support. While all five tracks are important to the program, the primary focus will be on testing and outreach. By applying significant resources in those two areas, U.S. DOT will ensure that standards are mature enough for implementation prior to requiring their use, and that the user community understands the benefits of using them. The descriptions below of the five program tracks include a brief explanation of how U.S. DOT will ensure a dynamic process for standards in each area, specific activities to be undertaken by U.S. DOT and its partners, and expected milestones under TEA-21.

The dynamic process presented illustrates how U.S. DOT will be involved with a standard or group of standards through its lifecycle. The lifecycle can be seen as three distinct stages: development, evaluation and demonstration, and deployment. Development includes the technical work needed to create and publish a standard for initial use. The evaluation and demonstration stage involves proving a standard in practice. Deployment is undertaken once standards are proved through testing and can be promoted for widespread use in the development of commercial products and the implementation of public sector ITS infrastructure. The role of the U.S. DOT in each of these three stages will be described in each section.

Development

U.S. DOT relies on established standards development organizations to ensure that a vigorous process is in place for developing, refining, and updating ITS standards. Development involves an iterative process throughout the life of any standard. While the majority of the work done by standards development organizations occurs in the development stage, standards must also be refined and updated based on their real-world application. For this reason, there must be a strong linkage between development and testing activities, and solid feedback mechanisms in place with the SDOs during all three stages of a standard's lifecycle. The standard development lifecycle is illustrated on Figure IV-1.

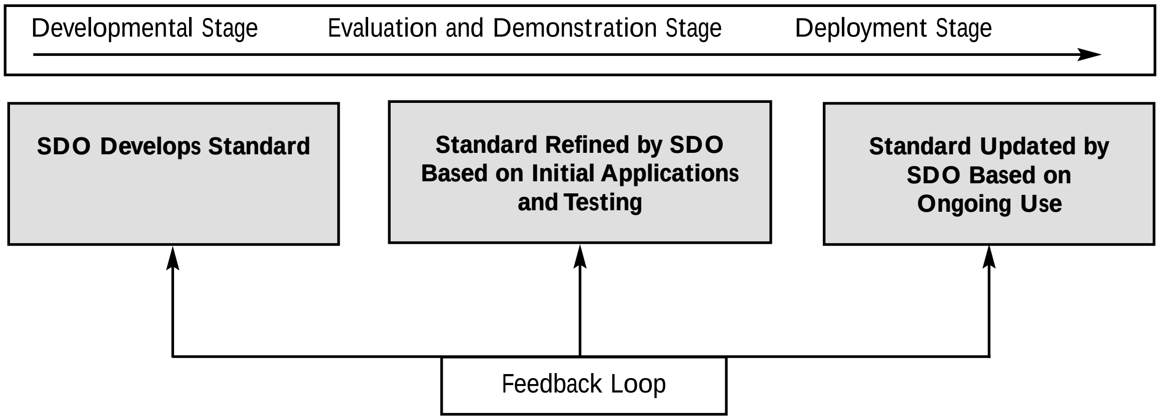


Figure IV-1: Standards Development Lifecycle

Under TEA-21, U.S. DOT will complete the development of the most important Phase I standards, initiate development of remaining Phase I standards, and expand development into Phase II standards. As the National ITS Architecture continues to expand into such areas as intelligent vehicles, data services, emergency services, and rural ITS applications, new standards may be required. For example, the need for standards for highway-rail intersection and archived data user services is currently being assessed. Standards in these areas are the first standards developed beyond the initial Phase I standards, and are grouped as "Phase II" standards. Development of Phase II standards began in 1999, with additional standards being added through 2003, and possibly beyond. Milestones for development under TEA-21 are listed below.

Milestones for Development

1999	Complete development (i.e., a final draft) of the most important Phase I standards – 70 standards to ballot or beyond.
	Initiate development of remaining Phase I standards.
	Initiate development of Phase II standards.
2000	Identify needs for rural ITS applications.
2001	Identify needs for intelligent vehicle applications.
2002-2003	Continue development of Phase I and II standards, as needed.

Testing

Once developed and published for use by an SDO, newly created ITS standards must be proved in practice to the satisfaction of intended users. Testing is an essential part of achieving this goal. To be successful, standards testing must involve cooperation among U.S. DOT, the standards development organizations, industry, and the user community. Industry must be engaged to develop products for use in testing. Even as standards are in development, industry is likely to develop prototype products that use the new standards. The SDOs are likely to validate and verify standards based on these prototype products before the standard is balloted. Once a standard is approved by the standards development organization, more rigorous testing of the standard will be initiated on industry-developed prototype products to see how the standard works in a real-world setting. The user community must be engaged at this time in defining testing and readiness criteria for each standard.

As standards are tested, U.S. DOT will assess the results in consultation with intended users. Once standards are ready for deployment, U.S. DOT will encourage the voluntary use of these standards, monitor deployment of the standards at the state and local levels, and initiate a rulemaking to require the use of proven standards in Federally funded ITS projects. Acceptance and certification testing will be needed at this point, so users can be assured that the products they purchase from vendors do in fact adhere to the specifications of the standard. U.S. DOT will not be directly involved in certification, but will work with industry to ensure that a process is in place to facilitate the establishment of appropriate certification criteria.

Feedback is an integral part of the testing effort. It is recognized that some standards may need to be modified by standards development organizations as information is gained about their real-world performance. The need for feedback will necessitate an interactive link between the standards development organizations and the testing process. This process is illustrated on Figure IV-2.

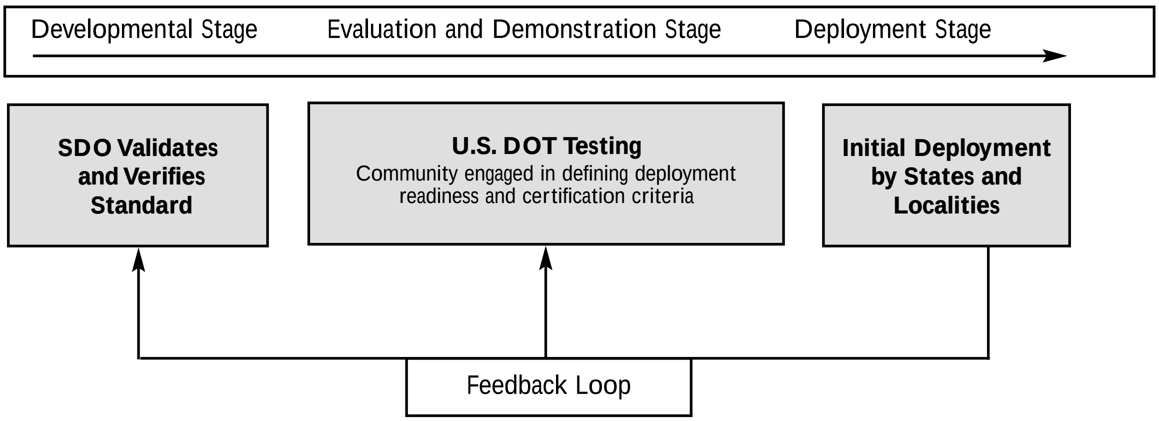


Figure IV-2: Standards Testing Lifecycle

U.S. DOT has just begun to undertake a comprehensive program to test the ITS standards now emerging from the standards development process. Testing will be conducted as part of pioneering public sector deployments to provide timely and meaningful information on standards performance to the ITS community. Through testing and widespread distribution of results, ITS standards will “mature” more quickly, thereby leading to their earlier acceptance by intended users.

U.S. DOT intends to leverage ongoing and planned ITS field deployments and to test standards in logical clusters. Where necessary, laboratory simulation testing or testing in a special purpose test bed also may be performed. Over the next 5 years, U.S. DOT will develop test plans, identify sites, conduct tests, analyze results, and disseminate information to the user community. U.S. DOT also will actively monitor the use of ITS standards in deployment. It is likely that standards testing will continue beyond the period covered by TEA-21. Specific testing milestones are listed below.

Milestones for Testing

1999-2000	Develop test plans.
	Identify sites and develop memoranda of understanding.
2000-2003	Conduct testing.
	Analyze and report results.
	Disseminate results.

Outreach and Education

The ITS standards program has initiated a multifaceted outreach and education effort to ensure that public agencies and private sector stakeholders involved in ITS deployment are aware of the availability and importance of using ITS standards. The overall strategy has three parts: nontechnical outreach, technical outreach, and training and education.

Nontechnical outreach is designed to present transportation stakeholders with the "business case" for using ITS standards. Agencies planning to use Federal funds to implement ITS projects need to understand why, when, and how to implement integrated ITS projects using standards. Nontechnical outreach will be initiated to inform policy-level planning and project decision makers, who have modest technical involvement, of the benefits of using ITS standards. This audience is important since these executives have a central role in creating policies, justifying budgets, and setting expectations that encourage ITS standards to be adopted and used throughout their organization in all plans and projects.

Technical outreach is aimed at technical staff involved in project development and implementation. Educational materials, such as fact sheets, user guides, sample procurement specifications, and lessons learned will be produced and developed for each ITS standard. U.S. DOT is working with standards development organizations to coordinate the development and distribution of this information. A key method of delivery will be through the ITS standards page on the U.S. DOT ITS web site, *www.its.dot.gov*.

Standards development organizations and U.S. DOT will work together to assess outreach and education needs for specific standards as standards approach publication. The relevant standards development organization will compile technical materials to accompany the publishing of the standard. These materials will serve as the earliest form of standard-specific outreach. Specific outreach and education needs will be incorporated into technical and nontechnical outreach as necessary, and standards course modules will be updated as appropriate. During the implementation stage, benefits of deployment and lessons learned will be disseminated to relevant audiences, and training courses will be delivered. This process is depicted on Figure IV-3.

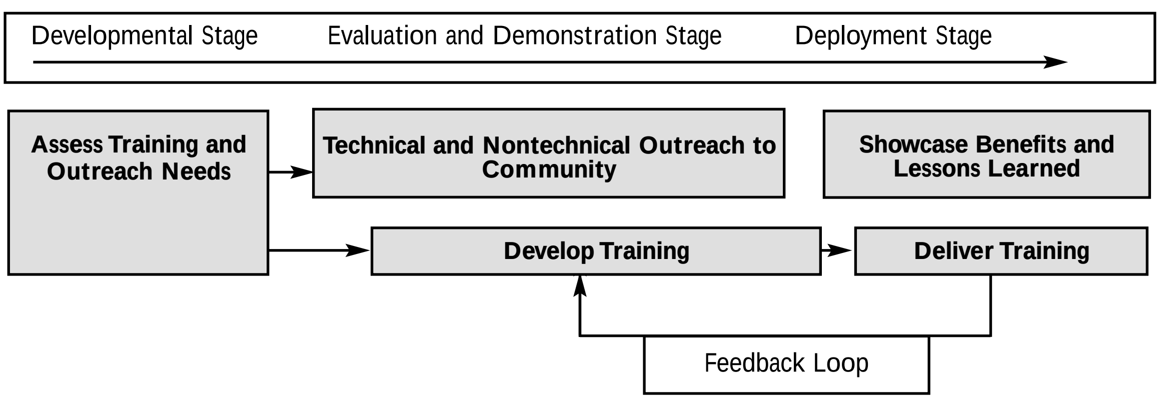


Figure IV-3: Standards Outreach and Education Lifecycle

U.S. DOT will deliver training and education mainly by updating and revising professional capacity building courses currently in existence. Standards modules within these courses will be modified as new standards are approved by standards development organizations and testing begins. Most training will be conducted through existing courses, but specific courses on topics such as NTCIP and TCIP are being developed, due to the widespread impact of these key communication standards on public sector ITS applications. In addition, Federal field staff will need specialized training to become stewards of the ITS standards program. They are the primary connection to state and local areas seeking to implement ITS standards. Specific milestones under TEA-21 follow.

Milestones for Outreach and Education	
1999	Develop technical outreach materials.
	Enhance the ITS standards web site.
	Initiate nontechnical outreach campaign.
	Deliver NTCIP training course.
	Initiate TCIP training course development.
2000	Complete TCIP training course development and conduct course.
	Incorporate standards modules into existing courses, emphasizing lessons learned from testing.
2000-2003	Provide technical outreach materials, web site information, nontechnical outreach and training courses for each family of standards as needed.
	Develop and deliver ITS standards modules as needed.

Technical Assistance

In addition to the documentation materials provided by the SDOs, there is a need for advanced technical support to help users through both early standards implementation and widespread general use. Technical assistance will be provided to help implementing agencies deal with the transition from legacy systems to systems that are compliant with ITS standards. Technical assistance will be an ongoing activity that will occur through TEA-21 and beyond. It is available to states and localities through the standards development organizations, Federal field staff, and the Peer-to-Peer Network.

During the developmental stage in the life of a specific standard, SDOs will be the primary providers of technical support. As standards are published, these organizations will help interpret the developing standards for prototype applications. During the evaluation and demonstration phase, the standards development organizations will continue to provide assistance. In addition, U.S. DOT will work with areas to identify site-specific technical assistance needs, and will develop additional materials to meet those needs. Once a standard is ready for deployment, U.S. DOT will provide more widespread technical assistance to the user community. This will be delivered primarily though on-demand peer support. Federal field staff, U.S. DOT technical experts, members of standards development organizations, and the Peer-to-Peer Network will provide this service to areas. In addition, Federal field staff will use ITS service plans to coordinate assistance to state and local areas. Through these activities, the standards program will assist users in the migration to ITS standards.

As an ongoing activity, technical assistance will involve an iterative process of identifying needs and the appropriate mechanisms for delivery. Therefore, feedback will be particularly important, as technical assistance will need to evolve to meet the changing needs of users. This process is shown on Figure IV-4.

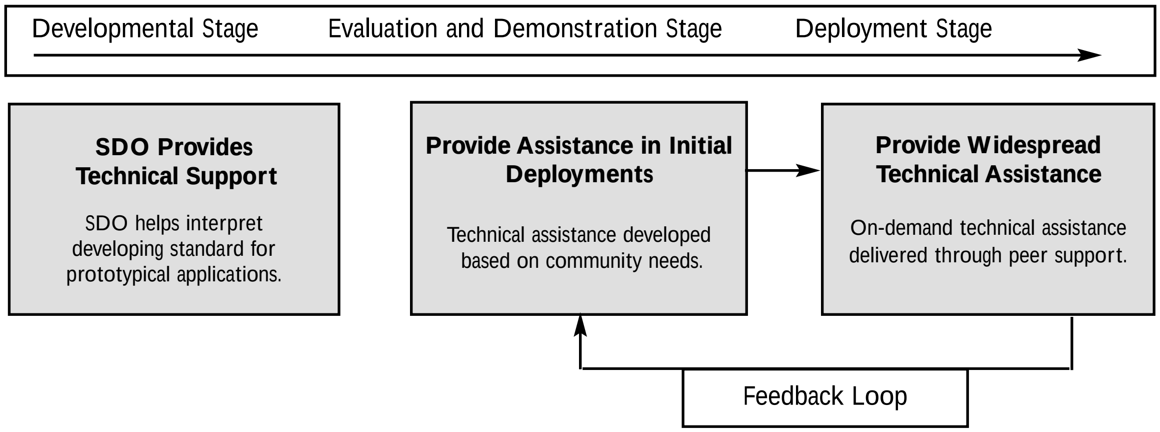


Figure IV-4: Standards Technical Assistance Lifecycle

Milestones for Technical Assistance

1999-2003	Identify technical support needs.
	Deliver technical assistance to state and local partners.
	Incorporate standards technical assistance needs into ITS service plans.

Policy Support

U.S. DOT expects to provide ongoing policy support to assist with implementation of TEA-21 standards requirements. Two key policy areas will be the focus of this effort: critical standards and conformance with ITS standards. These are separate and distinct issues.

Critical standards. TEA-21 required the Secretary of Transportation to identify by June 1, 1999 "which standards are critical to ensuring national interoperability or critical to the development of other standards." Standards designated as "critical" under the criteria of TEA-21 represent two types of ITS standards – national and foundation standards. National standards are standards that enable national interoperability in circumstances where available ITS services may be accessed by large numbers of users, such as people traveling from state to state. Foundation standards are needed for the development of other ITS standards.

U.S. DOT engaged the ITS user community to help identify critical ITS standards. Using the above criteria, stakeholders came to agreement on the designation of 17 standards as critical. This designation allows the Secretary of Transportation to invoke a provisional standard for any critical standard not published by a standards development organization by January 1, 2001.[8] There is a waiver option available, but U.S. DOT anticipates that all 17 critical standards will be approved and published by that time.

Designation as critical does not mean that a standard is automatically required for immediate use in Federally funded ITS projects, or that it is inherently more important than those not identified as critical. For example, there are important standards for public transit, commercial vehicle operations, and vehicle safety that are not critical to national interoperability.

[8] Section 5206 of TEA-21 permits the Secretary of Transportation to invoke provisional standards at any time for any ITS standard under development. The legislation goes on to require the Secretary to establish a provisional standard for each critical standard not adopted and published by the appropriate SDO by January 1, 2001.

ITS standards conformity. TEA-21 requires that ITS projects carried out using funds made available from the Highway Trust Fund conform to the National ITS Architecture, applicable standards or provisional standards, and protocols. The issue of conformity with standards is separate and distinct from the issue of critical standards. This policy applies to all ITS standards, whether critical or not. Interim guidance on this subject was issued in October 1998; final guidance will be prepared through the rulemaking process for anticipated release in 2001.

U.S. DOT intends for a standard to go through a rigorous process of real-world evaluation before being formally adopted by U.S. DOT for use in Federally funded ITS projects. Significant resources are being applied to ensure that standards are mature enough for implementation prior to adoption. Once a standard has gone through sufficient evaluation and testing, U.S. DOT will then initiate a process of adopting the standard through rulemaking. This process may take 1 year or more to complete and includes ample opportunity for public comment. Standards may be submitted for rulemaking as individual items or in groups. Once complete, a standard or group of standards will be formally adopted by U.S. DOT, and the conformity requirement will apply. Until ITS standards have gone through this process, U.S. DOT will strongly encourage the use of approved and tested standards in deployment. The lifecycle of policy support is shown on Figure IV-5.

