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URBAN TRANSPORTATION

Challenges to Widespread Deployment of Intelligent Transportation Systems

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The Honorable John Chafee
Chairman, Committee on Environment
and Public Works
United States Senate

The Honorable Frank R. Wolf
Chairman, Subcommittee on Transportation
Committee on Appropriations
House of Representatives

Established by the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, the Department of Transportation's Intelligent Transportation Systems (ITS) program has received federal funding of $1.3 billion to advance the use of computer and telecommunications technologies to enhance the safety and efficiency of surface transportation. The wide array of ITS technologies includes automated toll collection systems that eliminate the need for vehicles to stop at toll plazas; real-time information on traffic conditions and transit schedules for travelers; and automated traffic management systems that can adjust traffic signal systems to respond to real-time traffic conditions.

Concerned about the prospects for deploying integrated ITS in urban areas, you asked us to (1) report on how the Department has changed the focus of the ITS program since the Congress passed ISTEA; (2) examine progress in deploying integrated ITS and the key factors affecting deployment, including the status of the ITS national architecture (the framework which identifies the components of an integrated ITS) and technical standards; and (3) identify ways in which the federal government can facilitate the deployment of ITS. To respond to these objectives, we focused on the deployment of the metropolitan ITS infrastructure; we did not examine the development or deployment of other ITS elements, such as commercial vehicle operations and the automated highway system. We interviewed transportation officials in 10 urban areas that are among the nation's largest and most congested—and therefore likely to have the greatest need for ITS—and reviewed the existing studies on the ITS program. (A more detailed description of our scope and methodology is in app. I.)

Results in Brief

The Department of Transportation's long-term goal for the Intelligent Transportation Systems program—the deployment of integrated intelligent

transportation systems—has not changed since the Congress passed the Intermodal Surface Transportation Efficiency Act. However, the Department has recently changed the program's short-term focus to include a greater emphasis on deploying intelligent transportation system technologies rather than simply conducting research and operational tests. Its new focus emphasizes the deployments of integrated intelligent transportation technologies in selected urban areas, outreach and training to overcome the barriers to deployment, and a continuing research program to develop long-term intelligent transportation applications, such as the automated highway system.

Although the program envisioned the widespread deployment of integrated, multimodal intelligent transportation systems, this vision has not been realized. In part, the limited deployment of intelligent transportation systems is the result of the natural evolution of the program. For example, the program's national architecture and technical standards, which define the elements of the intelligent transportation systems and how they will work together, are prerequisite to a large-scale, integrated deployment of the systems. However, the national architecture for the systems was not completed until July 1996, and a 5-year effort to develop standards is planned for completion in 2001. In addition, the widespread deployment of the intelligent transportation systems faces several significant obstacles. These include a lack of technical knowledge and expertise among the state and local officials who will deploy the systems; a lack of quantitative data proving the systems' cost-effectiveness in solving transportation problems; and a lack of funds, in the light of other transportation priorities.

The federal government can take programmatic and financial actions to promote the deployment of intelligent transportation systems. The programmatic actions include providing technical assistance and training to state and local officials, disseminating information on the costs and benefits of intelligent transportation efforts, and completing the development of the technical standards in a timely manner. While officials from all 10 urban areas we contacted stated that intelligent transportation systems are a potentially useful tool in solving transportation problems, there was a wide variety of opinions on the appropriate federal role for funding the systems' deployment. Six urban areas stated that a large-scale federal deployment program would be necessary to achieve widespread deployment. In contrast, the remaining four opposed a large-scale program because it would limit local flexibility and would encourage the deployment of intelligent transportation systems where other, possibly

more cost-effective efforts could be undertaken. Officials from 5 of the 10 urban areas also stated that a smaller-scale federal seed program could also be effective in fostering deployment. Finally, officials from 9 of the 10 areas stated that federal financial assistance is needed to maintain deployed intelligent transportation technologies.

Background

During fiscal years 1991 through 1997, the Congress provided the Intelligent Transportation Systems (ITS) program with about $1.3 billion[1] for research and development, operational testing of the ITS technologies, and various activities to support deployment. The research and development efforts have explored new technologies and applications, while the operational tests have been the bridge between basic research and development and deployment. The activities to support deployment have included the development of an ITS architecture and a series of early deployment plans. All of the program's efforts are building on the important goal of developing a fully integrated ITS environment.

In an integrated ITS, all of the components of the ITS are linked, so as to produce greater benefits than would a fragmented deployment of the systems. For example, transit agencies use automatic vehicle location technology to manage bus fleets, and city departments of transportation can use advanced traffic signal control systems to optimally manage traffic. If these systems are linked, the speed and location data on transit buses can be used to monitor the traffic flow on arterial streets, which are typically not monitored, and traffic signals can be adjusted to enable transit vehicles to stay on schedule. Furthermore, if these systems are linked to a traveler information system, travelers can access both transit and traffic information from a single source and use this information to decide when and how to travel.

