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INTELLIGENT TRANSPORTATION SYSTEMS ASSESSMENT OF ITS DEPLOYMENT

Review of Metropolitan Areas

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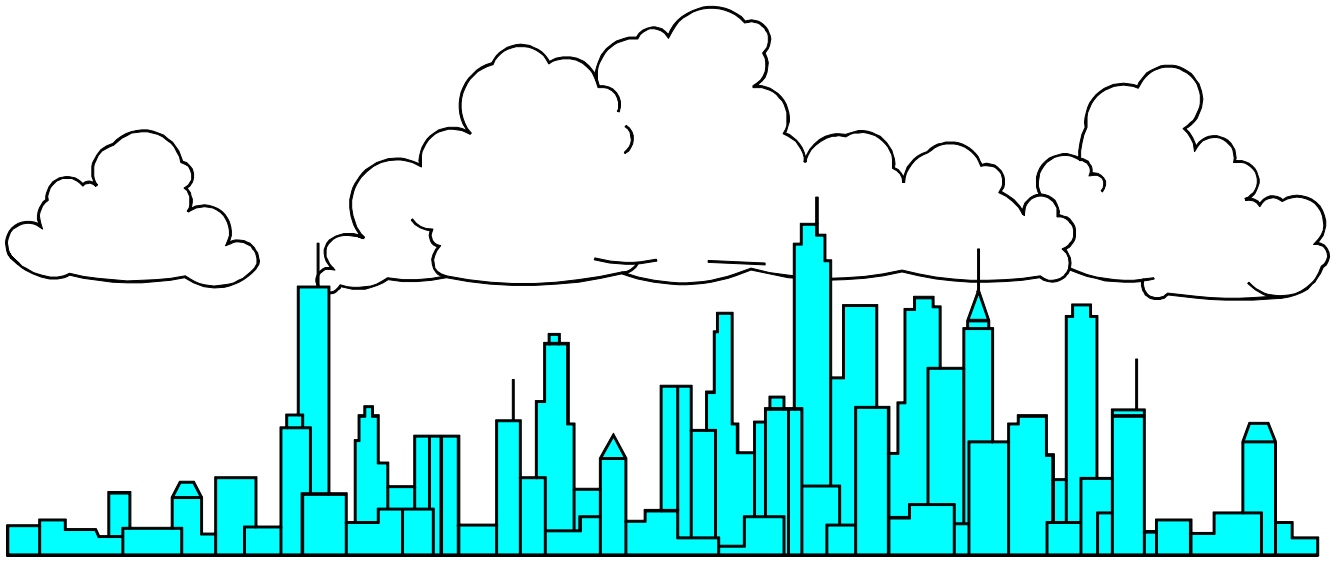
Discussions of Crosscutting Issues



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John A. Volpe National
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INTELLIGENT TRANSPORTATION SYSTEMS ASSESSMENT OF ITS DEPLOYMENT

Review of Metropolitan Areas
Discussions of Crosscutting Issues

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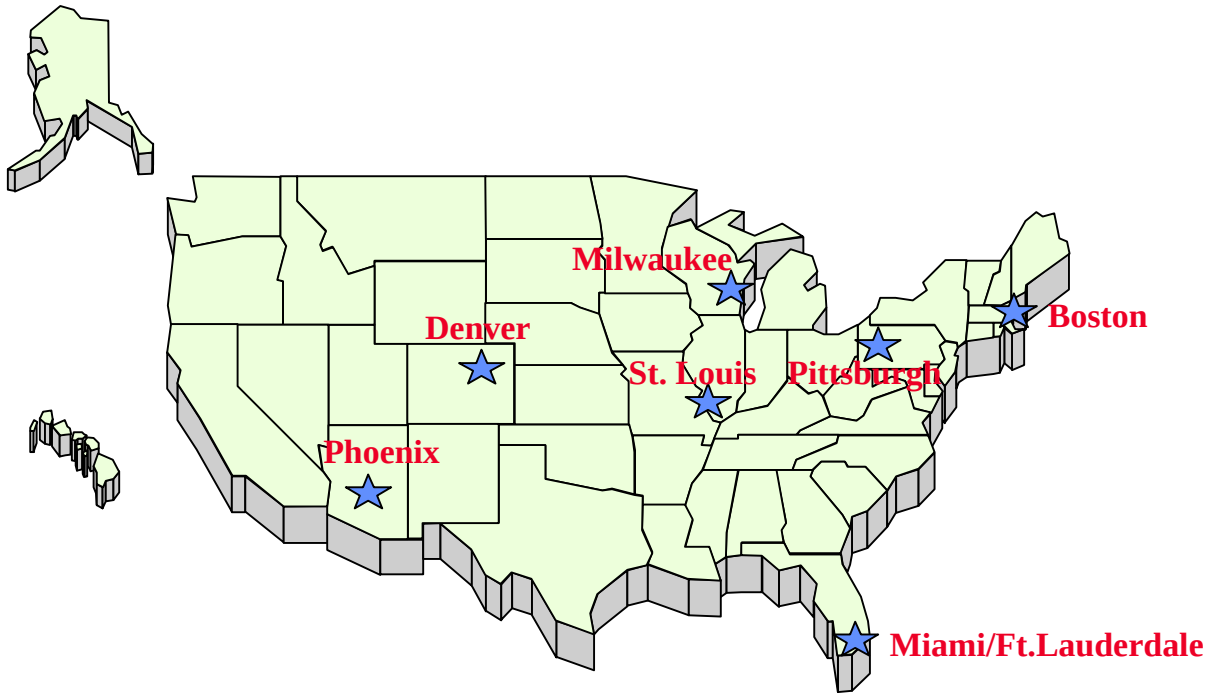
PREFACE

As part of the assessment of the development and deployment of ITS products and services in metropolitan areas sponsored by the U.S. Department of Transportation' s (U.S. DOT) Joint Program Office for ITS, analysts from the Volpe National Transportation Systems Center, EG&G Dynatrend, and Cambridge Systematics, Inc. interviewed a broad cross section of state, regional, and local transportation officials from June through October 1995. This review had a fourfold purpose:

- ⇒ To understand, within a metropolitan area, local, regional, and state transportation officials' views of ITS, including their perception of ITS, their motivation to deploy ITS, the extent to which ITS is considered, and the future role of ITS.
- ⇒ To assess the degree to which ITS are being planned and deployed and the funding sources for these activities.
- ⇒ To understand the interaction among agencies responsible for ITS, including the interaction among public sector agencies, the interaction with the private sector, and the interaction with elected and appointed officials.
- ⇒ To gain insights from their experiences, including the benefits of deploying ITS, the barriers to deployment, the keys to success, and the lessons shared.

Metropolitan Areas Reviewed



The team conducted interviews in seven metropolitan areas:

- ⇒ Boston
- ⇒ Denver
- ⇒ Miami/Ft. Lauderdale
- ⇒ Milwaukee
- ⇒ Phoenix
- ⇒ Pittsburgh
- ⇒ St. Louis.

Overviews that include the characteristics of the area and the agencies represented in the interviews are provided for each metropolitan area.

Over 130 officials in 70 agencies were interviewed. These interviewees held various positions within their organizations ranging from executive directors and managers to engineers and planners. The study team also reviewed transportation documents, such as state and regional transportation plans, state and metropolitan TIPs, and state and regional ITS plans. Based on these interviews, the review team prepared several white papers on topics that cut across the seven metropolitan areas. These papers are presented here to generate discussion within the ITS community and to solicit additional viewpoints. The white papers address these specific questions:

- ⇒ What motivates state and local transportation officials to deploy ITS?
- ⇒ Are state and local transportation officials planning ITS?
- ⇒ Are state and local transportation officials deploying ITS?
- ⇒ To what extent do public sector transportation officials interact when developing ITS?
- ⇒ What types of training and education are required by staff who work on ITS projects?
- ⇒ What benefits have been identified from deploying ITS?
- ⇒ What is the level of involvement of transit agencies in ITS?
- ⇒ What impact do environmental factors have on the planning and deployment of ITS?

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WHITE PAPERS

1. MOTIVATION

What motivates state and local transportation officials to deploy ITS?

From June through October of 1995, members of the Volpe National Transportation Systems Center interviewed a broad cross section of state and local transportation officials in seven metropolitan areas. The interviewees identified a number of motivating factors in the planning and deployment of intelligent transportation systems (ITS). Quantitative benefits of ITS were often stated as motivating factors and were often considered the ultimate determinant of whether ITS was deployed. However, when pressed to provide results of their own analysis, the interviewees were rarely able to produce valid quantitative data. Instead, the motivating factors cited most frequently were qualitative benefits and other more intangible factors.

This paper will describe the factors that motivate transportation officials to deploy ITS. It will focus not on the hard numbers which agencies purport to require, but on the common sense answers which interviewees provided in response to the question "What motivates state and local transportation officials to deploy ITS?"

Overall Findings

It is evident from the data that certain conditions predispose an agency or metropolitan area to be motivated to deploy ITS. A general knowledge of ITS and the possibilities offered by new technologies exists in all agencies that felt strongly motivated to deploy ITS. Similarly, the more comfortable transportation officials are with new technologies and the more willing they are to embrace change, the more motivated they will be to deploy ITS. Most importantly, the availability of funding for new technologies increases an agency' s motivation.

Representatives of state and local transportation agencies are motivated to plan for and deploy ITS by a wide range of factors. Several interviewees named ISTEA mandates as their motivating factor. Some talked about ITS in terms of operational efficiencies. One interviewee even claimed to be motivated because ITS is fun. Analysis reveals, however, that these responses deviate from the norm. The collected data indicated that five broad motivating factors were found across all agencies. The main motivations are congestion management (often stated as a need to better manage the existing system because no new capacity can be added), customer service, safety, economic development, and air quality improvements. It is interesting to note, that with the exception of air quality, the motivations for deploying ITS are also the typical motivations for traditional highway infrastructure projects.

MOTIVATION TO DEPLOY ITS							
Motivation	**State DOT**	**Transit Agency**	**MPO**	**County Agency**	**Local Agency**	**Authority**	**Law Enforcement**
Congestion Management	X	X	X	X	X	X	
Customer Service	X	X	X	X	X	X	
Safety	X	X	X	X	X	X	X
Economic Development	X		X		X		
Air Quality	X			X	X		

Additional motivational factors that were mentioned in some, but not all of the metropolitan areas, include solving specific transportation problems, reducing staffing needs, and avoiding complaints. ITS technologies will be considered more readily if they are linked to solving a specific problem, especially if no other options exist. Examples of this can be found in large infrastructure projects, such as the Boston Central Artery Project; projects updating old systems, such as the Pittsburgh Bridge and Tunnel Restoration Project; and the need to accommodate a large constituency, such as the City of Tempe' s bicycle detection and safety project.

The interviewees represented seven types of agencies and often had unique reasons or specific circumstances influencing their motivations. The availability of funding, the political situation in a state or metropolitan area, and the existence of a champion leading the ITS effort all contribute to the motivation to plan for and deploy ITS. There is, however, some correlation between the type of agency and the motivating factors:

⇒ **State DOT** officials are motivated by a need for congestion management, better utilization of the existing transportation system, and increased safety. The state DOTs focus primarily on freeways and consider congestion management in the context of freeways and not surface streets. Better use of existing infrastructure is sought, particularly in states with metropolitan areas in non-compliance with the Clean Air Act Amendments. In these areas new single occupancy vehicle (SOV) infrastructure projects cannot be built and other options such as ITS must be explored. Even in areas that meet air quality standards, officials are often forced by space and funding constraints to seek alternatives to adding new capacity. State DOT officials are also motivated to improve safety, which translates directly into a desire for improved incident detection and emergency response systems on the freeways.