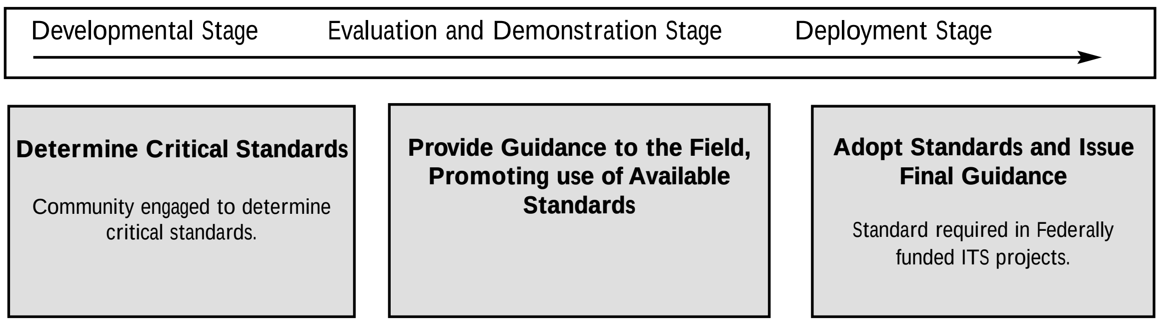


Figure IV-5: Standards Policy Support Lifecycle

Milestones for Policy Support

1999	Report to Congress on critical standards.
	Issue interim guidance on conformity with ITS standards.
2000	Notice of Proposed Rulemaking on conformity policy.
	Secretary of Transportation may issue provisional standards for critical standards still under development.
2001	Rulemaking on conformity policy.
2000-2003	Official adoption of ITS standards through rulemaking as appropriate.
	Ongoing support to Federal field staff.

These five elements – development, testing, outreach and education, technical assistance, and policy support – provide a dynamic process by which U.S. DOT will help ensure widespread implementation of ITS standards. These standards, in combination with the National ITS Architecture, will help achieve integration of ITS services.

V. EMERGING PROGRAM ACTIVITIES

The National ITS Program will continue to evolve in order to meet the changing needs of the transportation community. Five program activities, responding to newly identified user needs, have emerged since the 1995 National ITS Program Plan was published: intermodal freight, ITS data archiving, rail transit, pedestrian and bicycle safety, and accessibility. Each is described in detail in this chapter.

INTERMODAL FREIGHT

To maximize the capacity of the nation's transportation infrastructure, it is important to plan and manage transportation assets as a single intermodal system. This is especially vital given the rapid growth of the intermodal freight business. Between 1985 and 1995, the number of intermodal containers moving through ports worldwide doubled. In the next two decades, the volume of marine trade is expected to triple. Intermodal freight moved by truck has grown comparably with the increase in volumes via maritime, air, and rail modes, and is expected to keep pace. These increased volumes of intermodal freight movement will have a severe impact on the nation's highways, rail lines, waterways, and ports of entry.

Advanced information and communications technologies applied across the intermodal system offer important opportunities to strengthen the links between the separate modal systems, which are currently run as competing options with minimal cooperation between one another. U.S. DOT's Intermodal Freight Program is laying the groundwork to utilize ITS technology to help the public and private sectors bridge the modal interfaces within the nation, and at the borders with Canada and Mexico. The end goal of the Intermodal Freight Program is to provide safer, more reliable, and more efficient intermodal freight mobility over the nation's surface and maritime infrastructure. Better mobility will benefit both metropolitan communities and the freight community, while also contributing to U.S. DOT's strategic goals of mitigating congestion, enhancing economic performance, and ensuring national security.

In support of the Intermodal Freight Program's goal to facilitate goods movements across our borders, FHWA's International Border Clearance program is providing an important link to trading partners in the north and south. In 1997 and 1998, FHWA conducted field operational tests at seven sites – five on the Canadian border and two on the Mexican border. The purpose of these tests was to examine the feasibility of using ITS technology to expedite the processing of safety information at international border crossings. These tests were carried out in cooperation with the Department of Treasury, U.S. Customs Service, the Immigration and Naturalization Service, and our Canadian and Mexican partners.

Under TEA-21, U.S. DOT will advance intermodal freight research by leveraging the technology and lessons learned from ITS operational tests and the metropolitan and CVISN model deployments. The hallmark of the ITS Program is linking "stove piped" legacy information systems together to benefit the community at large. Linking information systems between the modes to provide an end-to-end information flow is expected to enhance, and make more efficient, the movement of freight through highly congested areas.

U.S. DOT believes that sharing information through systems linked by Electronic Data Interchange standards can facilitate movements of intermodal freight by identifying and bypassing transportation bottlenecks at ports and on highways, and by eliminating stops for vehicle and cargo documentation that increase operating costs and contribute to congestion. This belief has been substantiated by input from the intermodal freight community. Over the past several years, U.S. DOT has sponsored numerous studies, conferences, and outreach initiatives on intermodal issues. A consistent message has been that a transportation system's physical infrastructure must be effectively complemented by a data communications infrastructure if the system is to operate at its highest potential. Whether for transportation movements in general, or intermodal movements in particular, real-time data communications give transportation managers and vehicle drivers a chance to quickly respond to system delays or new demands.

During fiscal years 1999 and 2000, FHWA will conduct two field operational tests in cooperation with the U.S. Customs Service, to expedite the processing of U.S. DOT safety clearance concurrent with Customs' clearance through the National Customs Automation Program. The tests are taking place at the Ambassador Bridge in Detroit, Michigan, and the Columbia-Solidarity Bridge in Laredo, Texas. Further, the Corridor and Borders program, established by TEA-21, is providing the opportunity to deploy ITS applications to borders and corridors to expedite freight flows.

FHWA border and corridor activities also include participating with the North American Free Trade Agreement (NAFTA) Land Transportation Standards Subcommittee and the Transportation Consultative Group on Science and Technology to conduct joint technology tests at border crossings. The objective of this effort is to develop technological standards that are interoperable throughout North America, facilitating transportation and trade.

Also during FY 1999 and 2000, FHWA will conduct two intermodal freight operational tests. The first test, based in Chicago, will include the development of a secured multimodal electronic cargo manifest, allowing for the automated transfer of comprehensive cargo data across transportation modes and political jurisdictions. The primary objective of the test is to enhance operational efficiency for freight shippers and operators, while ensuring cargo safety and security for the public good. It will involve biometric smart card technologies to ensure system integrity and security. The system also will utilize an Internet-based electronic manifest. Lastly, the project will be installed and beta-tested in Chicago's O'Hare International Airport using approximately 10 manufacturers, 10 to 15 trucking companies, and 5 to 10 air cargo carriers and receivers that will be recruited by SecurCom and the ATA Foundation. After the beta test is successfully completed, a second airport and supply chain will be added at Newark, New Jersey.

The second test, based in Seattle, Washington, provides the opportunity to integrate ITS/EDI initiatives of transportation agencies and the intermodal freight industry in vehicle tracking, electronic clearance, traveler information, pick-up and delivery scheduling, incident management, and hazardous materials monitoring. The main objective of the test is to allow freight information to flow in advance of the physical movement of freight, and for this information to arrive at every checkpoint along the way in advance of the truck conveyance.

In FY 1998, the Intermodal Freight Technology Working Group was established under ITS America as a forum for government and industry to work together on projects that will shape the future of freight transportation movement. In FY 1999 and 2000, the focus will be on conducting and evaluating one or more intermodal freight operational tests with a consortium of government and industry participants to identify the resulting benefits and opportunities for sustaining the elements of the test in an operational mode. FY 2000 will consist of completing the process mapping for intermodal segments (the first phase of a chassis tagging project) and will begin a container identification and tracking project with the Intermodal Freight Technology Working Group. In FY 2001, the focus will be on developing intermodal freight user requirements as a building block leading to the eventual modification of the National ITS Architecture to include intermodal freight interfaces. In these ways, the Intermodal Freight Program will work to mitigate current congestion problems caused by intermodal freight demands upon the transportation system, while meeting the challenge of expected increased future traffic volumes. In FY 2002 and 2003, additional operational tests will be conducted.

ITS DATA ARCHIVING

The focus of ITS on the efficient use of transportation networks and services is dependent on operational data that are collected and made available for immediate use. However, if such data were archived and made available in a usable format, they also would be valuable for multiple purposes such as transportation policy, planning, safety analyses, program assessment, research, and related activities. A wide range of stakeholders has shown interest in data generated by ITS, including those involved in the following:

- Metropolitan transportation planning;
- Statewide transportation planning;
- Transportation system monitoring;
- Safety analysis;
- Air quality analysis;
- Commercial vehicle operations;
- Design, construction, and maintenance;
- Emergency management;
- Freight and intermodal planning;
- Land use regulation and growth management;
- Private sector uses;
- Traffic management;
- Transit management; and
- Transportation research.

The recently approved Archived Data User Service (ADUS), the 31st user service in the National ITS Architecture, addresses this new area and was integrated into the Architecture in September 1999. Archiving ITS-generated data for later use has many potential benefits, including supplementing or replacing existing data collection programs. In addition, the level of geographic and temporal detail in ITS-generated data is much greater than in traditionally collected data, and can support more sophisticated forms of analysis. These advances come at a relatively marginal cost because the basic collection and communication infrastructure is already deployed as part of ITS functions.

With such a wide variety of users who could take advantage of archived ITS data, both planning and operation of transportation facilities can be improved. Further, improved data for performing transportation research and evaluation of transportation programs will lead to more cost-effective expenditure of public funds. ADUS cuts across the metropolitan, rural, and commercial vehicle ITS infrastructures.

U.S. DOT will have a significant role in developing ADUS. Simply defining the functions and the data that should be maintained in ADUS is insufficient to achieve successful implementation. Direct involvement of U.S. DOT through research, testing, outreach, training, and deployment will promote development and use of ADUS in the field. Successful implementation will require resolution of numerous issues that have been identified to date, including:

- System access;
- Ownership;
- Data quality;
- Data management;
- Data and communications standards;
- Privacy concerns;
- Data analysis;
- Coordination with other data collection efforts;
- Liability;
- Confidentiality of privately collected data;
- Incremental and uncoordinated ITS deployments;
- Retrofitting versus new development of systems;
- Training and outreach; and
- Development, operating, and maintenance costs.

To help guide ADUS developments and deployment, a roadmap is being developed by U.S. DOT with input from a broad array of stakeholders. Key activities expected to be included in the roadmap include:

- Integrating ADUS into the National ITS Architecture (completed in FY 1999);
- Incorporating ADUS principles and concepts into ongoing standards development activities;
- Case studies of existing efforts to archive ITS-generated data;
- Focused efforts to implement ADUS-based systems as part of ITS grants or field tests; and
- Deployment of ADUS-based systems as part of routine ITS products and services.

The archived data user service is covered in greater detail in Appendix C: ITS User Services Update.

RAIL TRANSIT

As discussed in the "Metropolitan ITS Infrastructure Program Area" section of this document, the next 5 years will witness a transition in the transit ITS research and development program. This transition addresses the need to continue to move from examining and developing ITS technologies within individual systems and transit modes to investigating integrated transit systems across agencies, modes, and regions. The various transit modes that are directly impacted by the continued approach to integrated transportation services include bus, paratransit, trolley bus, light rail, heavy rail, and ferry services. A number of state and local transportation organizations are already operating and maintaining each of these modes within their agency and many of them include operational responsibilities for the highway and traffic system. Other transportation agencies have already established cooperative partnerships and coordinated activities to provide a seamless, intermodal, interconnected transportation system within their region.

One of the most significant intermodal connections that has already demonstrated a degree of connectivity both through institutional arrangements and through ITS technology applications is the bus-rail interface for the traveling public. Rail constitutes over one-third of all transit trips nationally and represents 59 percent of all transit passenger miles traveled. Individually, both the bus and rail industries have adapted advanced technologies into their systems over the years. To achieve a properly functioning integrated transportation system, however, efforts now need to be targeted more toward the interface connections, both for travelers' direct benefit and for the benefits to be derived from more effective and efficient operation of the transportation system. Just as the National ITS Program already addresses the movement of both people and commercial freight, the rail industry also addresses the movement of both people and freight. Current estimates are that intermodal rail freight represents the equivalent of 1.6 million large trucks that can be diverted from the nation's highways for the major part of the trip. These intermodal connections involving rail passenger service and rail freight service, which are to be explored during the next several years, represent the next logical step in achieving the seamless transportation system envisioned for America.

PEDESTRIAN AND BICYCLE SAFETY

With the number of pedestrian injuries and fatalities on America's roads rising, especially in rural areas, vehicle-pedestrian interactions have emerged as a possible program activity where ITS technologies can be used to improve safety. Sidewalks, bicycle lanes, and pedestrian walkways are a vital, if sometimes under-appreciated, element of our national transportation network. In large urban areas, pedestrian trips account for more than 90 percent of all daily travel. Thus, it is critical that these travelers be safeguarded in the same way as their vehicular counterparts. Under TEA-21, pedestrian and bicycle safety efforts will focus on creating more pedestrian-friendly intersections through the use of various ITS technologies. Three such areas are adaptive crosswalk signals that can detect the presence of pedestrians and change the cycle times to ensure safe crossing, in-vehicle technologies that detect and avert impending vehicle-pedestrian collisions, and traffic management models that include pedestrian and bicycle flows for safer road design. Beyond TEA-21, U.S. DOT may broaden its focus to consider ITS technologies that enable and enhance pedestrian transportation and make areas more "livable."

Adaptive crosswalk signals. Two user groups are particularly underserved by current pedestrian crossings – the elderly and the disabled. As the baby boom generation continues to age, demographics are shifting toward a higher percentage of elderly Americans. Also, the nation is continually striving to eliminate mobility constraints on Americans with disabilities, in accordance with the Americans with Disabilities Act. U.S. DOT will promote ITS solutions to pedestrian safety to meet the needs of these users, as well as the needs of other pedestrians.

For example, current pedestrian signal timing is based on an average walking speed of 4 feet per second. This travel speed assumption is too high for elderly or disabled pedestrians, who require more time to safely cross an intersection. U.S. DOT is supporting the development of adaptive pedestrian signal control that accounts for slower pedestrian speeds in intersection design. ITS technologies also can be used to sense waiting pedestrians, monitor their progress across the intersection, and adapt signalization in real time to ensure safety. In addition, systems can be designed to activate only when there is actually a pedestrian waiting to cross, thus minimizing delay to motorists.

In-vehicle technologies. The National ITS Program already includes efforts aimed at alerting travelers of hazardous conditions, and automatically preventing vehicle-vehicle collisions. Similar technologies, such as infrared pedestrian sensors and automatic collision avoidance systems, already exist and can be deployed to reduce the number of injuries in vehicle-pedestrian collisions.

Transportation management models. An initiative is underway to update current transportation management models, which consider pedestrian movements in only a cursory manner and do not consider bicycle movements at all. More complete models, that consider pedestrian and bicycle traffic flows, would enable transportation agencies to better incorporate pedestrian and cyclist needs into the planning process and to create more pedestrian-friendly intersections.

ACCESSIBILITY

Although the automobile has increased our nation's mobility as a whole, millions of Americans who cannot use private cars have limited access to places of commerce and recreation. Whether due to disability, age, or income, these Americans are cut off from business and cultural opportunities that are inaccessible by any means other than the automobile. This is especially problematic in rural areas, where low population density and great distances between destinations make public transit difficult to implement. The problem is only likely to worsen, since recent development trends, on the whole, indicate a continuing decrease in land-use density.

ITS technologies can improve this situation by facilitating ridesharing, paratransit, and other public transit efforts. Advanced public transportation systems can be particularly useful in rural areas, where coordinated information and dispatching can facilitate paratransit services in areas that are too sparsely populated to support traditional bus or fixed-guideway systems.