[1]Appendix II contains a figure showing the level of funding for the ITS program from fiscal years 1991 to 1997.

The Department Has Refocused the ITS Program to Emphasize the Deployment of Technologies and Systems

ISTEA required the Department of Transportation (DOT) to prepare a strategic plan that would specify the goals and objectives of the ITS program. In December 1992, DOT issued its plan, which stated that the long-term goal of using ITS technologies was to develop an integrated intermodal surface transportation system that would be safer, make more efficient use of the existing infrastructure, and enhance users' choices of travel modes. The plan assumed that building more highways was not the solution to congestion in urban areas and that the implementation of ITS technologies could reduce congestion and accidents, improve transit service, conserve energy, and minimize environmental impacts.

To meet its long-term goal, DOT initially outlined the four major components of the ITS program: research and development, operational tests of promising technologies, automated highway system technologies, and deployment support. DOT anticipated that these four program components would serve as the basic foundation for developing short-term ITS technologies, identifying long-term advanced systems, and providing the basis for the future deployment of ITS technologies. Following its initial program direction, DOT funded over 300 projects and identified several promising ITS technologies. DOT initially anticipated that the federal government would play a major role in identifying and developing these technologies, but individual users and private-sector manufacturers would pay for a substantial portion of the ITS deployment costs; no special federal funding program would be needed for the routine deployment of ITS. State and local implementers were expected to deploy ITS using existing federal program funds.

However, as part of its ISTEA reauthorization proposal, DOT is refocusing the program to place a greater emphasis on ITS deployment. According to DOT officials, the new ITS program will retain a research and development element and continue the long-term goal of an automated highway system but will refocus short-term efforts to include an emphasis on deploying ITS technologies and integrated ITS systems. In addition, the program will emphasize outreach and training to help the states and local governments overcome the obstacles to widespread deployment. DOT's earlier approach envisioned that most deployment efforts would not be funded by the federal government. DOT now believes that widespread deployment will not occur unless federal funding assistance is provided. As a result, DOT proposes to expand federal financial assistance by providing funding incentives of $100 million annually to help the state and local governments fund the cost of deploying and integrating the ITS technologies. DOT intends

that these incentives will help to promote integrated urban ITS as well as systems for improving the regulation of commercial vehicles.

Significant Obstacles Limit the Widespread Deployment of Integrated ITS

While data on the status of ITS deployment is not conclusive, most deployments have occurred in larger urban areas. However, even the larger areas are not deploying the kind of integrated systems envisioned in ISTEA. This is due, in part, to the fact that ITS is a relatively new research program that is still evolving and has yet to fully implement some fundamental program components, such as the national architecture and technical standards. In addition, significant obstacles are precluding the more widespread deployment of ITS. These include a lack of technical expertise and knowledge about ITS among those who will actually deploy the systems; a lack of cost-benefit data about ITS; and a lack of funding dedicated to ITS, in the light of other priorities for transportation investments.

ITS Deployment Has Been Concentrated in Large Urban Areas but Has Not Occurred in an Integrated Manner

Studies of the status of ITS deployment show that deployment has been concentrated in larger urban areas—those with populations of over 1 million. According to a 1995 study by Public Technology Incorporated (PTI),[2] 70 percent—7 of 10—larger urban areas were using ITS technologies to help solve their transportation problems. In contrast, the study reported that 43 percent of the urban areas with populations between 100,000 and 1 million were using ITS and that 14 percent of the urban areas with populations of less than 100,000 were using ITS. In another study, the Oak Ridge National Laboratory (Oak Ridge) conducted a survey of the nation's 75 largest urban areas and found that most larger urban areas had deployed ITS technologies but that deployment was less common in smaller urban areas.[3]

Data on which specific ITS technologies have been deployed are inconclusive. For example, according to the PTI study, the only ITS technology that a large number of urban areas had deployed was traffic signal control systems—systems designed to manage traffic flow by

[2]PTI is the nonprofit technology organization of the National League of Cities, the National Association of Counties, and the International City/County Management Association. In 1995, PTI conducted a nationwide survey of over 2,000 large and small local governments to identify ITS issues. PTI received over 400 responses from a wide cross-section of small and large units of local governments.

[3]The summary data on the survey conducted by the Oak Ridge National Laboratory, as presented by the U.S. Department of Transportation, Joint Program Office for Intelligent Transportation Systems, appear in A Report to Congress: The National Intelligent Transportation Systems Program (draft, Jan. 1997).

coordinating in real-time the timing patterns of traffic signals. The study reported that 60 percent of the larger urban areas had deployed such systems. In contrast, the Oak Ridge study showed that larger urban areas have planned or implemented a wide array of ITS technologies, including traffic signal control systems, freeway operation centers, incident management technologies, electronic toll collection, and transit technologies. In addition, our interviews with transportation planning officials in 10 of the nation's larger urban areas and a 1996 study of 7 urban areas by the Volpe National Transportation Systems Center[4] found that freeway management systems, incident management systems, and traffic signal control were the most widely deployed. The Volpe study also found that multimodal traveler information and electronic fare payment systems were the least deployed.