⇒ **Transit agency** officials are motivated by a need to enhance customer service, improve operational efficiency, and cut costs. While funding is a difficulty for many public agencies, it is of special concern to transit authorities which tend to have very tight budgets. Although transit officials often have the motivation, lack of funding causes them to vary widely in their ability to deploy ITS. A transit agency with the motivation to deploy ITS, but lacking the funds for immediate O&M, will be unable to make ITS a priority. On the other hand, when

the funding is available, transit officials look to ITS to squeeze more efficiency out of their system and to increase customer service, thus broadening their ridership base.

⇒ **Municipal transportation** officials are motivated by the desire to provide more reliable service with fewer financial and human resources. Cuts in budgets and in staffing have left municipal governments looking for ways to provide adequate services with reduced manpower; ITS is sometimes considered the means to achieve this. Two additional motivations for municipalities are to update equipment and reduce complaints from the traveling public. Local agencies often use the number of complaint calls as a measure of the level of service provided.

⇒ **MPO** staffs had very diverse responses to the question of motivation. Some of the more common answers include increased economic viability, enhanced mobility, improved safety, cost effectiveness, and more efficient use of the existing transportation system. Several regional agencies believe ITS will compel agencies to coordinate their activities. The significance of this belief should not be overlooked. One of the oft cited keys to successful ITS deployment is establishing good communications and coordination among agencies. The fact that MPOs and county transportation agencies are motivated by the hope of improved coordination reflects well on ITS.

⇒ **County transportation** officials are motivated by safety, customer service, and environmental concerns. They believe mobility will be increased with the real-time information provided by advanced technologies. County officials tend to take a broad regional view of ITS and are motivated by both operational and political concerns. Several counties in the seven metropolitan areas were actively involved in ITS planning and deployment.

⇒ **Law enforcement agency** staffs are primarily motivated by public safety. State and municipal law enforcement agencies are very involved in incident management programs on freeways and surface streets. Often they are leaders in establishing "low-tech" emergency response programs which later form the basis of a technologically advanced incident management program.

⇒ **Toll authority** officials consider themselves in competition with public facilities and are motivated by a need to provide the best possible customer service. One of the findings of the interviews is that toll authorities will consider ITS more quickly than other agencies. This is due not only to the agency' s ability to raise funds, but also to the strong motivation to provide better service and less congestion than public roads. Toll authority officials are also highly motivated to reduce their operating costs, thereby increasing revenues.

Implications

In order to ascertain the implications of the different agencies' motivations, the relationships between motivation and other broad factors, such as metropolitan area characteristics, agency type, location of agency and level of deployment were examined. It was found that level of deployment and agency type are not strongly related to motivation. However, certain metropolitan area characteristics, including high levels of congestion and willingness to accept change, are strongly associated with motivation. Additionally, the prevalent motivation stated by agencies in a metropolitan area can be indicative of the type of deployment that will occur in that area.

⇒ **Specific characteristics of metropolitan areas, including high levels of congestion and openness to change, effect motivation**. In particular, representatives in areas with heavy or increasing congestion have a stronger motivation to deploy ITS. In all of the areas reviewed, interviewees reported heavily congested peak hour traffic or forecasts of soon-to-be-exceeded capacity. As is evident from the following chart, congestion management is the most often cited motivating factor in ITS deployment among these seven areas.

MOTIVATION BY METROPOLITAN AREA

Metropolitan Area	Primary and Secondary Motivation
Boston	Economic development, congestion management
Denver	Cost effectiveness, customer service
Miami	Congestion management, air quality
Milwaukee	Congestion management, safety
Phoenix	Congestion management, customer service
Pittsburgh	Congestion management, safety
St. Louis	Congestion management, economic development

⇒ **Similar agencies tended to have similar motivations, with the notable exception of transit agencies and MPOs.** State DOT officials across all seven metropolitan areas were motivated primarily by congestion management and safety. Toll authorities, municipal agencies, and law enforcement agencies also stated similar motivations across metropolitan areas. Transit agencies on the other hand, evinced either no motivation or high motivation depending on their funding status. Because of this, transit agencies need to be more convinced than other agencies that funds spent on ITS are funds wisely spent. MPO officials, also gave very different responses to the question of motivation. Because an MPO is not an operating agency and because their focus may be broader than just transportation, MPO staff tend to approach ITS differently than other agencies. Their motivations differed from each other based on knowledge or lack of knowledge about ITS, and political priorities in their jurisdiction.

⇒ **Representatives of transportation agencies within a metropolitan area are not always motivated by the same factors.** For example, in the Boston Metropolitan Area, state DOT officials are primarily motivated by the desire to more efficiently manage congestion, MPO staff are motivated by the need to enhance economic vitality, City of Boston representatives want to improve traffic management, and the state police are motivated by public safety. Although certain motivations were mentioned more than others, contradictory opinions were offered frequently enough to reveal true diversity in the motivations of the various interviewees.

⇒ **The agencies stated motivation to deploy ITS has no correlation with a metropolitan area' s actual level of deployment.** Officials within the seven metropolitan areas listed similar motivations and yet the level of deployment of elements of the intelligent transportation infrastructure (ITI) differed dramatically. Although officials may be motivated to deploy ITS, other factors such as funding, politics and agency priorities actually determine whether or not ITS is deployed.

⇒ **The agencies motivations help explain why certain elements of the ITI were found to be more prevalent than others.** State DOT officials, for example, are primarily motivated by a desire to reduce congestion, thus explaining the proliferation of freeway management system (FMS) or elements of FMS throughout the seven metropolitan areas. On the other hand, no interviewees stated information sharing as a primary motivation, perhaps explaining the lack of regional multimodal traveler information centers found in these areas.

Proposed Activities

The motivations for deploying ITS evinced by state and local transportation agencies provide a clue to the results they hope to achieve by implementing advanced technologies. One suggestion is to market ITS to state and local transportation agencies based on the agencies motivations. For example, transit agencies are motivated by customer service, and therefore the customer service aspects of AVL and GPS should be emphasized.

2. ITS PLANNING

Are state and local transportation officials planning ITS?

From June through October 1995, members of the John A. Volpe National Transportation Systems Center (Volpe Center) interviewed a broad cross section of state and local transportation officials in seven metropolitan areas. One of the goals of these interviews was to determine the extent to which these transportation officials are planning intelligent transportation systems (ITS) statewide and regionally and if ITS-related solutions are considered in the metropolitan planning process. This paper will discuss the relationship between ITS deployment decisions and the state, regional, and metropolitan planning processes.

Overall Findings

The extent of *statewide ITS planning* varied considerably among the states. There was no statewide plan in three states, completed plans in two states, a plan under development in two states, and a proposed plan in one state. In two of the states that did not have plans, the transportation officials were focusing on regional or metropolitan area plans rather than on statewide plans. Although the statewide plans were called business, conceptual, or strategic plans, which seemed to indicate a high-level plan, most of the completed plans or completed drafts included descriptions of proposed projects. Officials in Colorado are using the Denver early deployment planning (EDP) study as the basis for their statewide plan.

STATEWIDE ITS PLANNING ACTIVITIES

State	Activity
Arizona	Proposed: Statewide ITS Business Plan
Colorado	In process: Statewide ITS Business Plan
Florida	Completed: Statewide ITS Conceptual Plan
Illinois	No Statewide Plan
Massachusetts	No Statewide Plan Focusing on EDP Studies
Missouri	No Statewide Plan Focusing on metropolitan area plans
Pennsylvania	In process: Statewide ITS Strategic Plan
Wisconsin	Completed: Statewide ITS Strategic Plan

The extent of *regional ITS planning* was more consistent than statewide planning. An EDP study was the most prevalent form of regional ITS planning; EDP studies were completed in four of the seven metropolitan areas reviewed. A corridor study was completed in one area, and a priority corridor study is currently underway in another. Only one area did not have a regional ITS plan. All studies were financed by federal funds with a state and local match.

In three areas that completed an EDP study, the lead was assumed by one or more state departments of transportation (DOTs); in the fourth area, the lead agency was the county DOT. State DOTs are also leading or have led the corridor studies.

REGIONAL ITS PLANNING ACTIVITIES

Region	Activity	Lead Agency	Funding
Boston	Completed: EDP Study	State DOT	Federal
Denver	Completed: EDP Study	State DOT	Federal
Maricopa County, Az.	Completed: EDP Study	County DOT	Federal
Saint Louis	Completed: EDP Study	Two State DOTs	Federal
South Florida	Completed: Intelligent Corridor System Study	State DOT	Federal
Southeast Wisconsin	In-process: Priority Corridor Study	Three State DOTs	Federal
Southwestern Pennsylvania	No Regional Plan		

Participants in the EDP studies were concerned that decisions made or projects promoted in the plans will not be implemented because there is a lack of funding. This lack of funding may result in a lack of direction or commitment once the EDP Process has ended, making the planning process less effective or even moot.

In several areas, EDP participants used previously developed coalitions to promote the EDP study, while in other areas, new associations had to be established. In some locations, however, there was some uncertainty as to who should be included in the overall process and who should be members of the steering committee. Obtaining the correct amount of participation from the general public and other stakeholders also was a concern. In addition, potential private sector partners were not being encouraged to participate in the EDP Process.

Several EDP studies focused heavily on freeway management systems (FMS) and less on transit. A balanced approach to deploying ITS technologies, which includes all modes of transportation, was not evident in all of the plans.

The extent to which ITS technologies and services were considered in the *metropolitan planning process* also varied considerably. In one area, ITS-type solutions had been included in the long-range plan since 1977; in two others, ITS is not consciously considered. In most areas, ITS solutions are being investigated during the development of congestion management system

(CMS) plans. In several areas, ITS solutions will be included in other management plans and major investment studies (MIS).

METROPOLITAN ITS PLANNING ACTIVITIES	
Metropolitan Area	**Activity**
Boston	Long-range plan (discusses policy to use ITS technologies) Future management plans and MIS
Denver	Long-range plan (includes HOV and ramp metering) Traffic signal system improvement plan Future management plans
Ft. Lauderdale	Current CMS plan (includes ITS-type technologies)
Miami	Incorporate ITS in all planning processes Current CMS plan
Milwaukee	Long-range plan (included ITS projects since 1977) Current MIS and future CMS plans
Phoenix	Long-range plan (includes enhanced traffic signalization) Future management plans and MIS
Pittsburgh	Long-range plan (mentions undefined future ITS activity) Bridge and tunnel restoration projects
St. Louis	Long-range plan (references EDP study) Current CMS plan and future MIS

If ITS projects are to be funded with federal funds and included in the transportation improvement program (TIP), they must go through the metropolitan planning process and compete against traditional projects for funding. In all areas, ITS or ITS-related projects were included in the TIPs.