VI. THE ROAD AHEAD

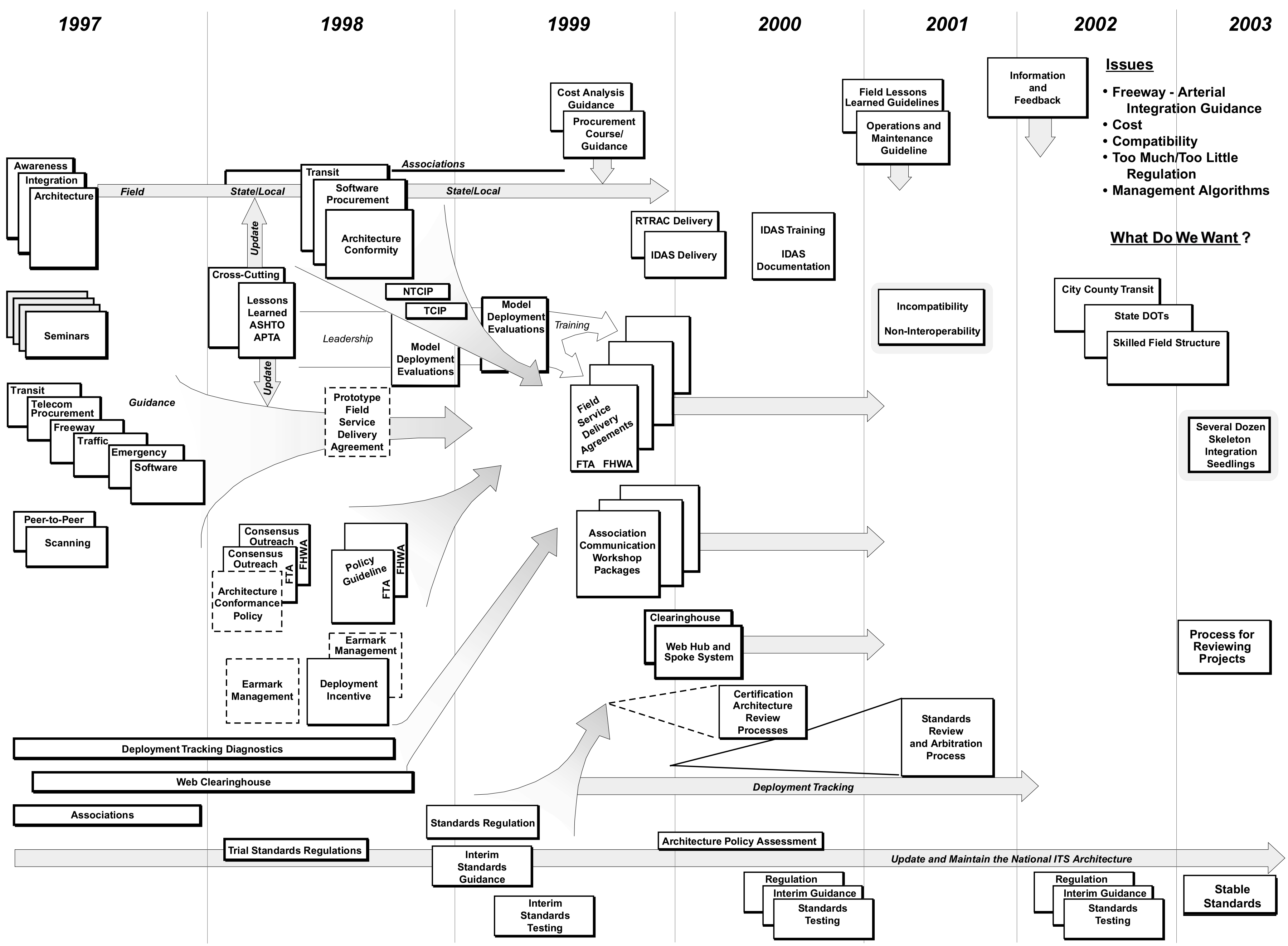
The National ITS Program is well on its way to achieving national ITS deployment and research goals by 2003. The Program stems from a strategic vision of how modern information and communications technologies can enhance the safety and efficiency of surface transportation systems and the quality of life of the American public. Under ISTEA, U.S. DOT partnered with a cross-section of representatives from diverse fields (transportation, electronics, and communications) and stakeholders from all sectors (public, private, and academic) to achieve the first phase of a national program to create a more capable, innovative, and cost-effective surface transportation system. Now the transformation of ITS into a mainstream element of surface transportation planning and infrastructure investment has begun. The activities outlined in this plan reflect both the opportunities created by TEA-21 and the actions necessary to realize and extend the benefits of that initial research.

APPENDIX A: PROGRAM AREA ROADMAPS

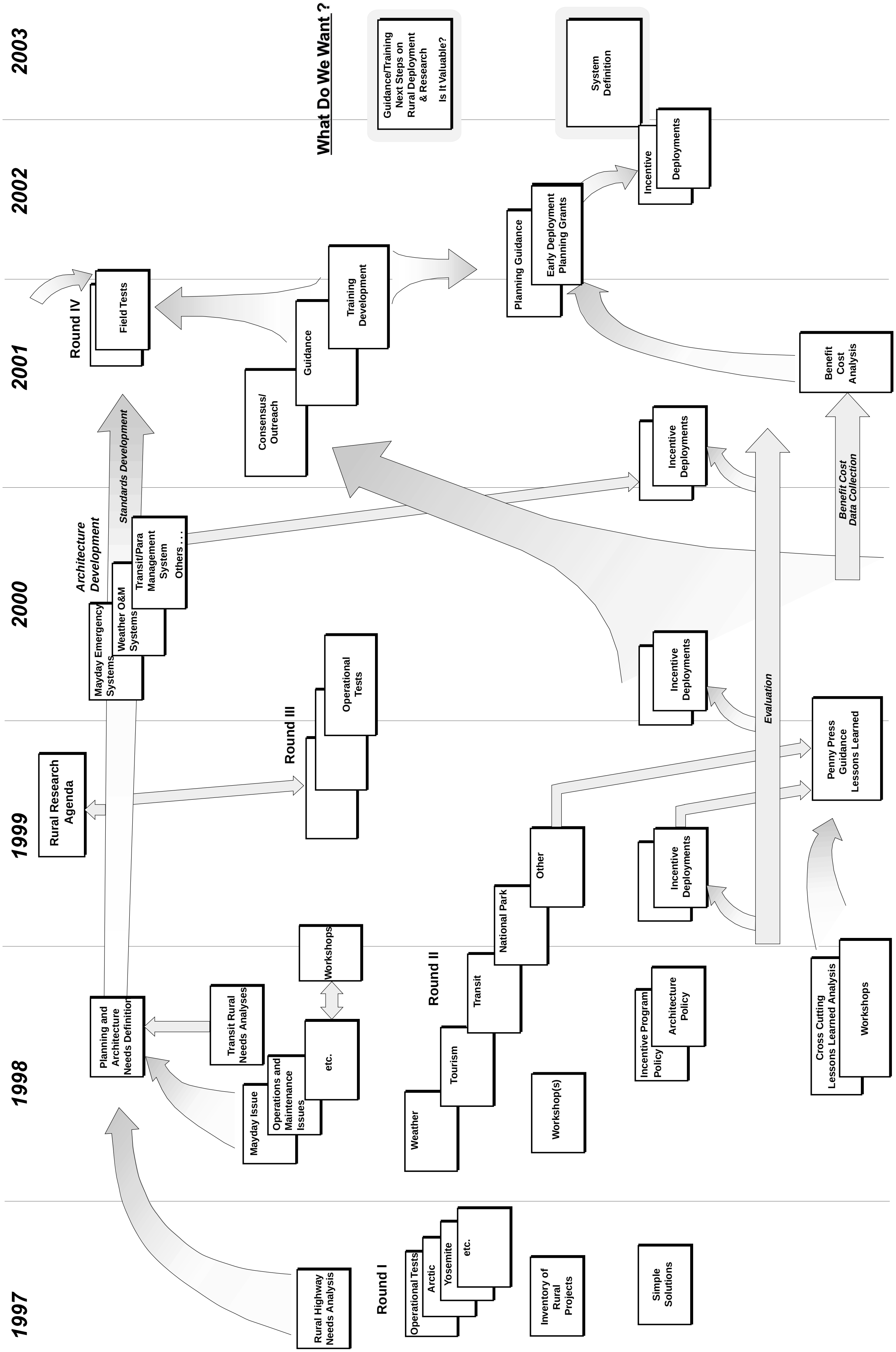
U.S. DOT has developed detailed roadmaps for each of the four ITS program areas. These roadmaps reflect the breadth and level of complexity of each program area. The maps, in order, are for:

- Metropolitan ITS Infrastructure;
- Rural and Statewide ITS Infrastructure;
- Commercial Vehicle ITS Infrastructure; and
- The Intelligent Vehicle Initiative.