An example of an area that has widely deployed ITS technologies is Minneapolis. The Minneapolis ITS program, part of the Minnesota Department of Transportation's "Guidestar" program, first began operational tests in 1991. Since that time, about $50 million in public funding and $13.5 million in private resources has been invested in Guidestar projects. With these funds, Minneapolis has upgraded its traffic management center to better monitor traffic flow and roadway conditions and has installed ramp meters at numerous on-ramps of the major expressways. These meters control the flow of traffic entering the expressways and, according to DOT, have helped increase highway speeds during rush hour by 35 percent. Other projects in the Guidestar program include the use of "smart tape" that will notify those motorists who stray onto the shoulders of highways, the electronic enforcement of traffic laws, improved oversight of commercial vehicle (truck) regulations, and a systems architecture to help integrate all ITS components.

Despite these deployment efforts, existing ITS studies and the transportation officials we interviewed indicated that urban areas have not integrated the individual ITS technologies. According to the Oak Ridge study, very few areas are designing and implementing ITS in an integrated manner. The Oak Ridge study found no examples of a fully integrated ITS. In addition, the Volpe study found that transportation agencies were implementing ITS to improve the efficiency of their agencies but were not integrating these technologies with other transportation agencies. For example, the study said that transit agencies have usually functioned independently of highway agencies and are developing stand-alone

[4]Intelligent Transportation Systems: Assessment of ITS Deployment, U.S. Department of Transportation, Research and Special Programs Administration-Volpe National Transportation Systems Center (July 1996).

systems. Several of the transportation planners we interviewed also noted that the deployment of ITS technologies had occurred in a non-integrated manner in their areas. For example, transportation officials in the Washington, D.C., area stated that local jurisdictions had implemented electronic toll collection, traveler information, and highway surveillance systems without integrating the components into a multimodal system.

Working Knowledge of the ITS Architecture and the Issuance of Technical Standards Are Needed

According to DOT and several transportation officials we contacted, widespread and integrated ITS deployment is dependent on the existence of a national ITS architecture and technical standards. However, the ITS architecture was not completed until July 1996, and DOT has just begun an extensive outreach and training effort to ensure that transportation officials around the nation have an adequate understanding and working knowledge of the architecture. Furthermore, a 5-year effort to develop technical standards began in January 1996. Several transportation officials stated that an effective outreach effort for the architecture and the timely completion of the standards are critical to ensure that the maximum benefits are obtained from the extensive ITS deployments that some urban areas plan for future years.

The ITS architecture identifies the basic components of an integrated ITS, the functions such components perform, and how such components "interface" or share information with each other (see app. III). A commonly used metaphor in describing the architecture is a home stereo system. The stereo industry has determined the overall architecture—that is, the functions that will be performed by the speakers, amplifier, radio receiver, compact disc player, etc.,—as well as how these systems will interact to produce a desired sound. Within these constraints, the manufacturers may produce a wide array of product types, and an individual may design a stereo system suiting his/her own needs and budget.

Technical standards are an outgrowth of the system architecture—they specify, in detail, how the components will communicate to one another. For example, the architecture states that electronic toll collection will include a roadside reader that can read an in-vehicle electronic toll tag. The architecture does not specifically state how this linkage will be made. Instead, the standards prescribe the form and content of messages between the reader, the toll tag, and the toll facility. DOT and ITS America[5]

[5]ITS America is a consortium of private firms, public agencies, academic institutions, and related associations that plan, promote, and coordinate the development and deployment of ITS technologies in the United States.

have been supporting the development of standards throughout the architecture development effort and in January 1996, contracted with five organizations to begin a 5-year effort to develop standards. While the standards development effort is scheduled for completion in 2001, some high-priority sets of standards are scheduled for completion within a year.

Adhering to the technical standards is important because the purchasers of ITS equipment do not want to be locked into proprietary systems that cannot be integrated with those of other manufacturers and for which replacement equipment or service may not be available if the vendor goes out of business. For example, in the 1970s the Chicago Department of Transportation contracted for a custom-designed traffic signal control system. Subsequently, the vendor went out of business, and the city had to scrap the system and purchase a completely new system.

Effective outreach and training for the architecture and standards and the timely completion of technical standards are critical in the light of the extensive plans for future ITS deployments. Officials from most of the large urban areas we contacted consider ITS a key component of their future transportation systems and plan to devote more resources to ITS in upcoming years. The transportation planners we contacted stated that they plan to implement more ITS projects in the future. For example, the New York City area's short- and long-term ITS deployment plans include over $450 million in ITS projects. In addition, DOT has awarded over $26 million in early deployment planning grants to 75 urban areas to determine their short- and long-term ITS deployment needs.