Implications

The seven metropolitan area reviews were analyzed to determine the extent to which ITS are being planned and the implications of these planning activities. Six primary patterns were uncovered:

⇒ **Regional planning, especially an EDP study, is a very positive approach to developing ITS.** The regional planning process serves as a catalyst for getting jurisdictions to work together and is an effective tool for promoting continuing interaction. It helps participants understand the ITS Program, serves as the first opportunity by many to become aware of and involved with ITS, keeps representatives informed of ITS activities of other agencies, and keeps the need for integration present among representatives. Also, a regional plan provides a development scheme that will prevent the uncoordinated deployment of ITS in the region. This plan can be a blue print for regional ITS deployment and a comprehensive plan from which individual project designs can be developed or a foundation on which future plans, programs, and projects can be built. The regional planning process also provides an opportunity for agency management to buy into ITS.

In particular, the EDP Process makes it easy for agencies to become involved in ITS planning. The EDP Process provides a forum, which encourages individuals and agency representatives to work together, usually more closely than previously experienced, and in some cases, for the first time. The process helps to improve coordination and cooperation among the participating agencies. A secondary benefit is that this increased communication among agencies enables institutional issues to be identified, reviewed, and addressed prior to any actual deployments.

⇒ **The availability of federal planning funds facilitated regional planning activities.** Federal funds were used in all regional-planning activities. The availability of funds is an incentive to plan ITS at the regional level. Another incentive was that fact that funds for the EDP and priority corridor studies were categorical funds that were specifically set aside for ITS planning activities. Officials did not have to compete internally within their agencies to implement these ITS planning activities.

⇒ **The level of local involvement in ITS planning is dependent on the lead agency, the structure of the steering committee, and the area' s geo-political structure** In all but one area reviewed that had a completed EDP study, representatives of the area' s municipalities were not involved extensively. In these areas, EDP steering committees usually were composed of state and regional agencies. Often, the large number of local jurisdictions prohibited a large percentage of municipalities from participating.

⇒ **When a state agency leads a regional study, there is a heavy emphasis on FMS**. The lead agency determines the focus of a regional planning study. In the areas reviewed, the state DOTs are responsible for the construction, operations, and maintenance of the freeway system, and therefore, the agency' s priority is the freeway system. Therefore, the focus of a state DOT-lead study will be on the freeway system.

⇒ **ITS technologies are not routinely considered in most metropolitan planning processes.** In most areas reviewed, identifying ITS technologies as possible solutions to an area' s transportation problems and investigating their effectiveness were not part of the day-to-day planning mentality of the MPO staff. In some instances, this was a result of a lack of knowledge about ITS, and in others, it was a lack of confidence in advanced technologies. In most regions, however, ITS technologies will eventually be studied as possible solutions during the development of management system plans and MIS.

⇒ **Potential private sector partners are minimally involved in the planning of ITS.** An opportunity to develop partnerships and identify areas of commercial interest was missed. If the private sector is to play a key role in the deployment of ITS technology, it must be involved in all aspects of ITS planning.

Proposed Activities

Based on the interview findings previously discussed, several activities to foster the growth of ITS deployment can be undertaken:

1. Successful efforts in regional ITS planning, including EDP studies, should be publicized so officials in other metropolitan areas become interested in developing an ITS plan for their area.
2. Support of regional ITS planning activities and categorical ITS planning programs should be continued.
3. Support for ITS planning should be expanded to incorporate statewide ITS planning activities.
4. To facilitate ITS planning, lessons learned from completed EDP projects, which may enable others to improve their planning efforts, should be widely circulated. A national forum, an "EDP Users Group," should be established to foster the exchange of information and to allow later participants in the process to benefit from the experience of earlier participants.
5. Local transportation officials should be encouraged to become more heavily involved in regional ITS planning, and state level officials should be encouraged to include transportation officials from local jurisdictions and non-highway agencies. One method to achieve increased local participation is to provide EDP funding directly to local agencies or agencies that better represent the local municipalities.
6. MPO staffs must be encouraged to incorporate the results of regional studies into their long-range transportation plans and TIPs.
7. MPO staffs must also be instructed how to incorporate ITS into their daily planning activities, especially into their management plans and MIS. Because local agencies have limited travel budgets, training should be brought to the state and local areas or funding should be provided to cover travel expenses.
8. To overcome the concern that recommendations from the plans would not be funded, participants in ITS planning activities should be encouraged to address funding options, including the allocation of current resources and the identification of new revenue sources and possible public-private partnerships, during the planning process. They should also be encouraged to involve policy makers and other key players in the planning process to obtain their buy-in, which in turn will ensure funding commitments and the success of ITS.
9. A national program in which federal funds are specifically set aside for ITS projects should be investigated. This process would allow projects developed during the ITS planning process to be submitted to the U.S. DOT and to compete for funding at a national level. This program would provide "seed money" to state and local jurisdictions to implement small ITS projects which can be used to justify future, larger, and integrated systems.

3. ITS DEPLOYMENT

Are state and local transportation officials deploying ITS?

From June through October 1995, members of the John A. Volpe National Transportation Systems Center (Volpe Center) interviewed a broad cross section of state and local transportation officials in seven metropolitan areas. One of the goals of these interviews was to determine if these transportation officials were knowledgeable of the core infrastructure and the extent to which they are deploying intelligent transportation systems (ITS) statewide, regionally, and locally. This paper will discuss the amount and type of ITS deployment that is occurring.

Overall Findings

At the time of the interviews, the U.S. DOT had defined a core infrastructure for deploying ITS traffic management and traveler information services within a metropolitan area. (Although this core infrastructure has been replaced by the Intelligent Transportation Infrastructure (ITI), this paper will continue to refer to the core infrastructure.) The knowledge of the concept varied among the interviewees. In general, state "highway" officials were the most knowledgeable, while local officials were least knowledgeable. Most interviewees, however, were familiar with the individual technologies that were part of the seven elements of the core infrastructure. Several interviewees were confused on user services vs. core infrastructure, and others stated that the core infrastructure was easier to understand than the user services. Some officials questioned the lack of a CVO component in the core infrastructure, and some expressed the need for a vision for rural areas.

The seven elements were in various stages of deployment within the seven metropolitan areas. Freeway management systems (FMS), incident management systems (IMS), and traffic signal control systems (TSCS) were in the most advanced stages, while regional multimodal traveler information center (RMTIC) and regional electronic fare payment (EFP) systems were least advanced. Implementation of transit management systems (TMS) and electronic toll collection (ETC) systems varied considerably among the areas. The timelines in Attachment A show the extent of actual and planned deployment of the core infrastructure elements.

There are no RMTICs in the seven metropolitan areas that were reviewed. In most areas, transportation officials will establish traffic operations centers (TOCs), traffic information centers (TICs), or operations control centers (OCCs) for their individual agencies before considering implementing a RMTIC, that combines information from several agencies. Because officials understand the value of disseminating traveler information, the creation of a RMTIC is a goal in the Boston (1999), Denver (1998), Miami/Ft. Lauderdale (1998), and Phoenix (long range) Metropolitan Areas. Also, traffic data and traveler information from the Milwaukee Metropolitan Area will be incorporated into the Gary-Chicago-Milwaukee (Priority Corridor) Central Information Center in Chicago.

ITS DEPLOYMENT ACTIVITIES							
Metropolitan Area	**RMTIC**	**FMS**	**IMS**	**TSCS**	**TMS**	**ETC**	**Regional EFP**
Boston	OCCs Deployed TOC Planned	Partially Deployed	Low tech Deployed	Deployed	Heavy and light rail	Partially Deployed	None
Denver	TOC Deployed	Partially Deployed	Low tech Deployed	Deployed	Bus and light rail	Deployed	None
Miami/Ft. Lauderdale	RMTIC Planned	Partially Deployed	Low tech Deployed	Deployed	Bus and light rail	Planned	None
Milwaukee	TOC Deployed	Deployed	High tech Deployed	Deployed	Buses	None	None
Phoenix	TOC Deployed	Deployed	High tech Deployed	Deployed	Para-transit	None	None
Pittsburgh	TOC Planned	Partially Deployed	Low tech Deployed	Deployed	Buses	None	None
St. Louis	TIC Planned	Partially Deployed	Low tech Deployed	Deployed	Light rail	None	None

⇒ **Some elements of a FMS were installed in all seven metropolitan areas.** Several small FMS were implemented many years ago specifically to monitor the flow of traffic through tunnels. More recently, FMS technologies are installed to monitor traffic flows on high-occupancy vehicle (HOV) lanes. In all areas, transportation officials plan to expand their FMS to cover a significant portion of their region' s highway system. Because the highway systems were under the control of state departments of transportation (DOTs) or toll authorities, most FMS were being installed by these agencies with little interaction with local agencies.

⇒ **An IMS was implemented in all seven metropolitan areas.** All areas had at least a "low-tech" IMS, which included a specific phone number for cellular phone users and motorist assistance patrols. Some areas used older technologies such as closed circuit television (CCTV) cameras and call boxes. In all areas, new FMS will incorporate technologies that can be used in IMS. Also, in most areas, a committee, which may include representatives from the state DOT, the state police or highway patrol, local police and fire departments, and other emergency response teams, was responsible for implementing the IMS.

⇒ **Traffic signal control systems were deployed in all metropolitan areas reviewed.** The level of sophistication, however, varied greatly among the municipalities. Older core cities had centralized systems that were approximately 20 to 40 years old, which need to be upgraded. Transportation officials in most municipalities are planning to upgrade their systems using time-based, closed loop, or traffic responsive systems as funding permits. In several areas, they will begin to install fiber optic cable and video monitors. Most TSCS

were under the jurisdiction of county or local governments. Several local transportation managers were surprised, but pleased, that TSCS were included in the core infrastructure.

⇒ **The deployment of TMS varied considerably among the metropolitan areas.** Although several properties have implemented automated vehicle location (AVL) systems, officials from two transit agencies stated that they did not have the funds to implement ITS as well as replace their bus fleet. Properties with light and heavy rail systems seem to deploy ITS more readily. Agencies with bus and paratransit fleets were inclined to implement computer-aided dispatching. Transit officials are wary of installing unproven technologies or technologies for which there are no national standards.

⇒ **Officials in transit and non-transit agencies are considering TMS concepts for fleet management.** Several agencies will use TMS technologies to monitor fuel and other fluid consumption, vehicle maintenance, and vehicle location and to dispatch emergency vehicles and snow removal equipment.

⇒ **Most toll authorities have implemented or are considering ETC systems.** Officials cited the needed to improve customer service and increase revenues as factors in their decision to implement advanced technologies. Also, in most instances, the implementation of an ETC system by a toll authority did not involve interacting with any other agency.

⇒ **No area has a <u>regional</u> electronic fare payment system.** In many areas, officials stated that there is no need for this element. Individual agencies, mostly transit properties, have isolated EFP systems. The magnetic stripe or "swipe" card is the most popular technology.

⇒ **Transportation officials are using advanced technologies for non-traditional purposes:**

- Checking parking violations and printing tickets
- Developing geographic information systems
- Tracking and collecting fees from taxi and limousine pools at airports
- Inventorying traffic signs and manholes
- Managing parking spaces and garages
- Counting traffic volume at retail centers
- Monitoring emissions
- Monitoring weather and road conditions
- Detecting bicycle traffic and activating signals to facilitate street crossing
- Providing tourist information.