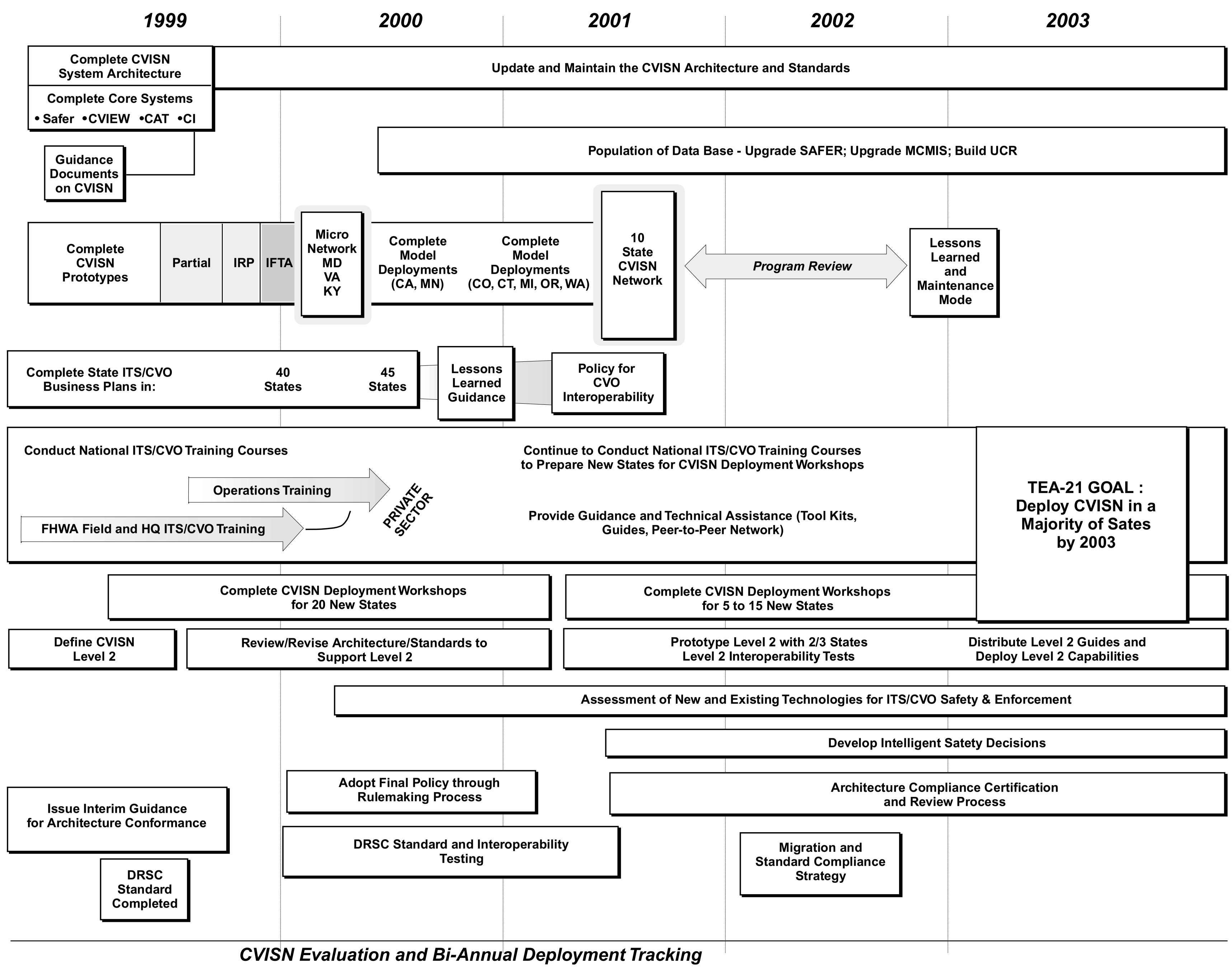
Metropolitan ITS Infrastructure



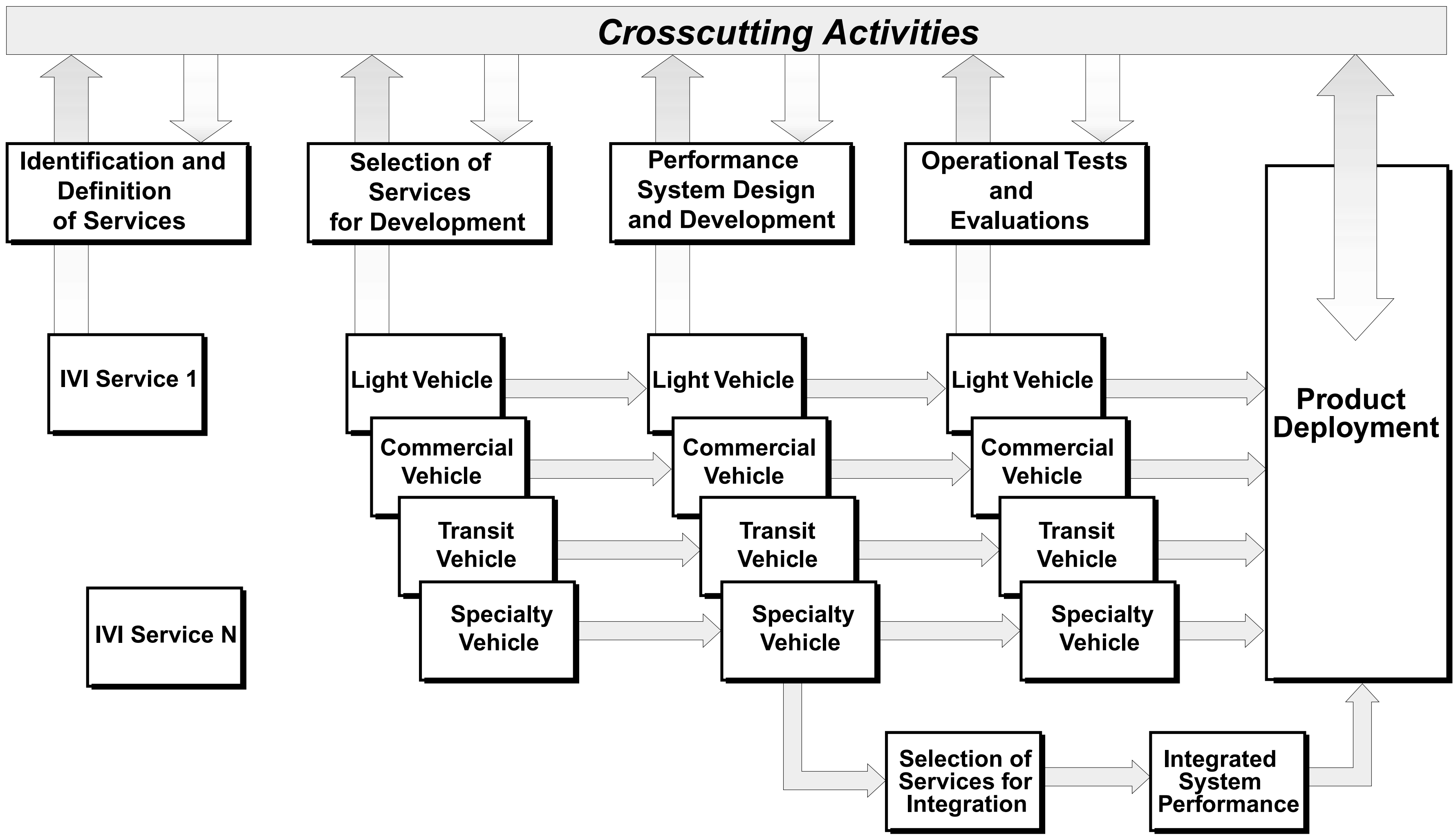
Rural and Statewide ITS Infrastructure



Commercial Vehicle ITS Infrastructure



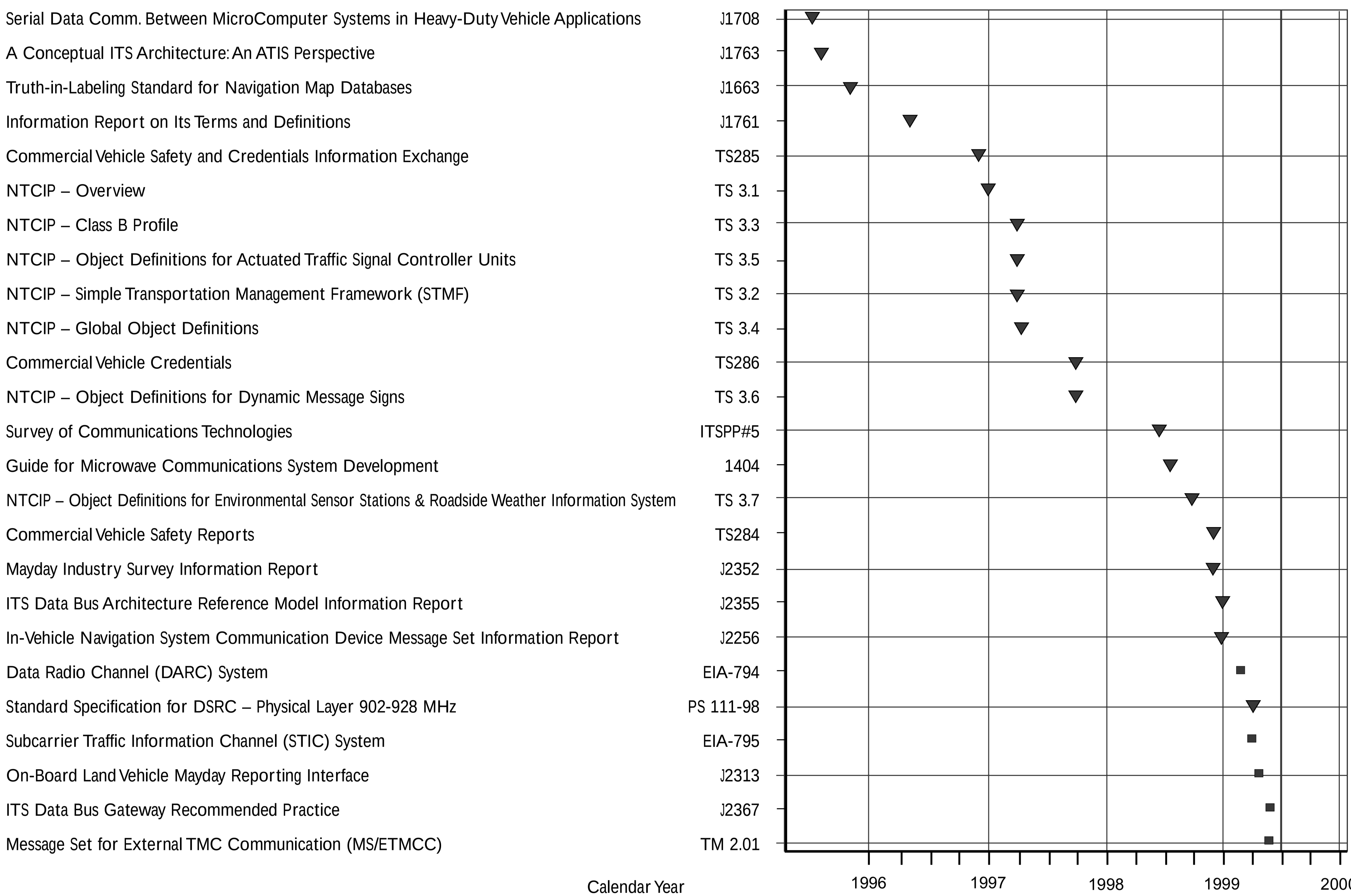
High Level Roadmap for IVI



APPENDIX B: ITS STANDARDS DEVELOPMENT MILESTONES

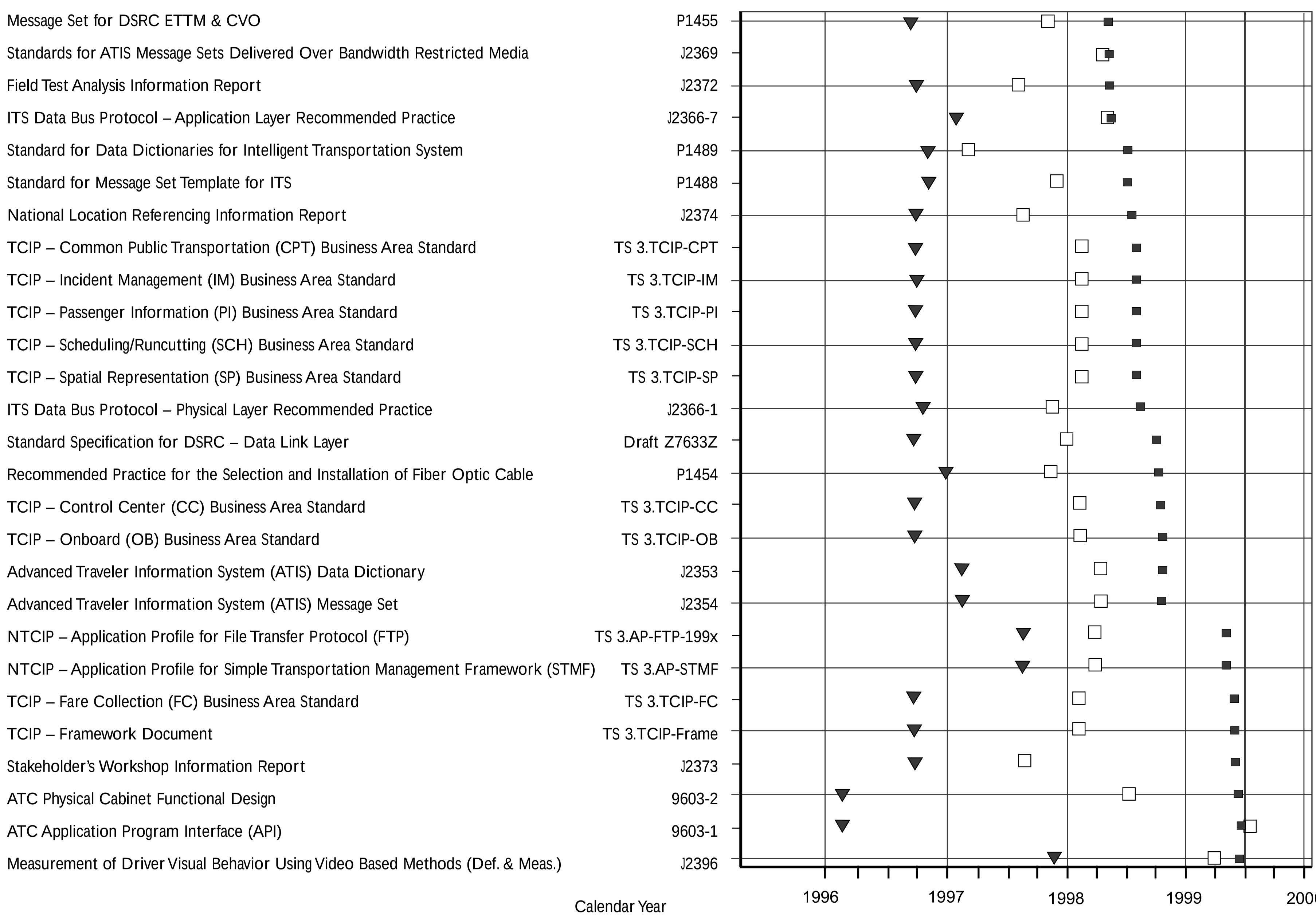
U.S. DOT actively tracks the development of ITS standards. The following milestone charts are for all Phase I standards currently under development. The first chart shows how many ITS standards are published and endorsed by standards development organizations. The other two charts show the projected schedule for balloting of the remaining standards under development. These charts are updated frequently and can be found on the U.S. DOT web site under ITS standards at *www.its.dot.gov/standard/standard.htm.*

U.S. Department of Transportation ITS Joint Program Office
Published and Endorsed Standards Document



Produced by JPL for the
U.S. Department of Transportation

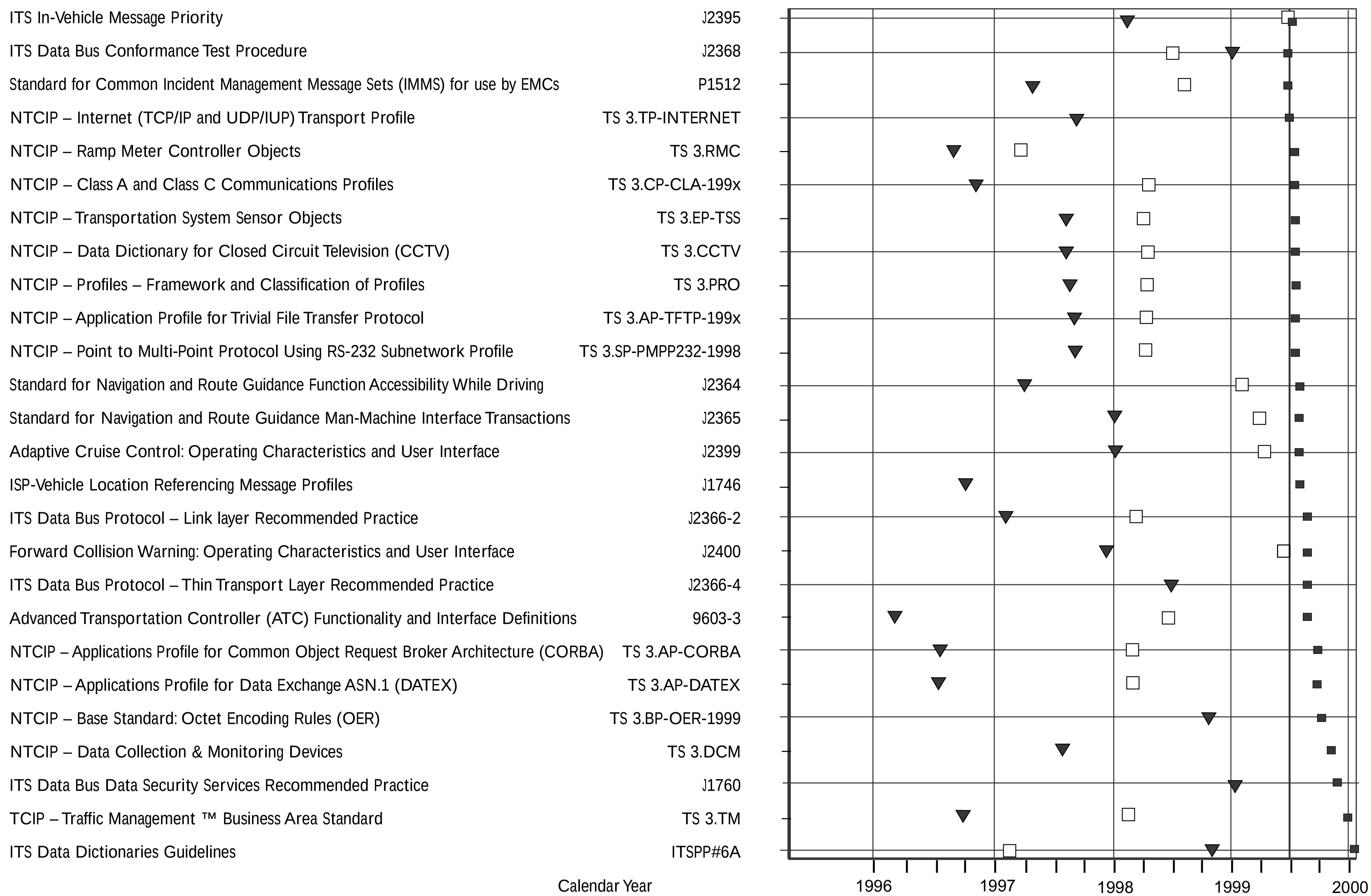
U.S. Department of Transportation ITS Joint Program Office
Standards Documents Development Milestones



Produced by JPL for the
U.S. Department of Transportation

▼ **Begin Standards Development**
□ **Original Plan Balloting Date** ■ **Current Plan Balloting Date**

U.S. Department of Transportation ITS Joint Program Office
Standards Documents Development Milestones



▼ **Begin Standards Development**

□ **Original Plan Balloting Date** ■ **Current Plan Balloting Date**

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APPENDIX C: ITS USER SERVICES UPDATE

The National ITS Program is focused on the development and deployment of a collection of interrelated user services. To date, 31 user services have been defined. Of these, 29 were fully described in the first edition of the National ITS Program Plan in 1995. Two new services have been identified since that time and are formally adopted through this update. This list of user services is neither exhaustive nor final. There is a wide array of transportation services that could be developed which are not included in this list. In addition, the services here are expected to continue to change over time. This list of services and the accompanying descriptions are expected to evolve and to be documented in future program plan updates.

USER SERVICE DESCRIPTIONS

Although each user service is unique, they share common characteristics and features, as described below.

- Individual user services are building blocks that may be combined for deployment in a variety of fashions. The combination of services deployed will vary depending upon local priorities, needs, and market forces. Within the National ITS Program Plan, user services have been grouped into “bundles” based on the likely deployment scenarios described later in this appendix.
- User services are composed of multiple technological elements or functions that may be common with other services. For example, a single user service will usually require several technologies, such as advanced communications, mapping, and surveillance, which may be shared with other user services. These common technological functions are one reason for the “bundling” of services.
- User services are in various stages of development and will be deployed as systems according to different schedules. Some of the technologies required by various user services are currently available in the marketplace, while others will require significant research and development before they can be deployed. The development and deployment of an individual service will be guided by the policies and priorities established by both public and private sector stakeholders. These policies and priorities will evolve based on changing technologies, economic factors, and market conditions.
- Costs and benefits of user services depend upon deployment scenarios. Once the basic technological functions, such as communications or surveillance, have been deployed for one user service, the additional functions needed by one or more related services may require only a small incremental cost to produce additional, often significant, benefits.
- Many user services can be deployed in rural, suburban, and/or urban settings. User services are not specific to a particular location. Rather, the function of the services can be adapted to meet local needs and conditions.

USER SERVICE BUNDLING

Although it may be possible to deploy a system that provides a single user service, in many cases, services are more likely to be deployed in combination with other services or “bundles” which share some commonality. The 31 user services have been sorted into categories termed “bundles.” The services within these bundles may be related in a number of different ways. In some cases, organizations that will deploy the services provided the rationale for the formation of a specific bundle. Other bundles were organized around common technical functionalities. The bundled services also will be mixed and matched among bundles, as well as within a single bundle. Greater detail on each bundle can be found in Chapter V, User Services Integration, of the 1995 National ITS Program Plan.

Since publication of the 1995 National ITS Program Plan, the National ITS Program has made a revision to how user services are bundled. Two previously separate bundles – "Travel and Transportation Management" and "Travel Demand Management" – have been combined into a single bundle labeled "Travel and Traffic Management." Table C-1 reflects that change and shows how the 31 user services are grouped. Each bundle is described in detail following the table.

Table C-1. User Service Bundling

Bundle	User Services
1. Travel and Traffic Management	1.1 Pre-Trip Travel Information 1.2 En-Route Driver Information 1.3 Route Guidance 1.4 Ride Matching and Reservation 1.5 Traveler Services Information 1.6 Traffic Control 1.7 Incident Management 1.8 Travel Demand Management 1.9 Emissions Testing and Mitigation 1.10 Highway-Rail Intersection
2. Public Transportation Management	2.1 Public Transportation Management 2.2 En-route Transit Information 2.3 Personalized Public Transit 2.4 Public Travel Security
3. Electronic Payment	3.1 Electronic Payment Services
4. Commercial Vehicle Operations	4.1 Commercial Vehicle Electronic Clearance 4.2 Automated Roadside Safety Inspection 4.3 On-Board Safety Monitoring 4.4 Commercial Vehicle Administrative Processes 4.5 Hazardous Material Incident Response 4.6 Commercial Fleet Management
5. Emergency Management	5.1 Emergency Notification and Personal Security 5.2 Emergency Vehicle Management
6. Advanced Vehicle Safety Systems	6.1 Longitudinal Collision Avoidance 6.2 Lateral Collision Avoidance 6.3 Intersection Collision Avoidance 6.4 Vision Enhancement for Crash Avoidance 6.5 Safety Readiness 6.6 Pre-Crash Restraint Deployment 6.7 Automated Vehicle Operations
7. Information Management	7.1 Archived Data User Service

Travel and Traffic Management. The Travel and Traffic Management user services were combined into this bundle, which deals with information collection, dissemination, and processing for the private vehicle network. These services collect and process information about the surface transportation system, and provide commands to various traffic control devices. Travel management services disseminate this information to travelers. When used in concert, these services can provide a comprehensive travel and transportation system. These services also provide information to support the Public Transportation Management and Information Management bundles.

Thus, the Travel and Traffic Management bundle will be of interest to transportation policy makers, public and private sector operators of transportation management centers, those involved in accident response or travel demand management, and private sector vendors supplying travel information products and services. User services in this bundle include: Pre-Trip Travel Information; En-Route Driver Information; Route Guidance; Ride Matching and Reservation; Traveler Services Information; Traffic Control; Incident Management; Travel Demand Management; Emissions Testing and Mitigation; and Highway-Rail Intersection.

Public Transportation Management. The transit authority is the most probable provider of these services, as it is responsible for implementing systems that are capable of better managing the public transportation system and providing improved transit and mode choice information. From a technical perspective, all the user services in this bundle will share a common public transit data base. The data will be available for all the services and can be customized for their specific function. These data also will support services in the Travel and Traffic Management and Information Management bundles. User services in this bundle include: Public Transportation Management; En-Route Transit Information; Personalized Public Transit; and Public Travel Security.

Electronic Payment. While this bundle contains only one user service – Electronic Payment Services – it supports deployment of many other services, both within and outside the transportation arena. This service will be developed, deployed, and operated by both public and private organizations.

Commercial Vehicle Operations. These user services support the goals of improving the efficiency and safety of commercial fleet operations, and will benefit both the states and the motor carrier industry. The bundle is organized around the use of advanced computer and communication technologies to improve the safety and productivity of the motor carrier industry throughout North America. From a technical perspective, the foundation for all the commercial vehicle operations user services is the information system. Each service will require some set of information on the motor carrier, the vehicle, the driver, and, in some cases, the cargo. The services are interrelated in terms of the specific types and functionality of information and data required. This network of information will be accessible by states and motor carriers nationwide. User services in this bundle include: Commercial Vehicle Electronic Clearance; Automated Roadside Safety Inspection; On-Board Safety Monitoring; Commercial Vehicle Administrative Processes; Hazardous Material Incident Response; and Commercial Fleet Management.

Emergency Management. Police, fire, and rescue operations can use emergency management services to improve their management of and response to emergency situations. These user services have common functional elements such as vehicle location, communications, and response. User services in this bundle include Emergency Notification and Personal Security and Emergency Vehicle Management.

Advanced Vehicle Safety Systems. Although each of these services addresses a separate function, they all contribute to the common goal of improving vehicle safety. With the exception of Automated Vehicle Operations, all these user services are characterized by near-term reliance on self-contained systems within the vehicle. Supplementing the on-board capabilities with additional sensors deployed in the infrastructure, however, can enhance the functionality of these user services. Within the vehicle, common functional elements, such as data storage, processing units, sensors, or actuators, could be shared among the user services in this bundle, including Automated Vehicle Operations. User services in this bundle include: Longitudinal Collision Avoidance; Lateral Collision Avoidance; Intersection Collision Avoidance; Vision Enhancement for Crash Avoidance; Safety Readiness; Pre-Crash Restraint Deployment; and Automated Vehicle Operations.

Information Management. This newly created bundle is the logical offshoot of both the Travel and Traffic Management and Public Transportation Management user service bundles. Both of the two original bundles focus on measuring transportation data for real-time use and disseminating it to the traveling public. However, the copious amount of data gathered in the process also are useful to planners, safety personnel, and other parties as an historical record of traffic flow at a very detailed level. User services in the Information Management bundle address how to process and store the data acquired by ITS monitoring systems in a manner that is efficient, thorough, and user-friendly. The first user service in this bundle is the Archived Data User Service.

USER SERVICE DEVELOPMENT PLANS

A development plan has been generated for each user service. The plans identify the needs that the user service is designed to meet, present an operational concept for how the service might function in its fully deployed state, describe the technologies that the service might use, discuss potential costs and benefits, and provide an assessment of the public and private sector roles in developing and deploying the systems that will provide the service. The user service development plans for the first 29 services are contained in Volume II of the 1995 National ITS Program Plan. Detailed user service development plans for the two new user services appear below. The plans follow the format used in the 1995 National ITS Program Plan. The numbering is according to their placement within the bundles shown in Table C-1. For example, the Highway Rail Intersection user service is the tenth service listed under Travel and Traffic Management. Thus, the numbering for this user service begins 1.10.