Limited Technical Knowledge, Cost-Benefit Data, and Funding Constrain Deployment

Our discussions with transportation planning officials in 10 urban areas and our review of several existing studies indicate that the lack of (1) knowledge about ITS applications at the state and local level; (2) data on the costs and benefits of ITS technologies; and (3) funding for ITS, in the light of other transportation investment priorities, are the key obstacles to the widespread deployment of ITS technologies.

Transportation Officials See Need for ITS Technical Knowledge

In our discussions of the potential for ITS deployment with transportation planning officials in 10 large urban areas, the officials consistently expressed concerns about the lack of knowledge about ITS at the state and local level. According to these officials, most transportation engineers do not possess the technical skills needed to operate and maintain advanced ITS computer and telecommunication technologies. Similarly, the deputy executive director of the Institute of Transportation Engineers said that

although the Institute was involved in developing the national architecture and the members of the Institute attended numerous training and outreach sessions, most members do not have the systems integration background needed to develop a clear understanding of what the architecture is, how it works, and how it benefits the ITS applications. He said that most state and local implementers of ITS will have to rely on system integration consultants to ensure that their systems are compatible with the national architecture. This view was also expressed by the executive director of the American Association of State Highway and Transportation Officials at an ITS conference. He said that the states and urban areas have a shortage of technically trained persons to deal with ITS because transportation agencies are primarily staffed with civil engineers, not electrical engineers or system integrators, and new skills are needed.

The issue of technical knowledge was also identified as an obstacle to deployment in several studies we reviewed. According to DOT's 1997 report on nontechnical barriers to ITS deployment,[6] the staffing and educational needs of transportation agencies is one of the most pressing issues confronting the ITS program. The report concludes that the successful deployment of ITS depends on retraining the existing employees and hiring individuals who possess new skills. Similarly, PTI's survey of urban areas found that a lack of staffing and employee training was an obstacle to deployment: 56.6 percent of respondents cited staffing and training as a problem. PTI also held a series of focus groups with local officials in 1995 and found that elected officials do not talk about ITS deployment as a priority and that few see any political benefits in spending more time and money on ITS. The 1996 Volpe Center report identified both the lack of training and education among the staff required to work on ITS projects and a lack of awareness about ITS among politicians and agency managers as barriers to successful ITS deployment.

Transportation Officials See Need for Cost-Benefit Data

Our discussions with transportation planning officials also revealed that the lack of quantitative data on the costs and benefits of deploying ITS is also seen as a deterrent to deployment. According to one official, there are no adequate economic models that local transportation planners can use to determine the costs and benefits of ITS, thereby making it difficult to justify expenditures on ITS-related projects. Several officials told us that quantitative data proving that ITS could reduce traffic congestion or make transit more reliable would enable them to secure funding for ITS projects.

[6]A Report to Congress: Nontechnical Constraints and Barriers to the Implementation of Intelligent Transportation Systems, U.S. Department of Transportation, Joint Program Office for Intelligent Transportation Systems (draft, Jan. 1997).

The lack of cost-benefit information was also seen as an obstacle in some existing studies. Over 43 percent of the respondents to the PTI survey indicated that the lack of cost-benefit data and the lack of proven applications were obstacles to deploying ITS. In addition, the 1996 study by the Volpe Center concluded that relatively few formal cost-benefit analyses of ITS had been conducted. The report further stated that transportation officials needed to conduct more analyses of the benefits of ITS deployments and that such data are needed to justify spending funds on ITS.

Transportation Officials See Need for ITS Funding

Our interviews with transportation planning officials and review of studies indicate that the competition for limited financial resources between ITS and traditional transportation projects will limit the deployment of ITS. For example, officials from the Philadelphia urban area stated that they have plans representing over $100 million in ITS projects, but because of the pressing needs of their existing transportation infrastructure, it was doubtful whether they would implement many of their planned ITS projects. The officials were particularly concerned that the need to repair the deteriorating roads and bridges in their area would leave little funding for ITS projects. In addition, all of the officials we interviewed from the 10 urban areas stated that because federal law precludes the use of federal funds to maintain ITS technologies, it will be difficult for some areas to deploy ITS. These officials were concerned that transportation planners in some areas would not want to make large capital investments in ITS technologies that could not subsequently be maintained.

Eighty percent of the PTI survey's respondents cited insufficient funding as an obstacle to deploying ITS. PTI concluded that the majority of local jurisdictions believed that the funding levels for ITS need to increase in order to successfully deploy ITS. In addition, the Volpe Center's report concluded that, due to funding limitations, transit agencies will spend little to deploy ITS technologies unless such funds are earmarked for ITS deployment and that transit administrators feel that pursuing ITS projects will force other budget items to be dropped or reduced. The Volpe report stated that these factors would reduce the viability of ITS projects for transit. Finally, a 1997 DOT draft report[7] concluded that the competition for limited financial resources between ITS and traditional transportation projects will limit ITS deployment.