By using advance technologies, public officials seek to perform labor-intensive activities more efficiency and to collect data and maintain inventories more accurately. These benefits differ from the normal benefits (improved safety, increased capacity, etc.) usually associated with ITS.

Implications

The seven metropolitan area reviews were analyzed to determine the extent to which ITS are being deployed and the implications of these deployment activities. Eight primary patterns were uncovered:

⇒ **Transportation officials will primarily introduce advanced technologies to address a specific need or to respond to a mandate.** Officials will only deploy ITS if they see a benefit to their agency or constituents or are required to do so. For example, jurisdictions within an air quality non-attainment area in Arizona are mandated by state law to synchronize traffic signals within and across jurisdictional boundaries on roadways that carry more than 15,000 vehicle trips per day. This requires the coordination of adjacent municipalities.

⇒ **The need to deploy the various elements of the core infrastructure are often dictated by the existing transportation infrastructure.** Several transportation officials indicated that certain elements are not required in their area. An EFP system will not be considered in an area that has a single fare structure nor will an ETC system be considered in an area that does not have a toll road. Officials feared that they would be pushed to install advanced technologies that were not needed in their area.

⇒ **Elements of the core infrastructure are not being integrated.** Transportation officials are implementing ITS to improve the efficiencies of their agency and claim that they do not have the resources to integrate their systems with other agencies. Also, some transportation officials lack a regional perspective of transportation and do not understand the importance of integration. Because transit agencies have usually functioned independently of highway agencies, transit officials are developing stand-alone systems and have little incentive to integrate their systems with highway-related systems.

⇒ **Differing priorities among interacting agencies may delay the deployment of ITS.** Local officials may oppose a state-initiated FMS or IMS if they believe such a system would adversely impact local traffic because of traffic diversion from the freeway onto local streets or traffic backing onto local streets at freeway entrances due to ramp metering. Transit officials may oppose large expenditures on highway-based ITS that do not benefit the transit agency.

⇒ **The deployment of the core infrastructure elements is seen as a public sector responsibility.** The role of traffic management has been traditionally the role of the public sector and this perception has not changed. Also, public transportation officials have not been able to define a specific role for the private sector, other than as vendor or contractor.

⇒ **State transportation agencies are leading the deployment of ITS.** State agencies are more knowledgeable of ITS in general and specific technologies. Local officials expressed concern that neither federal nor state agencies and organizations are reaching out to them to provide education and guidance.

⇒ **The requirements of a FMS and IMS are closely related.** The benefits derived from IMS are incentives to deploy ITS technologies and to develop FMS. Differing goals, such as improved public safety for law enforcement agencies and reduced traffic congestion for highway agencies, can be satisfactorily addressed by implementing a joint system.

⇒ **The need to monitor special events is an incentive to deploy ITS.** In several areas, officials plan to implement a system using FMS and IMS technologies to monitor vehicular and pedestrian traffic around sporting arenas and concert halls.

Proposed Activities

Based on the interview findings previously discussed, several activities to foster the growth of ITS deployment can be undertaken:

1. The needs of transportation managers must be identified and the most appropriate solutions to those needs should be presented to them. Transportation managers, especially at the local level, are not always aware of the technologies that are available or of the functions of the technologies. Transportation managers need to be convinced that the technologies are solving problems rather than just "looking for solutions."
2. Transportation managers must be convinced that they should embrace the national goals specified for the deployment of the Intelligent Transportation Infrastructure as their goals.
3. Transportation managers must be shown the benefits of integrating ITS within and among regions. Specifically, the integration of transit and highway ITS activities, especially the sharing of information, must be stressed.
4. Training courses, educational materials, and a forum to exchange information should developed for county and municipal officials. Training courses should be presented locally.
5. Because of their involvement is necessary in IMS, law enforcement agencies should be encouraged to participate in ITS activities.

4. PUBLIC SECTOR INTERACTION

To what extent do public sector transportation officials interact when developing ITS?

From June through October of 1995, members of the Volpe National Transportation Systems Center interviewed a broad cross section of state and local transportation officials in seven metropolitan areas. As part of this process, data was gathered on the level of interaction that takes place among transportation officials when planning and deploying ITS. Because interviewees discussed interaction both in terms of communication among transportation agencies within one metropolitan area and of information exchange among transportation professionals from different metropolitan areas, this paper discusses the extent of interaction that occurs among transportation professionals both *within each of the metropolitan areas visited* and *between different metropolitan areas.* It also presents implications of these levels of interaction and discusses proposed activities that emerged from analysis of both levels of interaction.

Overall Findings

Interaction among transportation professionals *within a metropolitan area* differs from one area to another, suggesting that the effects of these differing levels of interaction are not immediately apparent. It seems that the extent to which ITS is planned and deployed is not influenced by the level of interaction among officials of the transportation agencies in that area.

Interaction among transportation professionals *from different metropolitan areas* is largely informal and inconsistent. This interaction exists primarily as a result of membership in transportation organization, such as ITS America, the Transportation Research Board (TRB), and the Institute of Transportation Engineers (ITE), or is based upon individual relationships. However, officials from most areas would like to have increased interaction with officials from other areas.

Interaction within a Metropolitan Area

It is obvious from the data collected in the metropolitan area reviews that more interaction among transportation professionals would improve the existing level of knowledge about ITS and would help to deploy ITS more efficiently. Improved coordination can be achieved in two ways: as a by product of inter-agency project activity or through a medium that is specifically devoted to achieving ITS-related interaction.

⇒ **Involvement in regional ITS forums increases the interaction among an area' s transportation officials.** Early Deployment Planning (EDP) studies were conducted in five of the seven metropolitan areas visited. In these five areas, the EDP steering committees were found to help stimulate interaction among the agencies participating in them. In addition, of those five areas, transportation officials in four claimed to possess overall "positive" perceptions of ITS and to be "very familiar" with ITS.

METROPOLITAN AREA VEHICLES OF INTERACTION		
Metropolitan Area	**Forum**	**Scope**
Boston	EDP Steering Committee	Regional
	Electronic Toll and Traffic Management (ETTM) Committee	Statewide
	New England ETTM Committee	Multistate
Denver	EDP Steering Committee	Regional
	EDP Task Force Incident Management (IM) Coalition	Regional Statewide
	ITS Implementation Team	Statewide
Miami/ Fort Lauderdale	Freeway Incident Management Teams	County
	Dade County ITS Coordinating Committee	County
	Intelligent Corridor System (ICS) Steering and Advisory Committees	Corridor, to be Regional
	ITS Task Team	Statewide
Milwaukee	Southeastern Wisconsin Incident Management Program (SWIM)	Regional
	ITS Steering Committee	Statewide
	Gary-Chicago-Milwaukee (GCM) Priority Corridor	Multistate corridor
Phoenix	Metropolitan Area Governments Information Center (MAGIC) Coalition	Regional
	EDP Steering Committee	Regional
Pittsburgh	Pittsburgh Modal Integration Committee EDP Steering Committees	Regional Corridors
St. Louis	EDP Steering Committee IM Coalition	Regional Regional

⇒ **Incident management (IM) programs also increase the interaction among an area' s transportation officials and with law enforcement agencies.** IM programs are present in five of the seven areas visited. IM programs require inter-agency cooperation in order to succeed, and, therefore, positively affect interaction. IM coalitions can bring together not only representatives of the area' s transportation and law enforcement agencies, but also representatives from safety, emergency response, and operating agencies, as well as the

private sector. In one area, the initiation of an IM program led to the development of an ITS program. Of the five areas with IM programs, perspectives of the transportation officials from three of those areas can be characterized as "positive."

⇒ **Although in most areas the staffs of the state DOT and the MPO have a good relationship, the extent to which they interact on ITS may not be fully developed.** All MPO staffs realize that their authority has increased under the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), but some state officials have not grown accustomed to this changing role of the MPO. There is also a perception that many MPOs lack the technical expertise to understand and properly analyze ITS. Some MPO staffs hold this opinion and are, therefore, reluctant to assert themselves in planning and deploying ITS.

⇒ **Transit and law enforcement agencies, which traditionally acted independently, are interacting more with other transportation agencies.** ITS planning activities have increased the interaction between transit agencies and other transportation agencies. Involvement in IM programs has done the same for law enforcement agencies.

⇒ **The degree of interaction between municipal transportation agencies and other transportation agencies varies considerably**. Most local transportation officials are usually more concerned with integrating technologies with other agencies within their jurisdictions than with state agencies or agencies in other jurisdictions. However, officials from the core or central city within an area often have a more regional outlook than those from the outlying municipalities and therefore, are more likely to interact with state and regional transportation officials. In some instances, local transportation officials were not fully involved in developing the ITS plan for their region. Representatives from several municipalities, however, did state their desire to be more involved in regional ITS planning and deployment activities.

Interaction across Different Metropolitan Areas

Interaction among transportation professionals from different metropolitan areas varies across regions. In most areas, however, the existing level of interaction is perceived as insufficient by the transportation professionals in that area.

⇒ **Many transportation officials note that they would benefit from increased interaction with officials in other areas**. There is a strong desire to learn from the accomplishments and mistakes of others. These officials also point out that interaction is especially useful among areas that have similar levels of ITS developments and deployments.

⇒ **Interaction among officials from different areas usually occurs as a product of membership in professional transportation associations.** Interaction takes place during professional meetings and conferences and its existence is highly dependent upon the officials in that area' s involvement in these associations.

⇒ **Many officials believe that networking at conferences with peers and vendors is essential to being educated regarding ITS.** In one area, representatives of the transportation agencies travel to different states to view the applications of new technologies in those areas.

Implications

The eight findings were based on the information provided by the interviewees specifically related to their interaction with other public officials. The Volpe Center team developed several implications that place these findings in perspective with the wide range of information provided during the reviews.

Interaction within a Metropolitan Area

Several implications can be drawn from analysis of the levels of interaction among transportation officials.

⇒ **A correlation exists between the level of interaction among transportation professionals in an area and the familiarity and favorableness with which ITS is viewed in that area.** In one area, officials report a "considerable" level of interaction, and purport to have a "positive" opinion of ITS. Conversely, in another area, officials report a "not extensive" level of interaction and, in that area, some transportation professionals are not sure what technologies are included within the ITS parameter.

⇒ **There is an indirect correlation between levels of interaction and ITS planning and deployment activities**. A direct relationship does not exist between the level of interaction among transportation officials within an area and the development and deployment of ITS projects. However, as shown in the previous implication, interaction does contribute to positive attitudes and the perception of ITS, and attitudes and perception of success affect actual realizations of success.

⇒ **Interaction among transportation officials within an metropolitan area increases the likelihood of ITS elements being integrated.** In the Boston Area, representatives of three state transportation agencies joined together to develop the requirements of a statewide electronic toll collection system. In the Phoenix Area, representatives of the transportation agencies created the Metropolitan Area Governments Information Center (MAGIC) to improve regional mobility through enhanced multi-jurisdictional coordination and cooperation. This partnership fostered the coordination of traffic signals between adjacent jurisdictions. In the Denver Area, the staff of the MPO developed a Traffic Signal Improvement Plan. Through the interaction of the MPO and local jurisdictions, the traffic signals on over 50% of the principal corridors, consisting of 45% of the area' s signalized intersections, will be coordinated when the plan is fully implemented.