Highway-Rail Intersection User Service

1.10 HIGHWAY-RAIL INTERSECTION USER SERVICE

1.10. 1 Introduction

Highway-Rail Intersections, where highways cross rail lines at-grade, are a special case of Highway-Highway Intersections (HHI). HRI user service systems will provide improved control of highway and train traffic to avoid or decrease the severity of collisions that occur between trains and vehicles at HRIs. The primary users of this service are the highway vehicle driver (motorist) and the train crew responsible for operation of the train (e.g., locomotive engineer). Train types addressed by the HRI user service include freight, intercity passenger, light rail, and commuter rail. Highway users of this service (collectively referred to as motorists) include highway transit and emergency vehicle operators, as well as motorcyclists, bicyclists, and pedestrians.

The HRI user service directly supports the national transportation policy and safety goals as specified in Sections 1010, 1036, and 1072 of the Intermodal Surface Transportation Efficiency Act of 1991, and the National Highway System Designation Act of 1995. The HRI user service addresses the National Intelligent Transportation System's overall goal of improving transportation safety and the specific objectives of reducing the number and severity of transportation accidents, as well as the resulting fatalities and injuries. This service also indirectly supports the goals of enhancing productivity by reducing costs incurred by fleet and rail system operators and reducing costs to transportation dependent industries.

The HRI user service provides two major subservices: (1) the Standard Speed Rail (SSR) subservice, which applies to all trains operating at speeds of 79 miles per hour or less; and (2) the High-Speed Rail (HSR) subservice, which applies to trains operating at speeds greater than 79 miles per hour. The SSR subservice applies to traditional types of rail service including freight, intercity passenger, light rail, and commuter rail. The HSR subservice is intended to address the unique safety requirements imposed by high-speed passenger rail service operating on high-speed corridors.

The HRI user service will reduce the frequency and resulting fatalities and injuries of collisions at HRIs through improved control of train and highway traffic. Improved train control could be accomplished by two basic functions: (1) advisories and alarms to train crews of the operational status of an HRI warning device and of highway vehicle intrusions onto HRIs; and (2) automated stopping of high-speed (greater than 79 miles per hour) passenger trains on designated corridors in rare emergency situations when an obstructing highway vehicle on the HRI can be automatically detected in sufficient time to avoid a collision. Improved highway traffic control could be accomplished through the integration of ITS technologies into a variety of functions including: (1) improved HRI warning devices; (2) roadside variable message signs; (3) in-vehicle motorist advisory, warning, and automatic vehicle stopping; and (4) automated collision notification.

The HRI user service will be accomplished by the integration of ITS technologies and other ITS user services with the national network of railroad and highway operations. The Federal Railroad Administration (FRA) will assist in the development of HRI user services in close cooperation with FHWA, FTA, and the other participants in the National ITS Program.

1.10.2 Needs

HRI accidents are one of the most significant safety concerns of railroads and the FRA. In 1994, there were approximately 273,000 HRIs in the United States; 166,000 are public at-grade and 107,000 are private at-grade. Accidents at HRIs occur at a rate of about 4,900 each year, resulting in about 600 fatalities and 1,900 injuries annually.

Rail traffic volume is increasing to meet the growing demand for efficient intercity passenger and freight service, as well as light rail and commuter rail passenger service. Section 1010 of ISTEA established the need to improve the safety of HRIs to permit the implementation of high-speed rail passenger service on a limited number of rail corridors. The Secretary of Transportation has subsequently designated a number of corridors to provide high-speed passenger rail service at speeds from 80 to 125 miles per hour. Higher speed passenger operations between 125 and 150 miles per hour are planned for the future. These high-speed rail corridors cover some 2,600 miles and include some 2,800 public and private HRIs. The increased safety needs of passengers on future high-speed trains exposed to the risks of HRIs must be addressed by HRI user services.

The National Highway System Designation Act of 1995 also recognized the importance of improving HRI safety through ITS technology and required the National ITS Program to address, in a comprehensive and coordinated manner, HRI safety needs.

Many design factors must be considered in determining appropriate safety improvements at HRIs including train length, weight, speed, and frequency; number of tracks; crossing closure time; the amount and type of highway traffic; and HRI geometries such as highway sight distance. In addition, a number of human factors and motorist behavior issues need to be addressed. For example, motorists often take inappropriate risks at crossings based on the false assumption that trains can typically stop in time to avoid an accident at the HRI. However, a typical 100 car freight train traveling at 60 miles per hour would require more than 1 mile to stop, even using emergency braking. Motorists may also take risks to avoid delays at HRIs that have a history of long closures by freight trains. In addition, motorists might be confused as to how to interpret HRI warning devices that differ subtly from standard highway traffic signals. For example, the flashing red traffic light at a HHI signals motorists to stop and proceed when clear, whereas the flashing red lights at an HRI signals motorists to stop and always yield the right-of-way to trains. Furthermore, there are no national regulations on motorist responses to flashing lights; each state determines its own regulations on this issue.

Standards for design, installation, and operation of current HRI warning devices are covered in FHWA's "Manual on Uniform Traffic Control Devices," and in "A Policy on Geometric Design of Highways and Streets" published by the American Association of State Highway and Transportation Officials. However, there are no FRA regulations that mandate the type of warning devices to be provided at HRIs. There are presently two general categories of warning devices at HRIs: passive and active.

Passive warning devices are used at approximately 212,000 public and private at-grade HRIs. The national standard passive warning device is the "crossbuck," a white "X" shaped sign with the words "RAILROAD CROSSING" in large black letters. This is the standard traffic control and regulatory device used in all states to notify motorists that they should be alert to the possibility of a train approaching or moving through the HRI. It has the same meaning as a yield sign. Railroad advance warning signs or pavement markings may also be installed on the highway prior to the HRI to alert the motorist of an HRI ahead.

Active warning devices are installed at HRIs where additional alerting capabilities are required. There are approximately 60,000 public and 1,000 private HRIs that have active warning devices. Factors considered in determining the need for active warning devices include type of roadway, type and volume of vehicular and railroad traffic, hazardous material traffic, maximum speeds of trains and vehicular traffic, pedestrian traffic, accident record, sight distance, and geometry of the HRI. Active warning devices usually include two flashing red lights mounted horizontally below the crossbuck. This traffic control and regulatory device is referred to as "Flashing Lights."

Flashing Lights may be further augmented with "Automatic Gates" that lower when a train is approaching to serve as a barrier between the train and motor vehicles on the approach lanes of the highway on each side of the HRI. These are referred to as "Two-Quadrant" gates. Recently, research and limited deployment of "Four-Quadrant" gates and “Median Barriers” have been made to improve safety at HRIs. Median barriers are placed along the centerline of the highway starting at each of the two-quadrant gates. The median barriers help to prevent motorists from driving around the gate. Four-quadrant gates close both the approach and opposite lanes of the highway on both sides of the crossing as a means of preventing motorists from driving around gates. These concepts are discussed in more detail in Section 1.10.4.3.

Some HRIs are located near HHIs that are controlled with standard highway traffic signals. To ensure safe movement of traffic through these intersections and the adjacent HRI, active warning devices at the HRI often include the capability of engaging nearby highway traffic signals to prevent the progress of motorists across the tracks.

The HSR subservice will address the special needs of trains with operating speeds in excess of 79 miles per hour. Because collisions between high-speed passenger trains and highway vehicles are more likely to result in significant casualties, it is essential that additional measures be taken to protect trains from highway traffic incursions. The FRA currently requires trains operating at speeds in excess of 79 miles per hour to be equipped with in-cab signals and recommends the following safety measures for HSR HRIs:

- For train operations from 80 to 110 miles per hour, the HRI must be grade separated, or have special signing and active warning devices (including automatic gates) that provide constant warning time. Automatic four-quadrant gates should be considered. Train-activated advance warning systems also should be considered, especially where sight distance is restricted.
- For train operations from 111 to 125 miles per hour, the FRA must be notified and approval granted for a waiver from current FRA Track Regulations. The HRI must be either grade separated or blocked during train passage. The blocking device must provide an impenetrable barrier to protect passenger trains from highway vehicle encroachment onto the HRI.
- For train operations above 125 miles per hour, all HRIs must be permanent, blocked, or grade separated.

Railroad operations are designed to reduce incidents at HRIs by minimizing HRI blockage times, and sounding train horns, where not prohibited by local authorities. Also, some railroads are installing additional alerting lights on locomotives, referred to as ditch lights or crossing lights, and turning these lights on, along with the standard locomotive headlight, whenever they are moving (per 49 CFR 229.125).

Railroads control the movement of trains by train orders, time tables, manual block systems, and provide visual signals to train crews (either on the wayside or in the locomotive cab) by means of wayside control systems which are activated by the presence of the train and/or other trains located ahead. These signal systems are interconnected so as to preclude the entry of two trains into the same controlled section of track. Central dispatchers who are in voice contact with train crews may also control the signal. The railroads are conducting research and limited deployment of advanced train control systems that respond to electronic signals and have the ability to provide automated control of the train speed and braking. The advent of high-speed passenger trains sharing trackage with lower speed freight trains has presented additional challenges to the design of safe and efficient train control systems.

HRI user services are thus required to address the critical safety needs imposed by current rail operations (freight, intercity passenger, light rail, and commuter rail) over HRIs, as well as additional needs created by future high-speed rail passenger service. HSR user service systems will augment and replace current HRI warning devices to effectively enhance HRI safety. The factors influencing safety at HRIs that must be dealt with by HRI user service systems include risk-taking behavior of drivers, train operations, track and highway characteristics, and current HRI and highway traffic control systems. The new technologies that emerge to provide HRI user services must be proven cost effective and highly reliable before their wide-scale implementation in the highway and rail system environments. It is also critical for the improvement of HRI safety that the control and signal systems of the distinctly different highway and railroad modes are interoperable and communicate precisely with each other. The fact that approximately 50 percent of all HRI accidents occur at HRIs with today’s active warning devices is compelling evidence that these systems need to be improved. It is very important, therefore, to include HRI user services in the overall national plan for deploying ITS in both the near and long term.

1.10.3 Service Description

The HRI user service will integrate ITS technology into HRI warning systems to provide for improved control of train and highway traffic to avoid and reduce the severity of collisions at HRIs. The service helps to improve safety at HRIs by developing ITS technologies to enhance the safety effectiveness and operational efficiency of HRI safety devices. Two subservices are provided: (1) the standard-speed rail HRI subservice and (2) the high-speed rail HRI subservice. The HRI user service also will be applicable to the unique safety needs of highway users such as highway, transit, and emergency vehicle operators; motorcyclists; bicyclists; and pedestrians, as well as rail transit users, such as light rail and commuter rail.

Improved train control could be accomplished by two basic functions: (1) providing advisories and alarms to train crews of the operational status of an HRI warning device and of highway vehicle intrusions onto HRIs; and (2) automated stopping of high-speed (greater than 79 miles per hour) passenger trains on designated corridors in rare emergency situations when an obstructing highway vehicle on the HRI can be automatically detected in sufficient time to avoid a collision. The first function, crew advisories and alarms, are incorporated into the SSR subservice. The second function of automated stopping of the train is the basis of the HSR subservice and is intended primarily to address the additional safety demands of high-speed passenger trains.

Improved highway traffic control could be accomplished through a variety of ITS functions available under the HRI SSR subservice. First, the HRI user service will provide improved HRI warning devices for motorists. These improved devices will incorporate ITS technologies that will enhance their alerting capabilities, reduce their costs, and increase their performance in terms of reliability, maintainability, energy use, etc. The improved HRI warning devices could also provide warnings to the motorist that are either consistent with or incorporate standard highway traffic signals making them less likely to be misinterpreted by motorists. The HRI warning devices also will include features that allow them to be integrated effectively with nearby highway traffic signals to maintain safe traffic patterns at HRIs.

In addition to HRI warning devices, the HRI user service could provide roadside variable message signs for motorists. These message signs will effectively inform motorists and pedestrians of an HRI ahead and the need to exercise caution. These signs also will inform the motorist of the time to train arrival, expected delay times, and possible alternative routes to avoid excessive delays resulting from signal malfunctions or unusually long or slow trains. Furthermore, the message signs will inform the motorist if a train is already in the HRI and warn the motorist to stop.

The HRI user service could also provide for a wide range of ITS in-vehicle motorist advisory and warning functions. The most basic function is advisory only and does not require train-based information for implementation. The advisory function simply informs the driver that an HRI is ahead and caution should be exercised. The warning function will require train data and will provide the motorist with information such as the time to train arrival, the need to stop to avoid a collision with a train in the HRI, expected delay times, and possible alternative routes to avoid delays. This information could be provided to priority vehicles such as school buses, ambulances, police cars, and other emergency vehicles prior to wide-scale implementation. These in-vehicle HRI user services can be particularly effective in achieving safety benefits since all passive HRIs, in essence, can be made active without the expense of providing them with active warning devices. In its most extended form, the in-vehicle HRI user service can provide automatic stopping of vehicles to avoid an HRI collision.

The HRI user service also will help to reduce the severity of HRI collisions by providing collision notification functions. This function would permit the rapid notification of emergency response teams in the event of an HRI incident. The capability, if train based, could be either manual (e.g., the train crew initiates the notification) or fully automated (not requiring train crew intervention). The capability, if highway vehicle based, would most likely be provided by the emergency notification user service.

1.10.4 Operational Concept

1.10.4.1 Overview

Long-term implementation of HRI user services could be supported through establishment of Train Control Centers (TCC) and Traffic Management Centers (TMC). In this fully deployed concept of operation (circa 2012), the HRI user service provides real-time information on train position and estimated time of arrival at HRIs, HRI status, and roadway traffic conditions at HRIs.

The HRI user service could interface with the TCC and the train to provide HRI status to train crews and automated stopping of high-speed (greater than 79 miles per hour) passenger trains on designated corridors in rare emergency situations when a collision with an obstructing highway vehicle on the HRI can be avoided. TCCs could accomplish these train control functions through new Positive Train Control systems. These technologies are described in more detail in Section 1.10.5.

The HRI user service also will interface with TMCs to control highway vehicle access to the HRI, to provide motorists with warnings of train arrival times as a collision prevention service, and to permit travelers to select alternative routes to avoid delays and minimize traffic at the HRI. Improved HRI warning devices could provide warnings to the motorist that are either consistent with or incorporate standard highway traffic signals making them less likely to be misinterpreted by motorists. The HRI warning devices could include features that allow them to be integrated effectively with nearby highway traffic signals to maintain safe traffic patterns at HRIs. HRI warning devices could be augmented with roadside variable message signs that provide additional warnings of a train arrival at the HRI. The HRI user service also will provide in-vehicle visual and audible advisory and warning functions to assist motorists in avoiding collisions at HRIs. The HRI user service could help to reduce the severity of HRI collisions by providing collision notification functions.

While this conceptual description is based on central control functions resident at TCCs and TMCs, implementation of some HRI user services, especially early capabilities, could be accomplished with more distributed intelligence. For example, sensing, communication, processing, and control can take place directly between trains, HRIs, and highway vehicles to provide many HRI user services.

1.10.4.2 Train Control Functions

The HRI user service will provide for two levels of train control to prevent HRI collisions: (1) advisories and alarms to train crews of the operational status of an HRI warning device and of highway vehicle intrusions onto HRIs; and (2) automated stopping of high-speed (greater than 79 miles per hour) passenger trains on designated corridors in rare emergency situations when an obstructing highway vehicle on the HRI can be automatically detected in sufficient time to avoid a collision. The first function, crew advisories and alarms, applies to traditional types of rail service including freight, intercity passenger, light rail, and commuter rail, and are incorporated into the SSR subservice. The second function of automated stopping of the train is the basis of the HSR subservice and is intended primarily to address the additional safety demands of high-speed passenger trains. It is not envisioned that routine freight service trains would be stopped under this user service.

The SSR and the HSR user subservices will both require information on the operational status of traffic control systems at the HRI (such as whether the device is operational, fully deployed, etc.) and whether a highway vehicle has intruded onto the HRI. Information on the operational status of traffic control systems can be obtained by HRI remote monitoring systems using appropriate sensors technologies. If a malfunction of the traffic control system is detected, this information will be communicated to the TCC and TMC. Similarly, vehicle intrusions can be detected using sensors incorporating inductive loop, radar, and video technologies. Intrusion detection systems are intended for use with HRI barrier systems, such as four-quadrant gates, where a highway vehicle could become entrapped between the barriers. Intrusion detection systems employing video technologies also can be particularly effective in supporting efforts to enforce HRI traffic regulations by law enforcement officials.

Early implementation of the SSR subservice can be accomplished by communicating operational status of traffic control systems and vehicle intrusions directly to the crew of an approaching train as advisory and warning information for their appropriate action. Effective means of providing this information to train crews and training of crews on appropriate response actions are important areas of research. The communications can be established readily by existing technologies such as cellular phone. Later stages of implementation of the SSR subservice could be accomplished by communication of these data to the train crew through the TCC. In addition to notifying train crews for collision avoidance actions, notification of signal malfunctions also can be sent to the railroad dispatcher, signal maintainer, local police, and roadway authorities for purposes of corrective action to prevent future incidents.