[7]A Report to Congress: The National Intelligent Transportation Systems Program, U.S. Department of Transportation, Joint Program Office for Intelligent Transportation Systems (draft, Jan. 1997).

Federal Actions to Foster the Deployment of ITS

The federal government can take a number of actions to address the major barriers to ITS deployment that we identified. DOT can take, and in some cases has taken, a number of measures to address the programmatic barriers. These include continuing and expanding training and outreach programs, effectively disseminating information about success stories and the costs and benefits of ITS deployments, and completing the development of the ITS technical standards. Congressional action would be required to address the financial barriers. Among urban transportation planners, we found a wide range of opinions on the desirability of expanded federal deployment assistance and on how such assistance could best be structured. However, all officials we contacted said that the flexibility to use federal-aid funds for maintaining ITS efforts was desirable.

Programmatic Actions to Address Deployment Obstacles

Our review of the existing studies and our discussions with transportation planning officials in 10 of the nation's larger urban areas identified a number of recommendations on how DOT can assist state and local implementers to overcome the key programmatic obstacles to deployment. First, to address the issue of training and outreach needs, the 1996 Volpe Center Study proposed that DOT provide education to state and local transportation staff and develop an information transfer program whereby DOT would provide contacts to state and local officials for answering ITS questions. During our interviews, most officials stated that providing training and outreach was an important role for the federal government. In addition, providing training and technical assistance in deploying, operating, maintaining, and conforming ITS technologies to the national architecture and standards was frequently cited as one of the most important actions the federal government could take to foster deployment.

DOT has taken some actions to address the programmatic obstacles. Through a 2-year cooperative agreement with PTI, DOT has implemented an outreach and training program for local agencies. Under the agreement, PTI/DOT have created a network of local government elected officials to help share information between DOT and local officials. DOT has also developed an ITS 5-year capacity-building strategic plan for DOT staff, state highway agency staff, metropolitan planning organization staff, and other local government staff. The goal is to expand the knowledge of ITS among federal, state, and local transportation officials and to create a cadre of highly trained ITS professionals who are able to plan, design, implement, operate, and maintain ITS technologies.

To disseminate information on the benefits of ITS, DOT is developing benefits reports, in which it presents data based on the experience gained in field operational tests and other deployed systems. In a September 1996 report,[8] DOT provided the results on the benefits of ITS technologies, including time savings, crash reductions, and customer satisfaction. For example, the report indicates that the use of advanced traffic management systems on an Interstate highway in Minneapolis has reduced vehicle crashes by 27 percent. Second, DOT has implemented the Model Deployment Initiative. The initiative is designed to "showcase" sites that will demonstrate the costs and benefits of an integrated ITS system. DOT has selected four metropolitan areas as model sites—New York City, San Antonio, Phoenix, and Seattle—and expects these projects to be operational during 1997. However, the results from these model sites will not be available until late 1998 or early 1999.

Finally, the lack of technical standards is seen as an impediment to the widespread deployment of ITS. During our interviews, several transportation planners said that DOT needs to ensure that the efforts to develop the standards are completed in a timely manner. DOT has awarded contracts to five standards development organizations to complete the 44 highest-priority sets of standards over the next 5 years.

Mixed Views on Large-Scale Federal Financial Assistance for ITS

The transportation planning officials we contacted had mixed views on the need for dedicated federal funding for ITS deployment. Officials from 6 of the 10 urban areas supported a large dedicated program of $1 billion or more per year, stating that, in the light of other priorities, additional ITS deployments would not otherwise occur. Officials of the four other urban areas opposed such a program because dedicated ITS funds would be too prescriptive and might result in poor investment decisions. In the absence of a large program, officials from 5 of the 10 areas we contacted supported a smaller seed program. Officials from 9 of the 10 areas supported the concept of using ITS funds to maintain ITS technologies.

As shown in table 1, the officials we contacted were divided on the need for a large-scale federal aid program dedicated to deploying ITS. Typically, the supporters contended that future ITS deployments would be limited without specific funding for this approach. For example, a New York transportation planner stated that without large-scale funding, ITS investment would have to compete for scarce dollars with higher-priority

[8]Review of ITS Benefits: Emerging Successes, U.S. Department of Transportation, Federal Highway Administration (Sept. 1996).

road and bridge rehabilitation projects. The official believed that, under such a scenario, plans for deploying ITS would be delayed. Another official likened ITS to the Interstate system, noting that without dedicated funding, the Interstate system would never have been built.

Table 1: Transportation Planners' Views on Federal Financial Assistance

Type of program	Support	Oppose
Large federal program	**6**	**4**
Set-aside of existing program	0	
New funds	6	
Grant program	3	
Formula program	1	
Mixed grant/formula	2	
Smaller seed program	**5**	**5**

Source: GAO's analysis of interview data.

The six supporters of large-scale ITS funding all expressed a preference for newly authorized ITS money, as opposed to a set-aside of existing Surface Transportation Program or National Highway System funds. As one official noted, transportation officials would not support taking money away from existing programs and distributing it to ITS because there are too many other pressing needs.