⇒ **Without adequate interaction, transportation officials may have a false impression of other agencies' priorities regarding ITS.** In this situation, officials often have an incorrect impression of the priorities of other agencies. For example, in one metropolitan area, transit officials report that they believe other agencies in the area focus too many resources on highway needs and priorities and are concerned primarily with the highway rider. However, in describing their vision of the future of ITS, officials from the state DOT district office expressed a desire to focus more on transit and less on the highways.

⇒ **Differing agency priorities may hamper the interaction among agencies.** For example, the focus of state transportation officials is on freeway and incident management programs, which may require diverting freeway traffic onto local roads. Local officials are concerned with local and neighborhood traffic issues and fear that diverted traffic will adversely impact their jurisdiction. These differing priorities affect the degree and effectiveness of interaction between these two entities.

⇒ **EDP studies and other regional ITS planning activities created forums that fostered agency interaction.** Steering committees for these planning activities serve as catalysts for getting representatives of the various transportation agencies to work together. These committees also proved to be effective tools for promoting continuing interaction.

⇒ **The interaction between state DOTs and other levels of government is dependent on the openness of state DOT officials to allow other jurisdictions into the ITS process.** State transportation officials are leading ITS activities in most states. If these officials are aware that a wide range of stakeholders must be included in the ITS process, that the opinions of these stakeholders must be solicited, and that all modes of transportation must be considered, then interaction among all transportation agencies is greatly increased.

⇒ **Interaction requires increased communication.** By all accounts, ITS projects benefit from open interaction among agencies. In the ITS projects in which a large degree of communication occurs, transportation professionals noted a greater sense of involvement in the process and relate more of a stake in its success. In one area, progress in implementing ITS was delayed because of the lack of a truly open dialogue. This situation was reversed when the transportation officials in the area realized that a strong interaction among agencies is required to plan and deploy ITS and, therefore, increased the communications among their agencies.

⇒ **Agency functions may cause certain patterns of interaction to be developed**. At the federal level, representatives from the Federal Highway Administration usually interact with state DOT officials and representatives from the Federal Transit Administration with regional transit officials. There is little interaction between federal representatives and local transportation managers. At the state level, state law enforcement officials involved in ITS interact primarily with state DOT managers. In some regional planning activities, state DOT officials interacted with representatives of the MPO and viewed the MPO input as being representative of the local municipalities.

Interaction across Different Metropolitan Areas

Additional implications can be drawn from analysis of the interaction that occurs among officials from different metropolitan areas.

⇒ **The interaction of transportation officials across metropolitan areas is required for the development of an integrated regional ITS.** In the Gary-Chicago-Milwaukee Priority Corridor, the transportation officials from three states are working together to implement a regional multimodal traveler information center. In Southeast Florida, Florida DOT officials are working with a variety of transportation professionals and agencies from Broward, Dade, and Palm Beach Counties to plan and deploy the Intelligent Corridor System.

⇒ **The lack of funding for travel and training limit the degree to which transportation managers can participate in conferences and other educational activities**. Representatives of most agencies see the need to interact with peers and vendors. Usually this interaction occurs at meetings of professional associations. Most often, however, transportation managers are restricted to attending meeting of local chapters. This considerably limits their ability to network with others on a broader, national scale.

⇒ **Many transportation officials express a desire to know what technologies have been tried in other areas.** Before officials proceed with investments in development and deployment of ITS, they want to know if similar investments have been successful in other areas, especially areas that have similarities in geography and population with their own. This information is not readily available to many transportation managers.

⇒ **Transportation officials from some regions have incorrect impressions of the level of ITS activity that exists in other areas**. For example, in one metropolitan area, one county official remarked that, compared with other areas, the level of ITS activity in his region is barely worthy of study, when, in fact, the ITS activity in this metropolitan area is comparable in scope with that of other areas. Knowledge of ITS activities in other metropolitan areas would not only help transportation managers in implementing ITS technologies but would also aid them in building political, public, and administrative support in their area.

Proposed Activities

Many transportation officials believe an important role of the U.S. DOT is to act as a clearinghouse of ITS information. In this vein, the DOT should not only distribute ITS information, it should make it a goal to increase communication among agencies within specific regions and across metropolitan areas.

⇒ **Activities that require inter-agency coordination should be encouraged.** Officials from transportation agencies who were participants in regional planning studies, especially EDP studies, report increased interaction as a by-product of the planning process. Activities in which agencies have to work together to achieve specific goals create an environment of interaction that, once established, can be used to promote continuing interaction.

⇒ **Within a metropolitan area, state and local transportation officials from different agencies should be brought together for training programs.** Include members of other agencies in training for one agency. For example, if a training session is being presented at a transit agency, then officials from the other transportation and law enforcement agencies should be included both to foster interaction and to illustrate the benefits and uses of the specific transit training.

⇒ **An information exchange program should be developed.** Among different metropolitan areas, the U.S. DOT should sponsor information exchange and dissemination about the experiences of other areas so they are able to benefit from those experiences and avoid replicating mistakes.

⇒ **Educational and outreach programs must be brought to state and local transportation managers.** To overcome the funding and travel restrictions that state and local transportation officials face, programs should be delivered as close to the expected audience as possible.

⇒ **Forums that promote communication among area officials should be developed.** In most areas visited, officials repeated the need for increased interaction with other agencies. In response to this, the U.S. DOT should develop a nationwide forum to which officials can turn in search of ITS interaction and information.

5. TRAINING AND EDUCATION

What types of training and education are required by staff who work on ITS projects?

From June through October of 1995, members of the Volpe National Transportation Systems Center interviewed a broad cross section of state and local transportation officials in seven metropolitan areas. As part of this process, data was gathered on the training and education needs of transportation officials involved in the planning and deployment of ITS. Although the focus of the Volpe Center interviews was on deployment activity and agency interaction, not on training and education, extensive information on the need for training and education was gleaned as a by-product of the interview process. Training and education, or the lack thereof, was brought up repeatedly in response to questions regarding keys to successful ITS deployment, barriers to deployment, the U.S. DOT role in ITS, and the skills required by staff working on ITS.

This paper will describe the training and education needs of state and local transportation officials who plan and deploy ITS. It will begin with a review of staffing and education needs as defined in the Report to Congress, "Nontechnical Constraints and Barriers to Implementation of Intelligent Vehicle Highway Systems," and will then describe the training needs found in the review of operational tests. The findings from the metropolitan area reviews will then be presented and compared to the previous research efforts. In this way, the reader will learn how the broad concerns expressed several years ago compare with concerns expressed in the operational tests and the reality of actual deployment. The final sections of the paper will assess the implications of these findings and propose future activities in training and education.

Overall Findings

Research reveals that, until recently, the focus of ITS education and training has been on educating individuals at the university level. However, the release of FHWA's "Five Year Strategic Plan for Professional Capacity Building" may shift the focus from educating university-level engineers to training existing transportation professionals currently working on ITS. The findings from the metropolitan area reviews indicate that this change of focus will be welcome by state and local transportation staff.

Early Findings

The 1994 Nontechnical Constraints Report draws information from outside research, primarily the Urban Institute's "IVHS Staffing and Educational Needs" report, to analyze the potential staffing and education needs of individuals who plan and deploy ITS. While the parameters of the Nontechnical Constraints Report are broad and include potential training needs of commercial vehicle operators, the private sector, and the U.S. DOT staff, only the concerns

related to the training of state and local transportation officials will be considered here. These concerns include a lack of qualified engineers, a lack of expertise required to staff operations centers, a lack of training at colleges and universities, and some concern about which technologies will be the responsibility of the public sector versus the private sector.

The challenges to state and local government, as presented in the 1994 Nontechnical Constraints Report, focus on building expertise within transportation agencies. State and local organizations "tend to build upon existing staff expertise (which is rooted in civil engineering), not in those scientific and technical disciplines that are required for the deployment of many (ITS) products." They also "face financial and staffing constraints that will make it difficult for them to deploy, operate and maintain new IVHS technologies." Local agencies were thought to be particularly susceptible to the lack of funding and staff. No specific recommendations were made to help agencies face these challenges.

The Volpe Center' s analysis of other U.S. DOT-sponsored reports on non-technical issues encountered only a small amount of research on training and education. The conclusions of the research suggested that few mechanisms exist to provide training to staff who work on ITS projects. Recommendations presented in some reports were made to adopt an academic strategy to incorporate ITS subjects into university curricula.

Findings from the Review of Operational Tests

During the evaluation of ITS operational tests, some participants stated that current staffs lacked the skills necessary for ITS projects. This problem was thought to be caused by the newness of the ITS program and resulted in project delays. The resolution of the issue came through hiring additional technical and administrative staff and training existing staff. One lesson learned from the analysis of operational tests was that ITS products and technology must be promoted to state and local organizations, the general public, and the private sector. Funding should be provided for such outreach. Several interviewees recommended that the U.S. DOT and other agencies involved in ITS should develop educational materials for state and local transportation agencies. The material should include information on "ITS products and services, benefits of deploying ITS, identification of successful ITS deployments, explanation of federal and state policies and procedures, and formation of public-private partnerships." The implementation of a fellowship program for staff at state, regional, and local agencies who wish to develop greater expertise in the field of ITS was also recommended.

Findings from Metropolitan Area Reviews

It is evident from the data collected in the metropolitan area reviews that more training and education is required at the state and local level. Transportation officials are interested in training existing employees to better meet the demands of ITS. They are also concerned with educating the public and key state and local politicians in the hope that a greater understanding of the benefits of ITS will lead to greater acceptance. A comment from an official in the Denver Metropolitan Area is indicative of the attitudes of most interviewees: "Education regarding ITS

uses, products, and services is the best way to overcome institutional issues and change the way of thinking by politicians, practitioners, and the general public."

Although the interviews encompassed individuals ranging from high-level state officials to local engineers, the need for more extensive training was expressed uniformly, by all categories of interviewees:

⇒ **Many agencies consider knowledgeable staff and adequate training as the keys to successful ITS deployment.** Special skills are required to work on ITS projects and existing staff requires special training in order to acquire an ITS knowledge base. Lack of staff knowledge about ITS can hinder routine consideration of ITS as a transportation solution.

⇒ **Several barriers to ITS deployment relate directly to education or training.** Several agencies report a lack of ITS knowledge within staff and also a resistance to change among many of the older engineers. Some staff members are nervous about using unproved technologies and skeptical of the benefits of ITS. Lack of awareness or support by politicians, upper management, and the general public is also a barrier to ITS deployment. State and local politicians who understand ITS are more supportive of deployment than elected officials who have no concept of ITS. The general public is also expected to be more receptive to ITS once they have been educated to the benefits. One caveat expressed by several interviewees is that it is important for both politicians and the general public to be educated about the limits, as well as the uses of ITS, so they do not have unrealistic expectations.