The HSR subservice will provide for automated stopping of high-speed passenger trains on designated corridors in rare emergency situations when an obstructing highway vehicle on the HRI can be automatically detected in sufficient time to avoid a collision. This function could be accomplished through communications with the TCC and the capabilities of technologies such as new Positive Train Control systems. The HSR subservice will verify proper operation of HRI warning devices and will detect intrusions into HRIs employing barrier systems (e.g., four-quadrant gates) to ensure there is no entrapped highway vehicle or other obstruction in the HRI. Early detection by HRI sensors of malfunctioning devices or of stalled, disabled, or trapped vehicles blocking the HRI in the path of an oncoming high-speed passenger train would permit the train to be automatically stopped or slowed to prevent or reduce the severity of an HRI collision. This function will require that HRI warning devices be activated 1 to 3 minutes before the arrival of a high-speed passenger train. As each HRI is approached, the critical train stopping distance will be calculated based upon train operating and track approach characteristics and other factors. If the distance from the passenger train to an intruding vehicle or malfunctioning warning device exceeds the critical stopping distance, automatic stopping will halt the train before an accident occurs. If the distance from the passenger train to the vehicle is less than this critical stopping distance, a collision cannot be avoided, although intervention may reduce collision severity and help protect train passengers and crew.

The HSR HRI subservice provides real-time interactive coordination of highway traffic and train operations via TMCs and TCCs. These services will require information on train location, speed, weight, length, type of train (e.g., freight, high-speed passenger), and type of cargo (e.g., coal, hazardous materials). It also will be necessary to detect, depending on the level of user services provided, highway vehicle location, speed, and type of vehicle. This coordination permits the TCC to improve the efficiency of train operations as well as minimize travelers' delay.

1.10.4.3 Highway Control Functions - Warning Devices

Improved highway traffic control at HRIs will be accomplished through a variety of functions available under the SSR subservice. The HRI active warning system's ability to control highway traffic will be improved through the use of ITS technologies that will enhance alerting capabilities, reduce costs, and increase performance in terms of reliability, maintainability, energy use, etc.

HRI active warning systems will be capable of adaptive signal operation to account for the train's location, direction, and speed status to yield an estimate of train arrival time at the HRI and provide for constant warning times to the motorist. These systems will benefit from improved wayside or train-borne train detection technologies. Early implementation of these services can be accomplished by direct communication between the train and the HRI warning devices. Later, the required information can be enhanced through communication with TCCs and TMCs.

Four-quadrant gate technologies will be developed as an improved deterrent to motorists going around gates. A significant design challenge for these systems is to develop appropriate sequencing of the entrance and exit gates, and to provide for other features to prevent or minimize the risk of possible entrapment of highway vehicles. Four-quadrant gates block both lanes of the highway on each side of the HRI. If all four gates are lowered simultaneously, a motorist could pass under the gates being lowered on the near side of the HRI only to be blocked by the gates that have lowered on the far side of the HRI. However, delayed lowering of the gates on the exit lane of the highway on the opposite side of the HRI would provide additional time for a potentially entrapped motorist to break through the gate with minimal damage to his or her vehicle. Motorist awareness of this feature and ability to take advantage of it in a crisis situation are implementation issues to be addressed. Median barriers also may be used to inhibit motorists from going around gates. These barriers could be rigid or flexible to provide more or less of a physical barrier to motorists. However, these barriers also could pose an additional hazard to motorists if not properly designed.

HRI active warning systems will provide for improved integration of their operation with highway traffic control systems on adjacent roadway facilities. The improved HRI active warning systems also may incorporate red-yellow-green lights, consistent with standard highway traffic signals, to replace the flashing red lights used at HRIs today. This feature would give positive train movement information to the motorist in a manner consistent with HHIs. When current warning devices at HRIs display a "dark" indication, it means go, while a flashing red indication means stop and always yield to the train; motorists may not always properly interpret these messages. The use of standard highway traffic control signals also may be more cost effective than traditional HRI warning systems.

1.10.4.4 <u>Highway Control Functions - Variable Message Signs</u>

Highway traffic control devices at the HRI will be supplemented with roadside variable message signs. These messages will provide the minimum amount of information necessary for motorists (typical highway users as well as transit and emergency vehicle operators, motorcyclists, bicyclists, and pedestrians) to take appropriate safe action at HRIs. An example of the sequence of messages that could be displayed to a motorist approaching an HRI is the following:

1. "PROCEED" (HRI clear)
2. "TRAIN(S) ARRIVING, CLEAR THE INTERSECTION" (30-60 seconds prior to arrival of train)
3. "STOP - DO NOT ENTER - WAIT FOR TRAIN(S) TO CLEAR CROSSING" (20-30 seconds prior to arrival of a train; other tracks verified clear if at a multiple-track crossing)
4. "TRAIN(S) WILL CLEAR CROSSING IN # # SECONDS and/or WATCH FOR OTHER TRAIN"
5. "CAUTION" (after the train(s) clears the HRI)
6. "WAIT FOR PROCEED SIGNAL"
7. "PROCEED"

Traffic operations at intersections on adjacent roadways will be significantly improved with variable message signs that interact with the TMC and TCC. These signs can be provided with real-time information about the location and arrival time of trains so that traffic can be redirected and controlled to minimize delay times that may result, for example, from signal malfunctions or unusually long or slow trains.

Information on train movements relative to HRI can be provided to the TMC via remote systems that monitor the operational status of HRI signal systems. The TMC would be able to determine the activation status of HRI signal systems and thus monitor the progress of train movements and take action to alleviate the effects upon traffic congestion on intersecting and adjacent roadways. Possible responses might include temporary adjustment of traffic signal phasing and timing, the implementation of lane use and turn restrictions through dynamic lane assignment, and variable message signs. The information also could be relayed to emergency services personnel, police, fire, and ambulance services, to facilitate routings that avoid blocked HRIs and thereby optimize emergency response time. Similar actions could be implemented by the TMC in the event of HRI signal malfunctions.

1.10.4.5 <u>Highway Control Functions - In-Vehicle Services</u>

HRI user services will include in-vehicle functions at three basic levels of interaction with the motorist (typical highway users as well as transit and emergency vehicle operators, motorcyclists, bicyclists, and pedestrians): (1) driver advisories, (2) driver warnings, and (3) automatic stopping of the highway vehicle.

In-vehicle driver advisories are the most basic service and can be accomplished without information about train operations. This service is intended to take advantage of other in-vehicle ITS user services such as En-Route Driver Information and Route Guidance. These services will basically advise the driver that an HRI is ahead and caution should be exercised. These services will require that the location of HRIs be included in their geographic data bases and that the necessary software is included to provide the advisory messages. The advisories most likely would be in the form of graphic displays as well as voice and/or alarm audible messages.

In-vehicle driver warnings will require information about train operations. These services will inform the driver of an HRI ahead and will warn the driver to take appropriate action if a train is approaching or is in the HRI. This service requires data on train location, direction, and speed. These data can be provided to the vehicle in several different ways. Early implementation of this concept could be achieved by providing the data directly to the vehicle via communications with the train or through a wayside train detector located at the HRI or along the track approach to the HRI. An advanced concept for this service would involve interaction between the vehicle, TCC, and TMC. This service concept would permit the TMC to provide train arrival time information, expected traffic delay times, alternative routings to minimize traveler delays, and most importantly warnings to the driver to avoid collisions at the HRI. This service also will be extremely useful to highway transit vehicles and priority vehicles such as school buses and emergency vehicles to assist in avoiding collisions and responding rapidly to emergency situations. In its early stages of implementation, this service could be targeted to priority vehicles prior to wide-scale use.

The most advanced form of this service would involve automatic intervention of the in-vehicle system to stop the vehicle if a collision is imminent at an HRI. This service will require accurate data on vehicle and train dynamics as well as sensor, information processing, and vehicle control technologies. Information transmitted to the vehicle from the TMC may require augmentation with data obtained from infrastructure sensors to obtain the necessary accuracy on vehicle and train dynamics.

1.10.4.6 Automated Collision Notification

The HRI user service will help to reduce the severity of HRI collisions by providing automatic collision notification functions. This function would permit the rapid notification of emergency response teams in the event of an HRI incident. The effectiveness of these response teams can be significantly improved if they have advanced information on the nature of the collision. This information can be provided by the HRI user service by combining data on train characteristics (e.g., location of incident, train speed, train type, involvement of passengers, hazardous materials, etc.) obtained from the TCC and data on highway vehicle characteristics (e.g., type of vehicle, speed, acceleration forces, involvement of passengers, and hazardous materials, etc.) obtained from the TMC. This service can be based on the train, the highway vehicle, or both. If train based, the notification to the TCC could be either manually initiated by the train crew or fully automated through the use of appropriate sensor and communication systems. The notification, if highway vehicle based, would most likely be provided by the Emergency Notification and Personal Security user service. The TMCs and TCCs will require integration with control centers for emergency response teams.

1.10.5 Technology

Implementation of HRI user services will require the application of supporting technologies such as those described below.

1.10.5.1 New Positive Train Control Systems

New Positive Train Control systems are made up of the same technologies used in ITS: digital data links connecting locomotives, maintenance-of-way equipment, wayside base radios, and control centers; on-board computers, positioning systems, data radios, and display screens on locomotives and maintenance-of-way equipment; and control center computers. Positive Train Control systems can reduce the probability of collisions and over-speed accidents by two orders of magnitude, and can also improve running time, service reliability, capacity, and rolling stock and crew utilization.

1.10.5.2 Vehicle Proximity Alerting System (VPAS)

Section 1072 of ISTEA required field testing of a Vehicle Proximity Alerting System (VPAS) and comparable systems to determine their effectiveness as a safety warning device for “priority” vehicles approaching HRIs. As envisioned, the VPAS would be installed only on priority vehicles – school buses, large trucks, hazardous materials haulers, and emergency vehicles. VPAS provides an in-vehicle warning (visual and audible) to motorists at both passive and active crossings. VPAS benefits would be greatest at passive crossings where motorists currently receive no indication of an approaching train.

In July 1993, FHWA issued a request for proposals for VPAS devices to be evaluated for effectiveness as a means of improving HRI safety. Prototype testing by the FRA of promising devices identified by FHWA occurred in 1994 and 1995 at the Transportation Technology Center in Pueblo, Colorado. The VPAS concepts evaluated employ a variety of techniques to accomplish communication from an approaching train to a highway vehicle near the HRI. The communication systems typically use radio frequency devices. Basic systems would only inform the driver that a train is approaching, or that the crossing ahead is blocked by a train, but provide no further information. Enhanced systems would inform the driver of the train's approach, direction, and estimated time of arrival at the HRI, based on train position, speed, and direction of travel data.

1.10.5.3 Geographical Mapping Systems

Many of the HRI user services discussed require data bases of accurate information on the location of HRIs relative to highways and other related highway and rail system structures. Systems are available and are being developed for automated surveying of track and wayside infrastructure. One such system uses Global Positioning System (GPS) equipment and digital video imaging recording devices to video survey railroad facilities, including intersections of track and roadways, and to provide a longitudinal-latitudinal data base.

1.10.5.4 Other Supporting Technologies

A number of technology developments and applications need to be developed and/or enhanced and integrated to support implementation of HRI user services in addition to those discussed above. These technologies are briefly discussed below.

- Location technologies are required to accurately position trains and highway vehicles relative to each other as well as to HRIs and other rail and highway system structures. These technologies include GPS and inertial navigation systems as well as various other systems for dead reckoning.
- Train detection systems are required to determine train position relative to HRIs for purposes such as activating HRI warning and control systems. Those systems that also detect train speed and direction will have more potential applications. These systems may be either train based or infrastructure based.
- Highway vehicle detection systems are required to determine vehicle location relative to HRIs and to determine vehicle intrusions onto HRIs. These systems, especially those employing video technologies, can support efforts to enforce traffic regulations at HRIs.
- Communication systems are required for exchanging information between trains, highway vehicles, TCC, TMC, and various rail and highway system infrastructure elements.
- Remote sensor systems are required to monitor the operational status of HRI warning and traffic control systems.
- Motorist warning and control system technologies need to be enhanced by improving their safety effectiveness, operational efficiency, and costs.

1.10.6 Potential Costs and Benefits

1.10.6.1 Potential Costs

There are about 100,000 public HRIs with passive warning devices that are candidates for warning device improvements. These improvements would be of the type included in SSR HRI user services such as enhanced warning devices and variable message signs. Traditional active warning devices typically cost in the range of $50,000 to $150,000 per HRI. The national cost of upgrading all passive crossings with active warning devices would be prohibitive. Advances in warning device design using ITS technologies could reduce these costs. The capital and installation costs of installing active warning devices have typically been funded, since 1973, under continuing Highway Safety Acts. Since 1973, about $3 billion have been spent on upgrading about 60,000 HRIs. Railroads have typically accepted the responsibility for maintaining these new devices at a cost of about $1,300 to $2,200 per HRI per year. Since it is unrealistic to assume that all passive HRIs can be upgraded, U.S. DOT, working with state and local agencies, will continue to prioritize HRIs for upgrading on the basis of criteria such as the level of train and highway traffic, train speeds, hazardous materials traffic, etc.

A small subset of all HRIs includes the 2,800 HRIs on the designated high-speed rail corridors. These HRIs are candidates for improvement under the HSR HRI user service. There is little precedent for Federal funding of the types of improvements envisioned under this service. However, it is the established policy of the Federal government, as expressed in Section 1010 of ISTEA, to promote high-speed rail service, and to fund demonstration projects for improving HRI safety on the designated corridors. States, local public agencies, and railroads may be expected to share in the capital, installation, operation, and maintenance costs of HRI improvements. Costs for advanced warning and protection devices under the HSR subservice are not well established but could range from about $200,000 for a four-quadrant gate installation to about $1,000,000 for an energy absorbing barrier system or a low-cost grade separation. The HSR subservice also will require extensive infrastructure investments on railroads to implement automatic train control systems and TCCs as well as highway system investments for TMCs. Federal subsidies for these investments might be required to achieve high-speed rail passenger service on designated corridors. Much of the highway investment could be accomplished as part of a larger integrated ITS Traffic Control user service.

In-vehicle warning systems can address the needs of both the SSR and HSR HRI user subservices. In 1993, there were nearly 198 million registered motor vehicles in the United States, of which 146 million were automobiles. If all or a substantial portion of these vehicles included HRI collision avoidance systems, the total monetary costs could be substantial. The capabilities required of these in-vehicle systems, however, could be obtained as minor added functions to systems installed as part of other ITS user services such as En-Route Driver Information and Route Guidance. The actual cost of these systems has not yet been determined.

1.10.6.2 Potential Benefits

The primary benefit from the HRI user service will be a reduction in the number and severity of the 4,900 HRI collisions that occur annually. Also, the safety risk to large numbers of passengers on future high-speed rail trains will be significantly reduced. Secondary benefits will result from reductions in motorist delays and improved operational efficiency of railroad and highway operations. Higher train speeds along the designated corridors will be possible creating economic and social benefits for travelers and users of rail freight transportation. These benefits will increase as ITS technologies mature, promoting the exchange of information between TMCs, TCCs, trains, and highway vehicles. Improved information exchange will support user services such as En-Route Driver Information, Pre-Trip Travel Information, Route Guidance, Public Transportation Management, Emergency Vehicle Management, and Commercial Fleet Management.

1.10.7 Assessment of Roles

The public safety benefits and other potential public and commercial benefits of the HRI user service are expected to be high. Therefore, U.S. DOT will encourage joint public/private development efforts for enabling technologies. This approach, which underlies the U.S. DOT strategy for investment in ITS technologies and systems, is used to assess the appropriate role for U.S. DOT in developing the HRI user service.

The development of low-speed light rail and commuter rail service as well as high-speed rail service will need to be a cooperative effort between FRA, FHWA, FTA, and the relevant states and local agencies. The parallel development of ITS and HRI technologies provides a unique opportunity to integrate current and future highway and railroad traffic control systems. Due to the involvement of two significantly different modes of surface transportation, the design will be subject to regulation by highway, transit, and rail regulatory bodies.

1.10.7.1 Public Benefit

This user service addresses the most common and severe type of collision that affects railroad operations as well as the motoring public. This service therefore has high potential for public benefit. There also will be significant benefits in improving the efficiency of railroad operations as well as reducing unnecessary travel time delays, accidents, air pollution, and traveler frustration.

1.10.7.2 Potential for Private Investment in Development

This service will require significant infrastructure investment on both the highway and railroad systems. Provision of highway-based motorist warning and traffic control systems will primarily be the responsibility of public transportation entities. Private industry, however, will have primary responsibility for development of train control systems. Several railroads are currently involved in joint programs with the FRA to develop and demonstrate advanced train control systems. In addition, private industry has traditionally developed HRI motorist warning devices. Companies other than traditional railroad suppliers may develop new technologies to address HRI user service requirements. Additionally, the service may need to be designed as a capability that is integrated with other vehicle-warning devices and perhaps other ITS services as well. The market for highway infrastructure equipment will be state and local governments responsible for traffic management, while private railroad companies will develop train control systems and equipment.

1.10.7.3 Public and Private Sector Roles in HRI Deployment

The public sector role for installing, supporting, operating, and maintaining highway traffic control systems is high, since this service directly affects overall public safety and the publicly owned roadway network. State DOTs and local highway authorities have the primary role in the day-to-day operation and maintenance of traffic monitoring and control systems. The railroad industry has traditionally assumed the responsibility for maintaining HRI warning devices. In many cases, private sector firms will have roles as contractors executing the actual design, development, and integration of the technologies and equipment to perform HRI user services. The use of new technologies for these functions will broaden the market potential for private sector suppliers. Potential new markets for vendors of surveillance, communications, and control systems exist, and the public and private sectors may share rights-of-way for communications or other networks. In addition, private firms may also operate and maintain traffic control systems under contract to public agencies. Section 1010 of ISTEA permits public and private cooperative roles in the improvement of safety at HRIs to promote the implementation of high-speed rail corridors. State DOTs have taken a lead role in planning the implementation of high-speed rail service in their respective states.