Three of the six large-program supporters favored a grant approach, under which only applicants with a specific ITS proposal would receive funds. They stated that this approach would ensure that the funds went only to areas with a definite need and would encourage ITS innovations. The advocate of the formula approach, which would distribute ITS funds to all states on the basis of specific factors, such as total urbanized population, supported the formula approach because it would be to the advantage of his very populous urban area. The supporters of the mixed approach said that all areas should get some ITS funds but that larger amounts should be available for areas with well-developed plans for larger ITS initiatives.

Four of the 10 officials we interviewed opposed a large-scale federal-aid program. All of these officials generally opposed the establishment of additional federal funding categories. One official noted that transportation planners generally identify a problem and then identify and assess potential solutions on the basis of the projected costs and benefits. Other officials noted that these resource allocation decisions are best made at the local level, not at the federal level, and that to prescribe ITS would reduce state and local flexibility. One official noted that earmarking

large funds for ITS could lead to calls for large-scale federal assistance for intermodal projects, trucking projects, and so on. Some officials also said that such a program could drive unnecessary ITS investment, as decision makers chased ITS capital money, even though another solution might have been more cost effective. Finally, officials from one area noted that such a program was very premature, stating that despite the exaggerated claims made by ITS proponents, the benefits of many ITS applications have yet to be decisively proven.

In the absence of a large-scale program, the representatives from five urban areas supported a smaller grant program of about $100 million annually nationwide that could be used to fund experimental ITS applications, promote better working relationships among the agencies and jurisdictions deploying ITS in a single urban area, or support information systems for travelers. The opponents of the smaller program felt that this level of funding would be too small to be of much assistance.

Conclusions

The reauthorization of ISTEA in 1997 represents an important milestone for reassessing the direction of DOT's ITS program. After 7 years and $1.3 billion in federal funds for an ITS program emphasizing research and testing ITS technologies, DOT is proposing a more aggressive federal role that focuses on deploying ITS systems, particularly in large urban areas. However, before DOT can aggressively pursue ISTEA's goal of the widespread deployment of integrated ITS, it must overcome the obstacles cited in this report. First, the system architecture is relatively new, and state and local transportation officials have limited knowledge of its importance. Second, it will take time for state and local transportation agencies to supplement their traditional approach to solving transportation problems through civil engineering strategies with the information management and telecommunications focus envisioned by an integrated ITS approach. In addition, time will be needed to assess the results of DOT's model deployment program—a program designed to document the benefits of an integrated ITS deployment program located in four urban areas. Programs that focus on training for state and local officials on the system architecture and on more information on the benefits and costs of ITS applications are necessary prerequisites to the acceptance of ITS as an important tool for addressing transportation problems. Finally, widespread integrated deployment cannot occur without the technical standards that DOT proposes to complete over the next 5 years. These standards are needed so that state and local governments do not purchase

ITS technologies, such as electronic toll collection facilities, that are incompatible with the system architecture and other ITS applications.

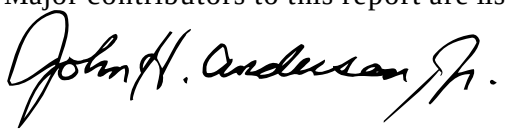
Agency Comments

We provided a draft of this report to DOT for review and comment and met with the Director of the ITS Joint Program Office and her staff to obtain the Department's comments. In general, they said that the report accurately portrayed the challenges that the ITS program faces in fostering the widespread deployment of integrated ITS systems. In particular, they said that the report accurately highlighted the nature and importance of the ITS architecture and standards. They reemphasized the fact that while ITS investments are being made, the urban areas deploying ITS need to consider the integration of the various technologies even in advance of the completed standards. The officials said that urban areas should plan to integrate their systems as early as possible rather than waiting until they have deployed individual ITS technologies. The officials also noted that we should reemphasize that our report focused only on metropolitan ITS infrastructure and did not review other areas of ITS—such as commercial vehicle technologies and the development of the automated highway system. We revised the beginning of the report to note that we focused on metropolitan ITS infrastructure only. Finally, the officials provided several specific editorial comments, which we have incorporated where appropriate. The officials made no comments on our overall conclusions.

We performed our review from October 1996 through February 1997 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Secretary of Transportation; the Administrator of the Federal Highway Administration; the Administrator of the Federal Transit Administration; cognizant congressional committees; and other interested parties. Copies will be available upon request.

Please call me at (202) 512-2834 if you or your staff have any questions. Major contributors to this report are listed in appendix IV.



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Abbreviations

DOT	United States Department of Transportation
ITS	Intelligent Transportation Systems
ISTEA	Intermodal Surface Transportation Efficiency Act
PTI	Public Technology Incorporated

Scope and Methodology

To determine how the Department of Transportation (DOT) has changed the focus of the Intelligent Transportation Systems (ITS) program since the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA), we first determined the original focus of the program. We did this by examining DOT's ITS strategic plan and other documents. We also interviewed transportation officials at the federal, state, and local level, as well as ITS experts in industry and academia. To determine any changes to the program's focus, we interviewed ITS program management and reviewed their draft proposal for reauthorizing the program.