⇒ **Individuals seek to educate themselves through information from trade organizations and publications.** The Institute of Transportation Engineers (ITE) was cited most frequently by state officials and the International Signal Manufacturers Association (ISMA) was cited most frequently by local officials as sources of ITS information. Also commonly mentioned were Transportation Research Board, American Association of State Highway and Transportation Officials, American Public Transit Association, and the Institute for Electronics and Electrical Engineers. Several other organizations, including the American Planning Association, American Public Works Association, American Society for Civil Engineers, and International Association of Chiefs of Police, were cited by a few interviewees. Vendors are an important source of information for many municipalities, but they do not provide a balanced picture of the technology available. State chapters of ITS America and local chapters of professional organizations are also important avenues of information for local transportation officials.

⇒ **Staff at state and local agencies perceive major roles of both U.S. DOT and ITS America to be training and education.** Many interviewees believe the U.S. DOT and ITS America are making great headway in training and educating ITS constituents; however, further education is needed in some areas. Some agencies believe their ITS America chapter provides them with more relevant training and educational opportunities than the national chapter. The municipal representatives were overwhelmingly of the opinion that neither the U.S. DOT nor ITS America have approached local transportation officials in an attempt to understand local needs.

⇒ **Local transportation staff are in the most dire need of training.** Most local officials are not as well versed as state officials in the different elements of ITS. Information from the U.S. DOT and ITS America does not always trickle down as far as the local practitioners, and due to funding and travel constraints, local officials are not always able to pursue ITS information. Because the active involvement of local officials is critical to full deployment of the Intelligent Transportation Infrastructure (ITI), the training and education of this group must be considered.

⇒ **Officials discussed that training and education needs to be ongoing**. They are concerned that rapid changes in ITS technologies cause the information acquired by training to become moot in a very short time.

⇒ **Training must be brought to the metropolitan areas because local practitioners do not have the funds to travel.** City and county officials often cited tight budgets and an inability to travel outside of the state as barriers to obtaining much needed ITS training. These travel restrictions often apply to state agencies as well.

⇒ **Lessons learned from deployments in other metropolitan areas are eagerly sought by many agencies.** Transportation officials want to be able to compare planning and deployment in their own area to that in similar areas. Information on benefit-cost analyses, level of deployment, and use of technologies would be useful in areas with similar population and transportation features.

Implications

Analysis reveals several implications resulting from the interview findings.

⇒ **The education efforts of the U.S. DOT and ITS America to date have met with some success.** Many of the interviewees, though unfamiliar with the term core infrastructure (now ITI), were aware of the individual elements that comprise the core infrastructure. State DOT officials were the most knowledgeable about the core infrastructure, while local officials were the least knowledgeable.

⇒ **The measurement of benefits could be improved if staff had greater analytical skills or knowledge about benefit measurement tools.** Many interviewees lack an approach to evaluate specific ITS technologies and also lack the expertise necessary to develop such an approach. Staff members questioned their ability to assess ITS alternatives and are seeking new tools to help them quantify the benefits of ITS.

⇒ **Agencies will benefit from both broad and specific training programs.** Representatives from many agencies suggested that they could benefit from training on both general topics and specific topics. General topics include the National ITS Program Plan, standards, public-private partnerships, federal funding, and public involvement. Specific topics include in-depth coverage of a single ITS application and how to obtain funding for specific projects.

⇒ **Agencies will seek out opportunities to obtain education, but demand that these opportunities be convenient, low cost, and accurate.** Education and training for ITS must be provided on different levels and in different forums. Many state and local practitioners are capable of understanding the technical aspects of ITS, but they may have very different training needs. A state practitioner may be more able to travel and more interested in highway and incident management, while a local official may be more interested in traffic signals and only able to attend local seminars. Transit agencies also have their own sets of requirements that are different from all other agencies. The agencies will take advantage of available training opportunities only insofar as they are accessible, affordable, and relevant.

⇒ **Training and education should extend to elected and appointed officials and the general public.** Public officials and the general public are two important ITS constituencies that must be educated. Interviewees believe that the more elected officials and the public know about the benefits and capabilities of ITS, the more support they will provide.

⇒ **U.S. DOT should set aside some ITS funding specifically for training activities.** A number of agency officials report a lack of funding for training and education. One agency suggested including training costs in product development, while others suggested separate funds be made available for ITS training.

⇒ **The EDP Process can be an effective tool for promoting training and interaction.** Representatives report that involvement in an EDP study helps them to understand the ITS process and reinforces the need for integration among participants. EDP studies can be catalysts for getting jurisdictions to work together and help to keep representatives informed of the ITS activities of other agencies.

Proposed Activities

Most interviewees believe an important role of the U.S. DOT, ITS America, and others is to provide training and education on new technologies. A number of specific suggestions were made on the topic of training and education, with an emphasis on obtaining more information with greater expedience. Most of these suggestions are compatible with the FHWA's "Five Year Strategic Plan for Professional Capacity Building" and should perhaps be considered in tandem with that report.

The "Five Year Strategic Plan for Professional Capacity Building" was released by the Office of Traffic Management and ITS Applications Training Team in March 1996. This report identifies the parties which require training and education and defines the amount of ITS knowledge they require in the short term (1-2 years) and the long term (5+ years). Four increasingly intense levels of knowledge are assumed to be required, although not everyone needs to reach the highest level. These four levels are awareness, overview, specialized, and intensive. The report then outlines a plan for meeting training and education needs using existing U.S. DOT and commercial courses, and pre-established agreements with trade organizations whenever possible.

The Plan' s targets for state and local transportation officials are closely in line with the requests made by these types of officials in the metropolitan area reviews. The agencies reported that training and education should be provided in five different areas: develop an information transfer program, provide training on the use of federal funds for ITS, provide localized training seminars, publicize the ITS program, and assist in partnership development.

⇒ **Develop an information (or technology) transfer program.** ITS practitioners would like the U.S. DOT to assign a contact who can provide answers to non-technical and specific technical questions from state and local officials. They would like to see the broad dissemination of ITS information, especially benefits data, but also information about what is or is not working in other metropolitan areas. Several agencies suggested publicizing ITS success stories, distributing quantitative analyses, and providing information specific to transit agencies. U.S. DOT needs to identify "best practices" and develop national standards Additionally, because technology changes so rapidly, the process of training must be continuous. Training and education must be an ongoing, not a one-time-only, effort.

⇒ **Provide education to state and local transportation staff.** Training programs should be brought directly to state and local agencies because of travel constraints. The content of such programs can focus on general ITS applications and also on specific ITS products and services. Training programs can be assembled that focus on specific agency types. For example, many transit officials believe that the current focus of ITS is highways and commercial vehicles, but training and education will help them see the uses and benefits of transit-oriented ITS. Transit agencies are often interested in ITS training, but only as it relates to the transit system. Similarly, ITS training should be provided directly to staffs of local transportation agencies that currently believe they are being overlooked by the U.S. DOT. Along this line, many agency representatives believe that ITS America should continue to promote and support local chapters.

⇒ **Promote and publicize the ITS Program to state and local elected officials and the general public.** The U.S. DOT and ITS America need to develop a nationwide public education and awareness campaign for ITS. This could dramatically reduce the public education efforts required by the state and local agencies during their initial ITS deployments.

⇒ **Provide guidance on the use of federal resources for ITS.** U.S. DOT needs to identify what technologies are eligible for federal funding and present the criteria that are used to determine the appropriate funding sources. Additionally, they should identify funding sources for on-going operations and maintenance of ITS projects. Because training is vital to the success of an ITS effort, there should be a training component within the ITS funding mechanism.

⇒ **Assist in partnership development.** The state and local officials require education in all aspects of public-private partnerships. They seek training in how to market their needs to the private sector and how to evaluate the proposals they receive from private firms. Several interviewees believe the U.S. DOT should provide guidance to partnering team. Some agencies require education to work through state regulations that impede partnerships.

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6. BENEFITS

What benefits have been identified from deploying ITS?

From June through October of 1995, members of the Volpe National Transportation Systems Center interviewed a broad cross section of state and local transportation officials in seven metropolitan areas. During these interviews, the topic of benefits derived from ITS planning and deployments arose regularly. Interviewees held up benefits of ITS not only as evidence of the cost- effectiveness of ITS, but as reference points that allow ITS projects to compete for funding with other transportation projects. Quantitative benefits were noted to be more valuable than qualitative benefits because hard numbers are needed to justify spending funds on ITS. In the metropolitan areas that were reviewed, relatively little formal benefit-cost analyses of ITS had been conducted, due to funding, labor, and time constraints. This paper will discuss the benefits of ITS that have been identified.

Overall Findings

At the time of the interviews, the U.S. DOT had defined a core infrastructure for deploying ITS traffic management and traveler information services within a metropolitan area. (Although this core infrastructure has been replaced by the Intelligent Transportation Infrastructure (ITI), this paper will continue to refer to the core infrastructure.) The extent to which quantitative benefits had been identified for each of the elements of the core infrastructure varied among the areas visited.

⇒ **Most of the benefit-cost analyses conducted on core infrastructure elements were on freeway management systems (FMS).** A significant amount of research exists based on the actual deployment of FMS, comparing pre-deployment transportation efficiency with post-deployment transportation efficiency. The analyses specifically illustrate the cost-effectiveness of those technologies. A notable amount of analyses also exist on the predicted benefits of transit management systems (TMS) and traffic signals control systems (TSCS). Conversely, in the areas that were reviewed, little formal benefit-cost analyses have been conducted on regional multimodal traveler information centers (RMTIC), or electronic fare payment (EFP) systems, either of an actual or predicted nature.

⇒ **Transportation agencies have experienced a wide variety of benefits from implementing ITS.** Included in these benefits are an actual 20% overall gain in freeway efficiency for implementing ramp meters achieved by the Wisconsin Department of Transportation (WisDOT), a predicted annual traveler time savings of $35 million for the implementation of a TSCS by the Missouri Highway and Transportation Department (MHTD), and a predicted annual savings of $117 million in capital investment and operating costs from implementation of an electronic toll collection (ETC) system on Florida' s Turnpike system by the Florida DOT.

⇒ **When pre-deployment benefit-cost analyses are conducted, they are often included in the proof-of-concept stage of ITS project development.** Consequently, most of the benefit-cost information available consists of predicted, rather than demonstrated, benefits.

BENEFITS OF DEPLOYING FREEWAY MANAGEMENT SYSTEMS

ITS Technology	Benefit	Agency	Type
Ramp Meters	Travel time decrease of 35% per morning peak hour	WisDOT	Actual
Ramp Meters	Savings of almost 1,500 driver hours per morning peak hour	WisDOT	Actual
Ramp Meters	Savings of nearly 75% of a person year every day in one direction	WisDOT	Actual
Ramp Meters	Savings of $0.23 per driver and net savings of $1,246 per morning peak hour	WisDOT	Actual
Ramp Meters	Savings of $57.50 per person over one year at the peak hour	WisDOT	Actual
Ramp Meters	Net savings of $311,456 per year when the benefits are combined from every vehicle	WisDOT	Actual
Ramp Meters	Reduction of 15% in crash frequency	WisDOT	Actual
Ramp Meters	Reduction of almost 20% in crash rate	WisDOT	Actual
FMS	Total recurrent congestion savings of approximately $12 million	MHTD	Predicted
FMS	An 18% reduction in accidents and $19 million in savings	MHTD	Predicted
FMS in Dade County	Total benefit of $37,615,897 per year	Florida DOT	Predicted
FMS in Broward County	Total benefit of $3,974,444 per year	Florida DOT	Predicted
FMS in Palm Beach County	Total benefit of $3,382,084 per year	Florida DOT	Predicted

⇒ **The benefit-cost analyses that have been conducted have usually yielded positive results.** For example, results include a predicted calculated benefit-cost ratio of 39.8:1 for bus signal preemption in Allegheny County, Pennsylvania, a predicted benefit-cost ratio of 4.5:1 for implementation of the Strategic Development Plan for the bi-state St. Louis Area, and a predicted 15:1 return in benefits to costs from implementation of the Colorado Traffic Operations Center (CoTOC) by the Colorado DOT. Other benefit-cost results are those predicted by the Florida DOT for implementation of an Intelligent Corridor System (ICS) in Southeastern Florida: a 5.89:1 ratio in Dade County, a 1.37:1 ratio in Broward County, and a 0.84:1 ratio Palm Beach County.