1.10.7.4 Role of the U.S. DOT in Developing Service

The HRI user service will be incorporated into U.S. DOT's National ITS Program and the National ITS Architecture. The Architecture will provide the framework for implementing the HRI user service. The role of U.S. DOT in developing the HRI user service will be significant.

1.10.7.4.1 Research and Development

The role of the U.S. DOT in research and development activities is to address deployment issues associated with the use of advanced system components, and to develop operational concepts and support systems for advanced motorist warning and highway traffic management and train control systems. U.S. DOT will encourage private industry involvement in the development of the necessary technology and equipment to be compatible with the functional specifications of these systems. U.S. DOT also will work with private industry to develop functional specifications for highway and railroad traffic surveillance and control systems such that system components may be fully integrated in an effective and efficient manner. Section 1036(e) of ISTEA and the Swift Rail Development Act of 1994 provide funding for demonstrations of new technology in the high-speed rail corridors.

1.10.7.4.2 Operational Tests

The role of U.S. DOT in operational tests of HRI user service systems is high. A number of current field-test activities supported by U.S. DOT that relate to HRI user services are currently underway. These activities include:

- Prototype assessment and field testing of VPAS concepts;
- Broad agency announcements for innovative new technologies to address high-speed rail HRI safety issues;
- Requests for proposals on Advanced Rail Technologies through the Transportation Research Board's Innovations Deserving Exploratory Analysis Program;
- Next Generation High-Speed Rail Program rail highway crossing hazard elimination demonstration projects;
- Four-quadrant gates with intrusion detection demonstration project in Connecticut;
- Vehicle arrestor net demonstration project in Illinois;
- Friendly Mobile Barrier energy absorbing barrier system development;
- Automated wayside horn demonstration in Nebraska;
- High-Speed Rail automatic train control demonstration projects in Michigan and Washington; and
- Obstacle detection research and low-cost grade separation demonstration in Florida.

1.10.7.4.3 Institutional and Legal

U.S. DOT will take an active role in fostering the necessary institutional arrangements required for deployment of the HRI user services. Liability issues have historically played an important role in influencing safety improvement decisions at HRIs. Highway traffic regulations generally require motorists to comply with HRI warning devices and to yield to train traffic. However, railroads and railroad signal suppliers are often found at fault in litigation resulting from HRI collisions. Railroads and local public authorities are therefore encouraged to improve safety at HRIs to minimize collisions and resulting litigation, but are also cautious in employing new concepts to accomplish this, as innovation may be construed as imprudent. These and other complex legal issues must be addressed within any comprehensive program to improve the safety of HRIs, in general, and, in particular, at HRIs on high-speed passenger train corridors.

1.10.7.4.4 Deployment

The role of the U.S. DOT in deployment of this service is to encourage adoption of advanced systems by states, local government agencies, and the railroad industry.

Archived Data User Service

7.1 ARCHIVED DATA USER SERVICE

7.1.1 Introduction

The Archived Data User Service (ADUS) describes the need for an Intelligent Transportation Systems Historical Data Archive and expands the National ITS Architecture to encompass the needs of the stakeholder groups of this user service. Many of these stakeholder groups previously had little or no involvement in the National ITS Architecture. ADUS requires ITS-related systems to have the capability to receive, collect, and archive ITS-generated operational data for historical, secondary, and non-real-time uses. ADUS prescribes the need for a data source for external user interfaces and provides data products to users. The goal is the unambiguous interchange and reuse of data and information throughout all functional areas.

ITS technologies generate massive amounts of operational data that are presently used primarily in real time to effect traffic control strategies. Examples include the adjustment of ramp meter timing based on freeway flow conditions and the use of variable message signs to communicate traffic incidents to travelers. These data offer great promise for uses beyond the execution of ITS control strategies, such as applications in transportation administration, policy, safety, planning, operations, and research. In most cases, ITS-generated data are similar to data traditionally collected for these applications, but are much more voluminous in quantity and geographical and temporal coverage. ITS has the potential to provide data needed for planning, performance monitoring, program assessment, policy evaluation, and other transportation activities, including multi-modal and intermodal applications. This user service describes the need for the collection, manipulation, retention, and distribution of data generated by ITS for use in other transportation activities.

7.1.2 Needs

There is a broad spectrum of users who must rely on any and all available sources of data to feed the applicable planning models, simulations, and control strategies. The users' needs for the data are outlined below with a partial list of their primary transportation-related tasks:

Metropolitan Planning Organization and State Transportation Planning: These agencies are responsible for short- and long-range identification of transportation improvements and policies including multi-modal passenger transportation improvements, congestion management, air quality planning, airport access planning, and the development and maintenance of travel demand forecasting and traffic simulation models. Operation and management of multi-modal transportation systems is becoming an important aspect of the transportation planning function.

Transportation System Monitoring: Monitoring agencies (often units within larger agencies) are responsible for the collection and analysis of transportation data for use by policy makers at all levels of government and other customers for policy analysis, performance monitoring, and investment analysis. An example is the Highway Performance Monitoring System that provides data for reporting to Congress on the condition, performance, and future investment requirements of the nation's highway system.

Traffic Management: Traffic management agencies are responsible for the day-to-day operations of deployed ITS (e.g., operation of traffic signal control systems).

Transit Management: Transit operating agencies are responsible for such things as day-to-day transit operations, including scheduling, route delineation, origin-destination surveys, passenger counts, fare pricing, vehicle maintenance, transit management systems, evaluation, and capital planning.

Air Quality Analysis: Agencies responsible for air quality analysis perform such tasks as monitoring regional air quality and assessing transportation plan conformity with air quality standards and goals.

Metropolitan Planning Organization/State Freight and Intermodal Planning: These agencies are responsible for the planning of intermodal freight transfer, goods movement, and port facilities.

Safety: Agencies responsible for transportation safety perform such tasks as identifying countermeasures for general safety problems or hotspots, automated collision notification, delivery of emergency medical services, automated crash investigation data entry, deployment planning for incident response, and hazardous site identification.

Design, Construction, and Maintenance: Planning for the rehabilitation and replacement of pavement, bridges, and roadside appurtenances, and the scheduling of maintenance activities are the functions of this user group.

Transportation Research: Transportation research agencies develop forecasting and simulation models and other analytic methods and investigate improvements in data collection practices. Transportation research encompasses many of the stakeholder functions.

Commercial Vehicle Operations: Agencies responsible for commercial vehicle operations perform such tasks as crash investigations, enforcement of commercial vehicle regulations, and hazardous materials response. ITS provides reports of violations and patterns in movements.

Emergency Management (local police, fire, and emergency medical): Emergency management agencies respond to transportation incidents and crash investigations. ITS provides data for patrol planning.

Private Sector: Several different types of private sector entities who have an interest in archived ITS-generated data have been identified: Information Service Providers disseminate traffic condition data and route guidance; carriers perform commercial trip planning to avoid congestion; and auto manufacturers develop vehicle designs that can be based on performance information from archived ITS-generated data.

Land Use Regulation and Growth Management: These agencies are responsible for development of land use plans and zoning regulations, establishment of growth impact policies, and community economic development.

All ITS historical and non-real-time data should be capable of being stored, disseminated, and/or manipulated to support users with pre-defined data products. These data include, but are not limited to, the following categories: (1) freeway data, (2) toll data, (3) arterial (non-freeway) data, (4) parking management data, (5) transit and ridesharing data, (6) incident management data, (7) safety-related data, (8) commercial vehicle operations data, (9) environmental and weather data, (10) vehicle and passenger information data, and (11) intermodal operations data.

7.1.3 Service Description

This user service will provide an ITS Historical Data Archive for all relevant ITS data and will incorporate the planning, safety, operations, and research communities into ITS. It will provide the data collection, manipulation, and dissemination functions of these groups, as they relate to data generated by ITS. The ITS Historical Data Archive will function as a data warehouse or repository to support stakeholder functions.

An example from transportation planning will illustrate the use of this service. (Many such example applications also exist for the other stakeholder groups.) Annual Average Daily Traffic (AADT), the daily traffic count estimates for a highway, are one of the most essential data types used by planners and engineers. Nearly all AADTs used by planners are estimates based on 24- or 48-hour short counts that have been adjusted using area-wide factors for daily and seasonal variability. Facility-specific data on the temporal distribution of traffic and its variability are extremely limited. ITS roadway surveillance equipment can provide detailed data on the actual average daily traffic and its variability. ITS data, as source data, would improve the accuracy and usefulness of one of the core performance measures (i.e., AADT) used by transportation planners. ITS data also will allow for direct measurement of congestion and permit separation of the recurring and nonrecurring components of congestion.

More detailed data will be required as the management paradigm becomes more widespread. Travel Demand Forecasting models for predicting long-term demand characteristics (20 years into the future) use average values – basically, one wants to make decisions about adding capacity to the nearest additional lane of accuracy (i.e., 2,200-2,300 vehicles per hour). Average peak hour traffic counts are precise enough for this purpose. However, for meeting the newer planning requirements that tend to be more short range in nature – such as congestion monitoring and microscale air quality modeling – information on extreme events is important. For example, consider a freeway section where the only traffic data available provide an average AADT developed from a factored 48-hour short count and K- and D-factors (factors to convert a daily volume to a peak hour volume) borrowed from other urban sites. A capacity analysis on this section using these data would not only ignore days where volumes were higher than average, but is prone to the sampling bias inherent in using factored and borrowed data. Since delay is a nonlinear function of volume as volumes approach and exceed capacity, these rare but highly influential events would be missed if the short-term and borrowed data were the basis for congestion monitoring. Moreover, the impact of incidents on delay would be completely ignored in the current approach. On the other hand, ITS roadway surveillance data would directly measure congestion, including days with abnormally high volumes and incidents.

The information obtained from ITS sources in the above example is also valuable in a multi-modal context. In addition to the highway surveillance data mentioned above, ITS technologies also can capture information about the movements of transit passengers and the performance of transit systems. When the highway and transit data are fused, effective multi-modal planning – such as designing transportation strategies for key corridors – can be achieved. Further, because the data are collected constantly, a continuous multi-modal performance evaluation program can be implemented. Such an effort would greatly aid transportation and transit planners in fulfilling Federal requirements and meeting local needs.

It is also possible to extend this example into the realm of traffic operations. Although ITS generally uses real-time data to implement control patterns, non-real-time data also can be of use. Consider that ramp metering is present for the hypothetical freeway segment mentioned above. The metering rates are generally pre-timed, actuated by mainline traffic flow, or a combination of the two. In the pre-timed case, data on historical volume and congestion patterns can be used to set metering rates by time of day. In advanced systems that are proactive (i.e., they predict traffic conditions in the very near future), historical patterns can be used in predictive algorithms. Finally, historical ramp metering rates and freeway traffic conditions are valuable to operators of traffic signal control systems in that pre-timed or proactive timing plans can be developed with that data. From an archival viewpoint, the needs of operators would tend to be more short term (what happened yesterday or last week) than those of transportation planners.

The discussion above cites only two examples of the uses and benefits of archived ITS-generated data. Examples for other stakeholder groups are just as meaningful and include:

Transit Management: Electronic Fare Payment allows continuous collection of fares as people board. Computer-aided dispatch systems allow origin/destination patterns to be tracked. Automatic Vehicle Identification on buses allows monitoring of schedule adherence and permits the accurate setting of schedules without field review.

Transportation System Monitoring: Traffic data can be collected as part of ITS operations and may eliminate the need for labor-intensive short counts on highways covered by ITS.

Air Quality Analysis: Roadway surveillance provides actual speeds, volumes, and truck mix by time of day. Modal emission models will require these data in even greater detail and ITS is the only practical source.

Metropolitan Planning Organization/State Freight and Intermodal Planning: Electronic credentialing and Automatic Vehicle Identification allow tracking of truck travel patterns, sometimes including cargo. Improved tracking of congestion through the use of roadway surveillance data leads to improved assessments of intermodal access.

Safety: Roadway surveillance data provide continuous volume counts, truck percents, and speeds, leading to improved exposure estimation and measurement of the actual traffic conditions for crash studies. ITS technologies (e.g., GPS) also offer the possibility of automating field collection of crash data, especially location, by police officers and others.

Design, Construction, and Maintenance: Roadway surveillance data provide continuous volume counts, vehicle classifications, and vehicle weights, making more accurate loading data and growth forecasts available.

Transportation Research: Traveler response to system conditions can be measured through system detectors, probe vehicles, or monitoring in-vehicle and personal device use. Travel diaries can be imbedded in these technologies as well.

Commercial Vehicle Operations: Electronic credentialing and Automatic Vehicle Identification allow tracking of hazardous material flows, allowing better deployment of inspection and response personnel.

Emergency Management: Electronic credentialing and Automatic Vehicle Identification allow tracking of truck flows and high incident locations, allowing better deployment of response personnel.

Private Sector: Roadway surveillance data and probe vehicles can identify existing congestion and can be used to show historical patterns of congestion by time-of-day. Incident location and status can be directly relayed.

Land Use Regulation and Growth Management: Improved identification of travel and congestion patterns provides a sound technical basis for establishing policies.

Finally, the functionality of ADUS will increase if opportunities for data fusion are pursued. The value of certain ITS-generated data is enhanced if additional information is added from other sources. One example is in the safety area. While locations of crashes (in terms of geo-coordinates) can be provided with high precision, safety agencies are concerned with matching crash locations with highway geometric features. This matching involves fusing the crash location data with other data (e.g., roadway characteristics inventories) and requires a common referencing system. Another example of data fusion potential is the collection of travel activity data. Traveler location data (such as those from automatic vehicle identification technologies) can identify where travelers are in time and space, again in terms of geo-coordinates. However, transportation planning agencies need to identify the origins, destinations, and lengths of trips by purpose of the trip. As the sophistication of systems and level of ITS deployment expand in the future, it may be possible to merge the location data with land use data, thereby inferring the type of trip without encumbering the traveler with an extra task.

7.1.4 Operational Concepts

7.1.4.1 <u>ADUS Functions</u>

The basic function for ADUS is to provide an ITS Historical Data Archive and to integrate user functional needs for data.

7.1.4.1.1 <u>Basis for Development</u>

The systems to support ADUS should be based on, but not limited to, existing data flows within the National ITS Architecture. As new data flows are added to the National ITS Architecture – and as additional uses of existing data flows are identified – they should be examined for their inclusion within the systems to support the ADUS. The systems should also be flexible enough to accommodate data flows unique to individual ITS deployments that may not warrant a change to the National ITS Architecture. They also should be capable of handling data from existing data collection programs that may not be deemed as being in the ITS realm.

7.1.4.1.2 <u>System Structures</u>

To accommodate both existing (legacy) transportation systems and the incremental deployment of new ITS, the information management systems which support data archiving may utilize one of two concepts, or a hybrid of these:

a. Decentralized – Each ITS facility possesses its own archiving function with a minimum of interconnects with other ITS facilities but utilizing standardized data definitions.

b. Centralized – Relevant data from each ITS subsystem may be captured in a central repository either directly or "virtually" through the use of appropriate distributed technologies and standards.

7.1.4.1.3 <u>System Functions</u>

The following functions should be implemented to support the ITS Historical Data Archive system deployment: data processing, data storage, and data retrieval.

7.1.4.1.3.1 <u>Data Processing</u>

Data Processing is the receipt and processing of incoming data from other ITS functions. ADUS should have the ability to perform the following data processing functions for designated users.

a. Store data in the same format as received from ITS subsystems.

b. Accommodate levels of aggregation and reduction of the data flows, depending on the type of data represented.

c. Sample raw data flows for permanent storage in accordance with user specifications. Permanent storage of the sampled data should be either online, offline, or both.

d. Apply quality control procedures to the data, including the flagging of suspect data and the editing of data.

e. Distinguish between the following data types: unprocessed (raw), edited, aggregated, and transformed (processed in conjunction with other data or methods).

Data processing functions may be assigned to different personnel. For example, data quality control and editing may be assigned to the group or agency responsible for the initial data collection. Subsequent data reduction may be assigned to personnel other than the original collectors of the data.

7.1.4.1.3.2 Data Storage

Data Storage encompasses both online and offline storage of raw and processed data. It includes:

a. Data Manipulation and Integrity – Original, unaltered data must always be preserved in the master archive for some minimum amount of time. The original data stored in the Historical Data Archive should not be modified as the result of user-specified data requests or data manipulation. Rather, edited or otherwise transformed data can co-exist with the original data but must be linked to them. User-defined data manipulation should only be processed from copies of the master archives (e.g., editing, formatting, aggregation, reduction, or fusion of data), and preparation of data will be processed and archived for designated users separately from the master archives.

b. Metadata and Meta-Attributes – ADUS should include specifications of detailed metadata and meta-attributes about the data stored in the archive. Metadata and meta-attributes should provide a complete description of the data in terms of standard data dictionary characteristics as well as providing analysts an indication of collection and sampling conditions, variability, quality control procedures, edits, and transformations. These features will promote careful use of the data and will help analysts understand the nature of the data. Metadata and meta-attributes should be assigned whenever quality control, data reduction, or data aggregation procedures are applied. In addition to metadata and meta-attributes, which are formal parts of the data archive, the development of caveats on the limitations of the data also should be encouraged.

c. Location Referencing – ADUS should encompass a common location referencing system for linking data elements in the archive.

7.1.4.1.3.3 Data Retrieval

Data Retrieval provides the interface between the data repository and users.