To examine progress in deploying integrated ITS and the key factors affecting the deployment, we reviewed recent survey results and research work prepared for DOT, conducted by Public Transportation Technology Inc. (PTI), the Volpe National Transportation Systems Center, and the Oak Ridge National Laboratory. On the basis of our review of these documents, we used a standards series of questions to conduct in-depth interviews with transportation planning officials in 10 of the nation's largest and most congested urban areas who are, because of their areas' size and congestion, likely to be familiar with ITS technologies.[9] We discussed whether (1) these areas had deployed ITS technologies, (2) which specific technologies they had used an why, and (3) what if any plans they had for future ITS deployment.

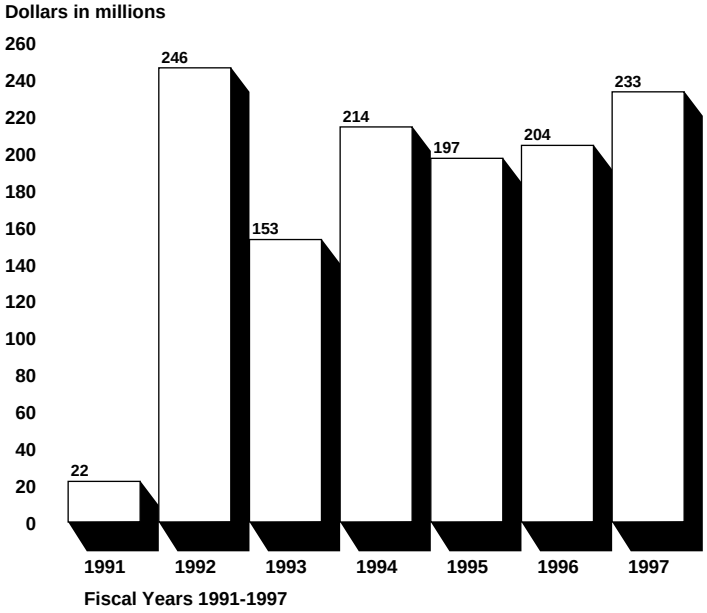
To identify ways in which the federal government can facilitate the deployment of ITS, we used a standard series of questions to guide the discussions with the officials of the selected urban areas. The discussions covered the types of financial and nonfinancial incentives that would be most effective in spurring deployment. We discussed the general pros and cons of federal financial assistance, as well as how a financial assistance program might be structured, including whether the program should be a large program of $1 billion or more annually or a smaller seed program of about $100 million. We also used the results of the PTI and Volpe studies, in concert with our interviews, to identify nonfinancial incentives the federal government could take.

[9]These areas included Detroit, Houston, Los Angeles, Miami, Minneapolis, New York, Philadelphia, San Francisco, Seattle, and Washington, DC.

The ITS Program's Funding Levels, Fiscal Years 1991-97

Figure II.1 shows the levels of funding for the ITS program. The total funding for the program, which includes projects in three modal administrations—the Federal Highway Administration, the Federal Transit Administration, and the National Highway Traffic Safety Administration—has increased from $22 million in 1991 to $233 million in 1997. The total funding for the 7-year period (fiscal years 1991-97) was $1.3 billion. This funding includes $645 million in contract authority granted for the program under the Intermodal Surface Transportation Efficiency Act (ISTEA) and $624 million provided through the appropriations process.

Figure II.1: Funding for the Intelligent Transportation Systems Program, Fiscal Years 1991-97