BENEFITS OF DEPLOYING TRANSIT MANAGEMENT SYSTEMS			
ITS Technology	**Benefit**	**Agency**	**Type**
AVL	An increase of 28% in bus schedule adherence through June of 1995	Milwaukee County Transit	Actual
AVL	A 20% overall gain in efficiency	Milwaukee County Transit	Actual
Radio system with AVL capabilities	Annual cost savings of 1.5 million	Regional Transportation District of Denver (RTD)	Predicted
Radio system with AVL capabilities	Capital equipment savings (bus system dispatching and operation efficiency) of 1.7 million during 10 years	RTD	Predicted
Radio system with AVL capabilities	Increased ridership by 1% because of safety and system performance	RTD	Predicted
Radio system with AVL capabilities	$2.6 million in farebox revenue during 10 years	RTD	Predicted
Radio system with AVL capabilities	Savings of almost 30,000 bus operation hours during the decade	RTD	Predicted
Bus signal preemption	Savings of 33% in travel time for all buses traveling on the South Busway	Port Authority of Allegheny County	Predicted
Bus signal preemption	Savings of 1,569 rider hours daily in the morning peak hours	Port Authority of Allegheny County	Predicted
Bus signal preemption	Savings of $299,250 annually for the morning peak period	Port Authority of Allegheny County	Predicted
Bus signal preemption	Savings of 120 rider hours daily in the evening peak period	Port Authority of Allegheny County	Predicted
Bus signal preemption	Savings of $387,000 annually for the evening peak period	Port Authority of Allegheny County	Predicted
Bus signal preemption	Total annual savings of $677,250	Port Authority of Allegheny County	Predicted

⇒ **Agency representatives note a myriad of qualitative benefits of ITS when asked to discuss that topic.** Among these are safer transportation systems, better traveler information, more user convenience, fewer customer complaints, less customer irritation, and greater efficiency with limited public staffs. Additional qualitative benefits predicted by agency officials include improvement in travel time and speed, improvement in air quality, and the public' s sense of contentment that their tax dollars are contributing toward the improvement of the transportation system. To arrive at these benefits, transportation officials often use intuition to determine if the system is "working better."

BENEFITS OF DEPLOYING TRAFFIC SIGNAL CONTROL SYSTEMS			
ITS Technology	**Benefit**	**Agency**	**Type**
New traffic control hardware and improved traffic signal system	Annual benefits through reduction in delays, stops, and fuel consumption in the network of $125,790 for the $98,660 project	Wisconsin DPW	Actual
New traffic control hardware and improved traffic signal system	Fuel consumption savings of $26,280 annually at current fuel prices ($1.20)	Wisconsin DPW	Actual
Signal capital improvements and signal re-timing program	Reduced air emissions by 30,000 kilograms per day	Denver Regional Council of Governments (DRCOG)	Predicted
Signal capital improvements and signal re-timing program	Daily user benefits of $250,000	DRCOG	Predicted
Signal capital improvements and signal re-timing program	Decreased fuel consumption by 50,000 liters per day	DRCOG	Predicted
TSCS	Annual time cost savings of $35 million	MHTD	Predicted
TSCS	Annual fuel cost savings of $2 million at $1 per gallon	MHTD	Predicted

⇒ **Representatives of state and local agencies believe it is more difficult to quantify benefits from ITS than from traditional transportation projects.** The primary ITS benefits are believed to be quality-of-life issues, including ease of movement, convenience, and security. These benefits are nebulous and not easily captured quantitatively. Insufficient knowledge of where to begin analyses and lack of exposure to other regions' benefit-cost work has contributed to the shortage of studies conducted.

BENEFITS OF DEPLOYING INCIDENT MANAGEMENT SYSTEMS			
ITS Technology	**Benefit**	**Agency**	**Type**
Incident Management System (IMS)	Savings of $6,173 per incident during a 17-minute single lane blocking incident	MHTD	Predicted
IMS	Annual savings of $502,000 per mile	MHTD	Predicted
IMS	Travel time and fuel savings of approximately $46.7 million per year	MHTD	Predicted
IMS	Overall savings for the St. Louis metropolitan area freeway system of $50 million per year	MHTD	Predicted

BENEFITS OF DEPLOYING ELECTRONIC TOLL COLLECTION SYSTEMS			
ITS Technology	**Benefit**	**Agency**	**Type**
ETC	61 fewer toll lanes at mainline plazas	Florida DOT	Predicted
ETC	Savings of $117 million in capital investment and operating and maintenance costs at mainline plazas	Florida DOT	Predicted
ETC	30 fewer toll lanes at ramp plazas	Florida DOT	Predicted
ETC	Savings of $28 million in capital investment and operating and maintenance costs at ramp plazas	Florida DOT	Predicted

Implications

The seven metropolitan area reviews were analyzed to determine the benefits that are derived from deploying the elements of the ITS core infrastructure. Two primary patterns emerged:

⇒ **The vast majority of transportation officials recognize the importance of measuring benefits of ITS and would like to conduct studies in the future.** Benefit-cost analyses and before-and-after studies were cited as the most effective methods for identifying benefits of ITS, while models were believed to be less useful for measuring quantitative benefits, as they often resemble "best guesses."

⇒ **Formally-identified ITS benefits prove the cost-effectiveness of ITS.** This proof may be used by transportation officials to gain greater leverage with which to compete for state and local funds with other budgetary considerations. Thus, not only do benefit-cost evaluations illustrate the cost-effectiveness of ITS, these evaluations may result in some of the funding burden for ITS shifting from the federal level to the state and local level.

Proposed Activities

The shortage of data available for formal benefits of ITS deployments points to the need for transportation officials to conduct more analyses of benefits. In light of the amount of benefit-cost information available in the metropolitan areas visited, it is clear that voids exist in the identification of benefits derived from the core infrastructure elements of RMTIC and EFP systems. State and local agencies should be encouraged to add a phase of benefit-cost identification to their work elements in planning and deploying ITS. Additionally, transportation agencies would benefit from the results of analyses conducted by other regions as well as from instruction of how the analyses were conducted. Results of all benefit-cost analyses should be distributed as widely as possible as they become available.

7. TRANSIT AGENCY INVOLVEMENT IN ITS

What is the level of involvement of transit agencies in ITS?

From June through October 1995, members of the John A. Volpe National Transportation Systems Center (Volpe Center) interviewed a broad cross section of state and local transportation officials in seven metropolitan areas. As part of the review, a wide range of transit authority staff, from general managers to operations personnel, were interviewed to determine the extent to which these transit agencies were involved in the deployment of intelligent transportation systems (ITS). This paper will present ITS issues unique to the transit industry as discussed by the representatives of the transit agencies within the seven metropolitan areas reviewed. The findings and implications contained in this paper are based on the perspective of these officials.

TRANSIT AGENCIES INCLUDED IN REVIEW

Metropolitan Area	Transit Agency	Service Modes	Passenger Miles
Boston	Massachusetts Bay Transportation Authority (MBTA)	Bus, HR, LR, CR, T, F	1.28 billion
Denver	Regional Transit District (RTD)	Bus, LR	237.3 M
Miami / Ft. Lauderdale	Metro-Dade Transit Agency (MDTA)	Bus, HR, AG	412.6 M
	Broward County Mass Transit Division (BCT)	Bus	102.2 M
	Tri-County Commuter Rail Authority (Tri-Rail)	CR	88.6 M
Milwaukee	Milwaukee County Transit System	Bus LR being studied	150.0 M
Phoenix	Regional Public Transportation Authority (RPTA)	Bus	143.3 M
	City of Phoenix Public Transit Department	Bus	
	Phoenix Transit System	Bus	
Pittsburgh	Port Authority of Allegheny County (PAT)	Bus, LR, IR	376.0 M
	Beaver County Transit Authority (BCTA)	Intercity and Local Bus	10.2M
St. Louis	Bi-State Development Agency (Bi-State)	Bus, LR	176.0 M

Key: HR - heavy rail; LR - light rail; CR - commuter rail; T - trackless trolley; F - water ferry; IR - incline rail; AG - automated guideway; M - million

Notes:

Boston - Brockton Area Transit Authority and Cape Ann Transportation Authority also provide bus service.
Phoenix - Total passenger miles is for "Valley Metro," a cooperative group of 10 transit agencies in the region.
Pittsburgh - In addition to PAT and BCTA, 5 other county transit systems provide bus service in the region.

Overall Findings

Approximately 20 individuals representing nine transit agencies in the seven metropolitan areas were interviewed by the Volpe Center team. There are 26 transit agencies providing service in the areas reviewed. Several representatives from transit divisions located within some of the state DOTs were also interviewed.

⇒ **Transit officials perceive that the focus of ITS is more on highways than on transit.** Many of the agency officials expressed concern that the ITS program was utilizing a very fragmented approach to the disadvantage of the transit industry. Non-transit public staff agreed with transit representatives that the ITS focus is on highways. ITS applications for transit and intermodal integration of ITS components has not been heavily stressed. This lack of an ITS focus has led transit officials to apply ITS at a level that is lower than expected. Representatives from three transit agencies relayed that they were cautious to incorporate too many ITS technologies within their transit system without knowing where transit would apply in the overall national ITS plan.

⇒ **The major motivational factors expressed by transit personnel in utilizing ITS are to improve customer service and to increase operating efficiency.** Customer service improvements provided by ITS were seen as more reliable on-time routes, safer transit stations and vehicle travel, and greater service information. One administrator said that expanded ridership should result from the customer service improvements. The increased efficiencies are to be achieved predominantly through cost savings from better data collection leading to maximizing the routes and schedules. Further cost savings due to using ITS technologies would be obtained through implementing trip-distance fare schedules and advanced payment verification systems. One manager remarked that the ITS technologies installed must be able to generate additional revenue and not just be cost effective. Two transit agency officials added that one of their primary motivational factors for utilizing ITS is to maintain the viability of transit as an alternative to the automobile.

⇒ **Officials at over half of the transit agencies interviewed reported that their agency staff does not routinely consider ITS applications.** Transit agency managers provided a number of reasons for not routinely considering ITS, including limited funds for their basic transit operations, uneasiness about deploying technologies with no proven benefits to transit, and their staff' s unfamiliarity with the technologies. It appears that transit managers of relatively newer transit systems and those providing rail service are likely to consider ITS more than managers of older, established transit agencies and those providing primarily bus service. Bi-State Development Agency representatives recounted how it was possible to consider ITS technologies for almost every aspect of their MetroLink light rail system because there were no constraints such as those imposed on an existing system.