7.1.4.1.4 Applicable Standards

Archived data should be standardized to at least a minimum level by following all existing data standards and systems. These include, but are not limited to:

a. American National Standards Institute 16
b. American National Standards Institute 20
c. Model Minimum Uniform Crash Criteria
d. Emergency Medical Services Standards
e. National Crime Information Center 2000
f. National Incident-Based Reporting System and state standards
g. National Law Enforcement Telecommunications System
h. Highway Performance Monitoring System (FHWA)
i. Traffic Monitoring Guide (FHWA)
j. American Association of State Highway and Transportation Officials' Guide for Traffic Data Programs
k. Institute of Electrical and Electronics Engineers Standard for Data Dictionaries for ITS (P1489)
l. Institute of Transportation Engineers Traffic Management Data Dictionary
m. National Transportation Communications for ITS Protocol
n. Transit Communications for ITS Protocol
o. Applicable electronic data interchange standards (e.g., American National Standards Institute's ASC X.12)
p. Motor Carrier Management Information System (FHWA)
q. Highway Safety Information System (FHWA)
r. Fatal Accident Reporting System (NHTSA)

s. General Estimates System (NHTSA)
t. National Transit Database (FTA)
u. Hazardous Materials Incident Reporting System (RSPA)
v. Railroad Accident/Incident Reporting System (FRA)

7.1.4.1.5 Privacy

Permanent or temporary storage of data within the systems to support ADUS should preclude the possibility of identifying or tracking either individual citizens or private firms and should follow the ITS Privacy Principles developed by ITS America ("Fair Information and Privacy Principles"). This means that even in the case where unprocessed data (i.e., data received directly from collection sources) are archived, privacy principles should be strictly followed. Identifiers of individual citizens or private firms should be stripped from all data before archiving unless full disclosure of the intended use is made and informed consent is obtained. Unique system-developed identifiers that do not allow identification of individual citizens or private firms may be assigned to stored data.

7.1.4.2 Vision

In the near term, ADUS should be routinely considered during the design of an ITS deployment. ADUS should address the capability of collection and verification of data from local ITS center functions and archiving those data into a master historical data base repository. The archive should be capable of providing data base products to ITS agencies and other stakeholder agencies. Stakeholders may request user-defined data products. ADUS should accept transportation data input from stakeholders.

Ideally, the near-term ITS Historical Data Archive will be a transportation data warehouse. The archives will receive and archive all incoming ITS operational data. Later, voluminous real-time data will be stored in accordance with the local historical archiving practices. The warehouse would provide all data users with data archiving and data products toolboxes for predefining their archiving and retrieval processes. The data archiving toolbox will include data aggregation, data exploration, and data fusion technology to enable the users to predefine the gathering and archiving of their data. The data products toolbox will provide analysis, modeling, scheduling, and report writing processes to enable the users to predefine their desired data products.

In the mid-term, archived data should be fully automated and able to support local, state, and Federal DOT data archiving requirements. Archived data should be compatible with other data sources to increase the number of useful applications. Metadata and meta-attributes of all ITS-generated data should be standardized. Demand management may evolve to real-time traffic demand management and use ADUS data bases as the source for the predictive traffic demand model. Information Service Providers may utilize archived data to provide travelers with route guidance and travel planning and to provide traveler planning data to ITS. Many planning functions may be automated, including data analyses and reports.

In the long term, ADUS may provide a fully automated central ITS data warehouse capable of collecting, verifying, and archiving ITS data at local, state, and Federal agencies. ADUS may provide agency-unique ITS data products to ITS centers and designated users. The ADUS data warehouse may be integrated with user functions so that the data products are provided in a seamless fashion. For example, data from the warehouse may be sent directly to models rather than being subjected to intervention by user analysts. The information generated from ADUS will be so pervasive and useful that it will be considered integral to transportation practice.

7.1.5 Technologies

ADUS is essentially embodied in an information management system. Therefore, several information technologies apply to its development. System designers should make full use of these technologies when implementing ADUS. These include, but are not limited to: (1) relational, distributed, and object-oriented data base design (among others); (2) data warehousing; (3) data mining; (4) expert systems; and (5) geographic information systems. Relational, distributed, and object-oriented designs, and data warehousing are information technology concepts that aid in the management and retrieval of data. Data mining can be applied to find specific nuggets of critical source data required to identify unusual trends in transportation networks, that might be buried in the huge volume of information that exists in transportation information systems. Expert systems can be used as an aid in data quality control. Geographic information systems can be used for managing and displaying data generated by ITS.

7.1.6 Potential Costs and Benefits

7.1.6.1 Potential Costs

Implementing ADUS will involve development, operation, and maintenance costs. Operating agencies such as state DOTs and local traffic engineering agencies are the purveyors of ITS. As an information management system, an implemented archived data system requires data base administration, backup procedures, routine operation of quality control and summarization programs, responding to special users, maintaining existing code, and developing new code for new applications. Even if the data "owners" are convinced of the data's value, staff resources for operation and maintenance may be slim. In fact, operating costs for the data archive may be higher over time than the initial capital costs of constructing it. Moreover, because there is little precedent in the field, the costs of building, operating, and maintaining an ITS archival system are largely unknown. Finally, the distribution of costs among stakeholder groups, including the formation of public/private partnerships, could help defray costs to any one group. It is therefore crucial that these costs be explicitly addressed in future funding of ITS deployments. System owners and operators also should be free to pursue innovative approaches to paying for archived data systems, including the use of non-ITS funds (e.g., state and local planning allocations).

7.1.6.2 Benefits

For the most part, data generated by ITS are similar to data collected by other transportation agencies via traditional means (e.g., traffic counts), but ITS-related data are collected continuously and at a very detailed level. For example, roadway surveillance data can be used in many stakeholder applications, including: development and calibration of travel demand forecasting and simulation models; congestion monitoring; transit route and schedule planning; intermodal facilities planning; and air quality modeling. Users will benefit from ITS-generated data because those data will supplement, and in some cases replace, existing data collection programs. Example benefits to specific stakeholders were outlined in Section 1.3. In general, these benefits relate to:

a. *Removal of temporal sampling bias from estimates and allowing the study of variability.* Nearly all the data currently collected for planning, operations, administration, and research applications are through the use of sample surveys (e.g., household travel surveys, short-duration traffic counts). Although attempts are made to adjust or expand the sample, the procedures are imperfect. With continuous data, there is no need to perform adjustments to control sample bias. (Equipment or non-response errors are still present, though.) Further, continuous data allow direct assessment of variability, which is becoming an important factor in the study of personal travel habits and the effect of extreme events (e.g., days with very high volumes or severe incidents).

b. *Provision of detailed data needed to meet emerging requirements and for use in new modeling procedures.* The next generation of travel-demand forecasting models and air quality models (modal emission models) will operate at a much higher level of granularity than existing models. Traditional data sources are barely adequate for existing models, and it will be extremely difficult to support the next generation of models with them. Much ITS-generated data are collected at the levels of detail necessary to support these models. For example, roadway surveillance data (volumes, speeds, and occupancies) are typically reported every 20 seconds and GPS-instrumented vehicles can report positions and activity at time intervals as small as 1 second. Also, GPS-derived locations can pinpoint incident locations to within a few meters. This level of detail will be required for the input and calibration data used by the new models.

c. *Supplementing and, in some cases, replacing existing data collection programs.* Many state DOTs have extensive traffic count programs that entail the collection of data with portable equipment. ITS roadway surveillance equipment can provide this same function automatically and continuously and avoid the problems associated with installing and removing portable equipment on heavily traveled urban roadways. In the transit area, electronic fare collection systems can circumvent the need to conduct periodic boarding surveys. In the freight planning area, ITS technologies may permit tracking commodity flows without the need for special surveys. In the safety area, accurate crash location identification will aid the cross-linking of highway attributes to crashes.

d. *Stimulating the support of other users for ITS initiatives.* If groups besides those involved in ITS development see value in data generated by ITS, they will be inclined to learn more about ITS and to support deployment. In other words, mutual interest in data generated by ITS will stimulate cooperation among stakeholders. This could prove to be extremely valuable in the "mainstreaming" of ITS into standard transportation practice, particularly among transportation planners.

e. *Complementing the integration of transportation systems in general.* To a very large degree, integration of ITS components can be viewed as the sharing and use of data between individual ITS components, usually in real or near real time. (For example, a form of integration is the transfer of freeway surveillance data for purposes beyond control of the freeway such as for traffic signal control and traveler information.) For integration to occur, system linkages must be established. It is precisely these linkages that can be tapped to archive data under this user service. Therefore, ADUS can be thought of as another form of ITS integration – the linking of ITS components with the rest of the transportation world.

f. *Evaluating and monitoring the benefits and impacts of ITS products and services.* ITS-generated data can provide a valuable basis for evaluating the deployment of ITS within an area.

As the focus of transportation policy shifts away from large-scale, long-range capital improvements and toward better management of existing facilities, ITS-generated data can support the creation and use of new system performance measures that are required to meet this new paradigm. Also, as states and metropolitan areas develop regional architectures based on the National ITS Architecture, the specification of this user service will foster consideration of the data archiving function. Finally, as ITS-generated data are used more frequently for non-real-time purposes, it is likely that additional uses not currently foreseen will emerge.

7.1.7 Assessment of Roles

7.1.7.1 Public Benefit

The potential for public benefit is related to the myriad uses of archived data. Because such a wide variety of users could take advantage of archived ITS data, both planning and operation of transportation facilities can be improved. Further, improved data for performing transportation research and evaluation of transportation programs will lead to more cost-effective expenditure of public funds.

7.1.7.2 Role of the U.S. DOT in Developing Service

The role of U.S. DOT in developing ADUS will be significant. Simply defining the functions and the data that should be maintained in ADUS is insufficient to achieve successful implementation. Therefore, direct involvement of U.S. DOT will promote development and use of ADUS in the field. This involvement can take several forms as presented in the following sections.

7.1.7.2.1 Data Quality Control and Editing

The goal for ITS data management is the unambiguous interchange and reuse of data and information throughout all functional areas of ITS. The approach for achieving this goal is the standardization of meta-attributes within ITS Data Dictionaries that facilitate data interchange within ITS and between ITS and external systems. Meeting the goal also requires an ITS Data Registry as a particular kind of a logically centralized repository for all ITS data elements and other data concepts that have been formally specified in the National ITS Architecture. The standardization of ITS communication message protocols will result in the goal of unambiguous data interchange. These standardization efforts are currently in progress and seeking consensus within the ITS standards domain. The ADUS stakeholder agencies need to participate in the standardization procedures to define any unique data concepts within their domain.

"Accepted Practice" procedures for performing quality control and editing on ADUS data should be developed. Because ITS operations are a new phenomenon, little is known about how to identify and adjust questionable data received from field equipment. Data quality is a particular concern for those data elements that are aggregations of raw data (i.e., what should be the "rules" for handling not only questionable but missing data in the aggregation process). A research effort jointly funded by several states is examining quality control and editing procedures for vehicle classification and weight data. Consideration should be given to performing similar studies for other forms of traffic surveillance data (e.g., volumes, speeds, densities) and for other types of archived data as well. Once the procedures are established, there is an additional need to develop automated tools to facilitate quality control and editing.

7.1.7.2.2 Data Analysis Techniques

For some data, accepted procedures would be used to summarize archived data generated by ITS for the convenience of stakeholders and would promote the use of ADUS. Demonstration of analytic methods (including graphical displays) will be extremely valuable to stakeholder groups. This is especially important because the sheer volume of data may be daunting to some groups not accustomed to working with large data sets. Assistance could take many forms including providing software and sample data, case studies of how other stakeholders use data, or documenting analysis techniques for specific applications (e.g., congestion monitoring, bus route planning, and travel demand forecasting model input preparation).

7.1.7.2.3 Coordination with Other Efforts

Coordination with ongoing data dictionary efforts is crucial to the future development of ADUS. There are several ongoing efforts to develop data dictionaries for various sub-components of the National ITS Architecture (e.g., Traffic Management Data Dictionary). Because these efforts are specifying data structures, they are highly relevant for ADUS, and it would be advantageous if the users identified here could have input to these efforts. Consideration also should be given to developing an Archived ITS Data Dictionary in accordance with the guidance provided by this document and the input of users. The endeavor of creating a data dictionary will enable users and system architects to resolve many of the technical issues raised here.

Similarly, the needs of stakeholder groups can be represented through participation in the standards development process that may have an impact on the relevant data. Other efforts have the potential for influencing the nature and compatibility of data used in ITS technologies, and are relevant to ADUS.

The ADUS program should be integrated into other Federal, state, and local data collection programs. Although ADUS is only one source of data for users, it can be used to supplement or replace many existing data programs. Examples include submittals of certain data to the Highway Performance Monitoring System and statewide traffic monitoring. Full consideration should be given to how ADUS fits into a comprehensive data collection program, including data sharing and standards.

7.1.7.2.4 Training and Outreach

Training the various users in each other's needs is seen as an ongoing requirement. Personnel not directly involved in ITS operations may have a limited working knowledge of the National ITS Architecture and of ITS in general. Likewise, personnel who have a background in systems engineering rather than in transportation do not typically have an appreciation for the breadth of traditional transportation functions. Education and outreach activities need to be increased for all associated professionals. Several immediate options are available including training under the Professional Capacity Building effort and recruitment of all users for Regional Architecture Workshops. Finally, key decision makers will need to be convinced of the value of developing an ITS archive. It is therefore crucial that the benefits be clearly articulated and presented to them, perhaps through the use of case studies.

7.1.7.2.5 Field Demonstration

A concentrated field effort to demonstrate the implementation and use of ADUS should be undertaken. Similar to the concept of ITS Field Operational Tests, ADUS demonstration would provide a model for how to perform system development as well as how the data may be used. A key part of the demonstration would be to document the value of the increased information provided by ADUS to local decision making and operations. Full documentation on the institutional issues as well as the technical hurdles to developing such a system must also be addressed.

7.1.7.2.6 Institutional and Legal

At the Federal level, U.S. DOT will take an active role in fostering the necessary institutional arrangements required for deployment of ADUS. Successful implementation will require resolution of numerous issues that have been identified to date, including development, operating, and maintenance costs; system access; ownership; data quality; data management; data and communications standards; privacy concerns; data analysis; coordination with other data collection efforts; liability; confidentiality of privately collected data; incremental and uncoordinated ITS deployments; retrofitting versus new development of systems; conformance with metric conversion standards; and training and outreach.

7.1.7.2.7 Deployment

The role of the U.S. DOT in deployment of this service is to encourage the adoption and use of advanced systems by states and local government agencies.

7.1.8 Milestones and Activities

The key near-term activities are:

a. Revise the National ITS Architecture to include ADUS;
b. Incorporate ADUS's principles and concepts into ongoing standards development activities;
c. Develop case studies of existing efforts to archive ITS-generated data;
d. Focus efforts to implement ADUS-based systems as part of an ITS grant or test program; and
e. Deploy ADUS-based systems as part of routine ITS products and services.

APPENDIX D: LIST OF ACRONYMS AND ABBREVIATIONS

AADT	Annual Average Daily Traffic
ACN	Automated Collision Notification
ACS	Adaptive Signal Control Systems
ADUS	Archived Data User Services
API	Application Program Interface
ARTS	Advanced Rural Transportation System
ASPEN	A roadside inspection tool used for CVISN safety information exchange
ATC	Advanced Transportation Controller
ATIS	Advanced Traveler Information System
CAT	Carrier Automated Transaction
CC	Control Center
CCTV	Closed Circuit Television
CFR	Code of Federal Regulations
CI	Credentialing Interface
CORBA	Common Object Request Broker Architecture
CORSIM	Corridor Simulation
CPT	Common Public Transportation
CVIEW	Commercial Vehicle Information Exchange Window
CVISN	Commercial Vehicle Information Systems and Networks
CVO	Commercial Vehicle Operations
DARC	Data Radio Channel
DATEX	Data Exchange
DOT	Department of Transportation
DSRC	Dedicated Short Range Communication
EDI	Electronic Data Interchange
EMC	Emergency Management Center
EMS	Emergency Management Systems
ETTM	Electronic Toll Collection and Traffic Management
FC	Fare Collection
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FOT	Field Operational Test
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
FTP	File Transfer Protocol
FY	Fiscal Year(s)
GHz	Gigahertz
GPRA	Government Performance and Results Act
GPS	Global Positioning Systems
HHI	Highway-Highway Intersection
HQ	Headquarters
HRI	Highway-Rail Intersection
HSR	High-Speed Rail
IDAS	ITS Deployment Analysis System
IFTA	International Fuel Tax Agreement
IM	Incident Management
IMMS	Incident Management Message Sets

IRP	International Registration Plan
ISP	Internet Service Provider
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation System(s)
ITS/CVO	Intelligent Transportation Systems for Commercial Vehicle Operations
ITS JPO	ITS Joint Program Office
ITS America	Intelligent Transportation Society of America
IVI	Intelligent Vehicle Initiative
JPL	Jet Propulsion Laboratory
MCMIS	Motor Carrier Management Information System
MHz	Megahertz
MS/ETMCC	Message Set for External TMC Communication
NAFTA	North American Free Trade Agreement
NHTSA	National Highway Traffic Safety Administration
NTCIP	National Transportation Communications for ITS Protocol
O&M	Operations and Maintenance
OB	Onboard
OER	Octet Encoding Rules
PI	Passenger Information
R&D	Research and Development
RSPA	Research and Special Programs Administration
RTTRACS	Real-Time Traffic-Adaptive Control System
SAFER	Safety and Fitness Electronic Records System
SCH	Scheduling/Runcutting
SDO	Standards Development Organization
SP	Spatial Representation
SSR	Standard Speed Rail
STMF	Simple Transportation Management Framework
STIC	Subcarrier Traffic Information Channel
TCC	Train Control Center
TCIP	Transit Communications Interface Profiles
TCP/IP	Transmission Control Protocol/Internet Protocol
TEA-21	Transportation Equity Act for the 21st Century
TM	Traffic Management
TMC	Traffic Management Center
TRANSIMS	Transportation Analysis and Simulation
TSIS	Traffic Software Integrated Systems
UCR	Unified Carrier Register
UDP/IP	User Datagram Protocol/Internet Protocol
U.S. DOT	United States Department of Transportation
VPAS	Vehicle Proximity Alerting System
XML	Extensible Markup Language

APPENDIX E: REFERENCES

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