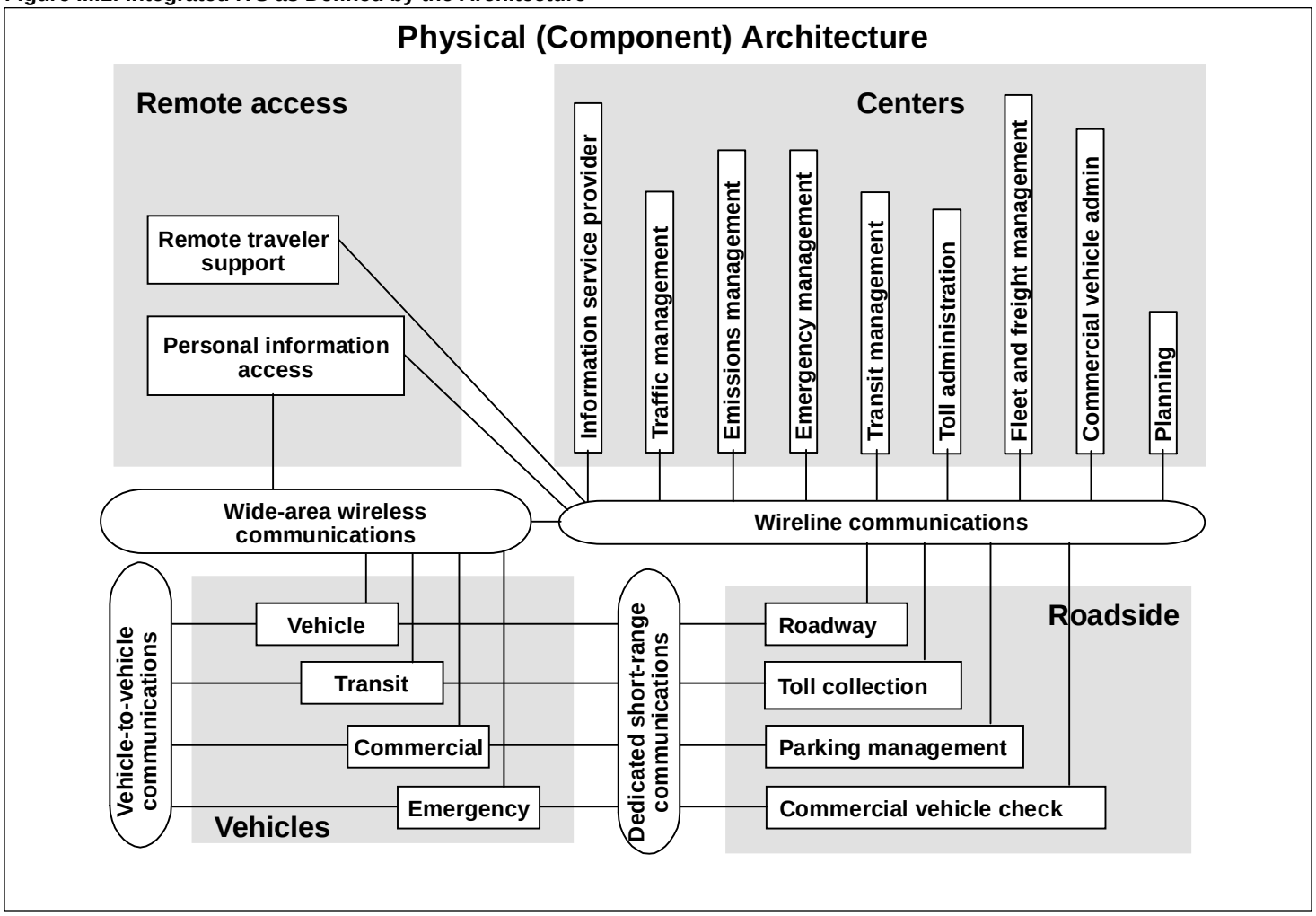


Note: For fiscal years 1992-97, ITS funding includes both the contract authority granted under ISTEA and the funds provided through the appropriations process. In fiscal year 1991, funds were provided through the appropriations process. Fiscal year 1995 reflects a rescission, and fiscal year 1996 reflects the reduction associated with ISTEA section 1003.

Source: DOT.

Overview of the ITS Architecture

Figure III.1: Integrated ITS as Defined by the Architecture



Source: DOT.

The National ITS architecture provides overall guidance to ensure system, product, and service compatibility/interoperability without limiting the design options of a stakeholder. The architecture provides a common structure for the design of intelligent transportation systems. It is not a system design nor is it a system concept. What it does define is the framework around which multiple design approaches can be developed, each one specifically tailored to meet a user's individual needs. The

architecture defines the functions that must be performed to implement a given user service, the physical entities or subsystems where the functions reside, the interfaces/information flows between the physical subsystems, and the communication requirements for the information flows. Figure III.1 outlines the physical architecture that defines the physical components of an integrated ITS system.

The physical architecture defines four systems that encompass 19 subsystems:

Center subsystems deal with those functions normally assigned to public/private administrative, management, or planning agencies. For example, the traffic management subsystem processes traffic data and provides basic traffic and incident management services through the roadside and other subsystems.

Roadside subsystems include functions that require convenient access to a roadside location for the deployment of sensors, signals, programmable signs, or other interfaces with travelers and vehicles of all types. For example, a toll collection subsystem interacts with vehicle toll tags to collect tolls and identify violators.

Vehicle subsystems are installed in a vehicle. For example, commercial vehicle subsystems store safety data, identification numbers, and other regulatory information to expedite commercial vehicle clearance by interacting with roadside commercial vehicle check points.

Traveler subsystems are designed to be accessible to the traveling public to help them make optimal travel choices. For example, a traveler at a shopping center can access an information kiosk to determine which bus to take and the time of the next scheduled departure. Alternatively, a commuter can access information on freeway traffic conditions via a home personal computer. These systems derive information from traffic, transit, and other management centers.

The architecture also identifies a basic communications infrastructure by which these subsystems can share information. It is this communication between subsystems that results in a truly integrated ITS system.

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