⇒ **The majority of transit agencies treat ITS projects differently from traditional transit projects.** The reasons cited were the use of different funding sources, competition with higher priority capital projects, and the necessity of building coalitions for ITS projects. Competition with traditional projects requires the benefits for the ITS project to be proven under numerous reviews. A Massachusetts Bay Transportation Authority (MBTA) official

said that customer impacts and trade-offs between technological and conventional solutions are carefully examined. Coalitions come in the form of inter-departmental coordination; the extensive use of working groups; and the reliance on other transportation agencies to provide infrastructure, products, or services so that transit agencies can deploy ITS. Representatives from the Pittsburgh and South Florida areas said that ITS are treated the same as other projects by their agencies. However, in Pittsburgh, when the projects are reviewed outside of the transit agencies, they are treated differently because each project is not examined as a part of a larger integrated program, only as a series of separate projects.

⇒ **Enhanced traveler information, fleet and schedule management, and automated data collection were seen as the most important future uses for ITS by transit agencies.** Traveler information will be improved through the use of conveniently-located information kiosks and real-time maps, improved customer information phone systems, and the integration of transit information into the regional multimodal traveler information centers (RMTIC). Automated vehicle location (AVL) technology will be the basis for fleet and schedule management. Transit managers unanimously saw ITS being used for data collection, enabling real-time and origin-destination information to be gathered, eventually leading to modifications to routes and fare structures.

⇒ **Quantitative benefits are being developed for only about one-third of all ITS-related projects being planned and deployed by transit agencies.** The transit agencies value the importance of quantitative benefits that support ITS deployments, but all transit officials expound the difficulties of conducting the analysis. Difficulties include determining the evaluation criteria, the need to refine traditional transportation analytical models, the large amount of data required for proper analysis, the shortage of "before" comparative data, and the limited transit staff available to perform the extra analytical work. The Denver Regional Transit District's (RTD) 1989 benefit-cost study on a new radio and AVL system showed a ten-year, $19.3 million benefit in labor savings, capital equipment savings, and increased fare box revenue. Analysis of the Milwaukee County Transit's AVL system identified an increase in bus schedule adherence from 90 to 94 percent and a corresponding gain in overall operations efficiency. The MBTA's Gasoline Alley project produced savings of $500,000 from improvements in maintenance and data processing, and reductions in waste and pilferage. Preliminary analysis of the Pennsylvania Department of Transportation (PennDOT) / Port Authority of Allegheny County (PAT) signal preemption project estimated the benefit-cost ratio at 40:1.

⇒ **Qualitative benefits for transit agency ITS projects include improved customer service, increased data flow, increased safety, and enhanced operational efficiency.** The benefit of enhanced operational efficiency would be achieved with greater coordination between modes, greater operational and vehicle control, and reduced staffing needs. Customer service benefits included better information to the transit users resulting in greater ridership and fewer complaints. Data flow benefits would be obtained through expanded ridership and fare data, and employee carpool and single-occupant vehicle (SOV) trip data for employers. Safety will be improved greatly through the installation of AVL and enhanced communication systems. Traffic congestion and air quality improvements were mentioned as ITS benefits only by a minority of transit agency representatives.

⇒ **Competing with highway projects and inadequate funding are the major barriers to deploying transit ITS projects.** Transit agencies have neither the political nor public support to directly compete with highway projects, many of which have been planned for years. Transit officials noted that because limited transit funds are not earmarked for ITS deployment, they must internally choose between adding or maintaining vehicles and routes versus installing new technology. Coordination and cooperation among state, regional, and local agencies with differing agendas has also been a deterrent to transit ITS deployments. The overall nervousness of the transit industry about using unproven technologies and the high cost of research and development associated with using these technologies was also presented as a barrier.

⇒ **Transit officials believe that most politicians support highway projects over ITS and other transit projects.** Transit personnel said that most politicians are not aware of ITS. In general, the transit representatives believe that local politicians do not support ITS and most statewide politicians are primarily concerned with road construction, operation, and maintenance projects. The general consensus is that support for ITS transit applications will not be extensive until politicians are forced to look at transit' s capabilities to mitigate highway congestion. This is occurring in some areas.

⇒ **Transit managers must gain support for ITS projects, both internally and externally.** A key to gaining support is to introduce working systems to top management, political leaders, and others that approve funding. Pilot projects provide the perfect opportunity to deploy successful applications of ITS products and services. Simple technology will also ensure more successful deployments and make it easier to obtain support. Relevant constituents, including the transit end users, should be included in developing ITS applications.

⇒ **Transit managers would like greater emphasis on transit in all regional and metropolitan ITS planning activities.** The Early Deployment Planning Study (EDP) Process was cited as the primary ITS planning activity. Although the transit officials feel that the EDP Process is an effective tool for promoting interaction, they believe that highways maintain too great a focus and would like a more balanced approach with greater multimodal emphasis.

⇒ **Transit agencies must better coordinate their uses of technology.** Technology will need to be tailored to meet each agency needs; however, greater knowledge of the products being used and how they are applied could assist in reducing the overall cost and development time of ITS deployments for the entire transit industry. Greater coordination should aid in creating more uniformity in transit technologies and reduce the research and development costs and time delays that have been added to many transit ITS applications. Until national standards can be cooperatively developed, caution was specifically noted in the use of proprietary software and unproven AVL systems.

⇒ **In general, ITS at the transit authorities are handled by high level staff and there is usually no staff dedicated solely to ITS efforts**. In addition to mid- and upper-level managers, currently, hardware and software computer specialists, communications personnel, and operations planners are the positions most used for ITS by transit agencies.

⇒ **Transit staff require additional skills to develop and implement ITS projects.** The majority of transit officials would like to acquire additional technical specialists for ITS deployments, but are able to supplement these shortfalls with the use of skilled outside consultants. Specialists most needed by the transit agencies are experts in communications, GPS and geographic information system (GIS) applications, electrical engineering, computer software, and traffic signal control technology. Perhaps the greatest skill shortages are not with the deployment end, but with the operations and maintenance of the ITS equipment. New technical systems are becoming too complicated for many of the existing staff (operators, dispatchers, and bus mechanics), will force transit agencies to provide training and retraining programs, or will even result in changes to the hiring practices of many transit agencies.

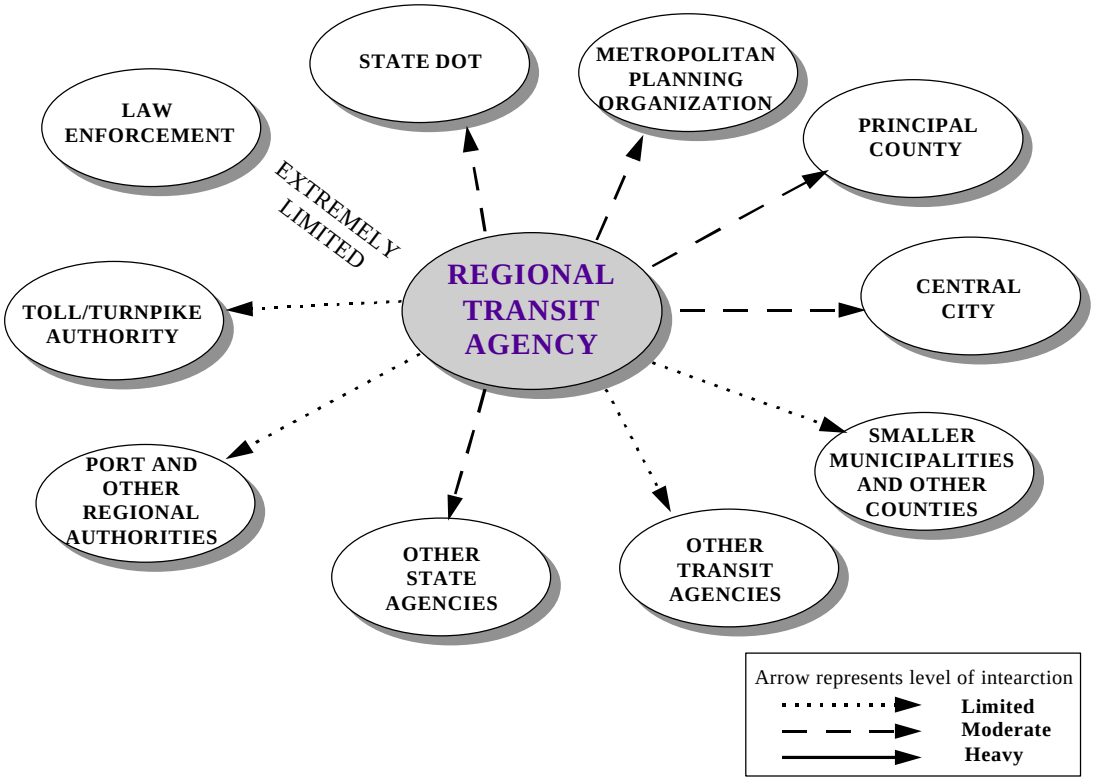
⇒ **Vendors, consultants, and peers throughout the transit industry continue to provide the most usable ITS information to transit practitioners.** Information from other sources, including professional associations, is not at the level needed to quickly mainstream ITS applications into the transit industry. Interviewees stated that national organizations are providing only limited information regarding ITS to the transit agencies, or information that is too theoretical and not pertinent to transit operations.

⇒ **Transit agencies are minimally involved in public-private partnering.** Transit administrators value the private sector involvement within the ITS program because it opens up additional project funding sources, brings in necessary expertise, and provides some limited opportunities to avoid the extensive and restrictive government procurement process. However, most transit agencies are involved with the private sector only through consultants who write much of their project specifications, contractors who perform the project tasks, and operators who provide privatized public transit and paratransit services; all of which are not partnering activities. Also, although they see the benefits that the private sector brings, transit agency officials may be apprehensive to fully embrace public-private partnerships. Some felt that some businesses offering technology know little about transit operations or the transit vehicles. Other interviewees felt that some corporate officials sometimes use their clout with politicians and push specific technologies.

Private sector partnering has occurred or is being developed for the Wellington Garage Project with intelligent parking management in Boston, the Woburn Regional Transportation Center with smart infrastructure in Boston, the Sunpike privatized intermodal HOV system in Miami, and the MDTA' s interactive "smart kiosk" bus shelters also in Miami. Phoenix Transit System, a contracted operator in the Phoenix Metropolitan Area, has developed an innovative intelligent fare box that they plan to market to other transit agencies. If successful, the public transit agencies in the Phoenix Area will benefit from fare box sales.

⇒ **Interaction between transit agencies and other transportation agencies and government entities is increasing.** Normally, transit agencies acted more independently than other transportation agencies. ITS planning and deployment, however, has been responsible for increased regional interaction by transit agencies. The EDP Process has resulted in transit agencies working more closely with state DOTs, MPOs, as well as other metropolitan agencies on ITS projects. Based on the review, transit agencies usually interact to a moderate level with one locale, either a principal county or a central city, usually not with both. Transit interaction on ITS projects with other metropolitan governments, other transit agencies, port authorities, and turnpike authorities is very limited. Interaction on ITS projects between transit agencies and state and local law enforcement agencies is almost nonexistent.

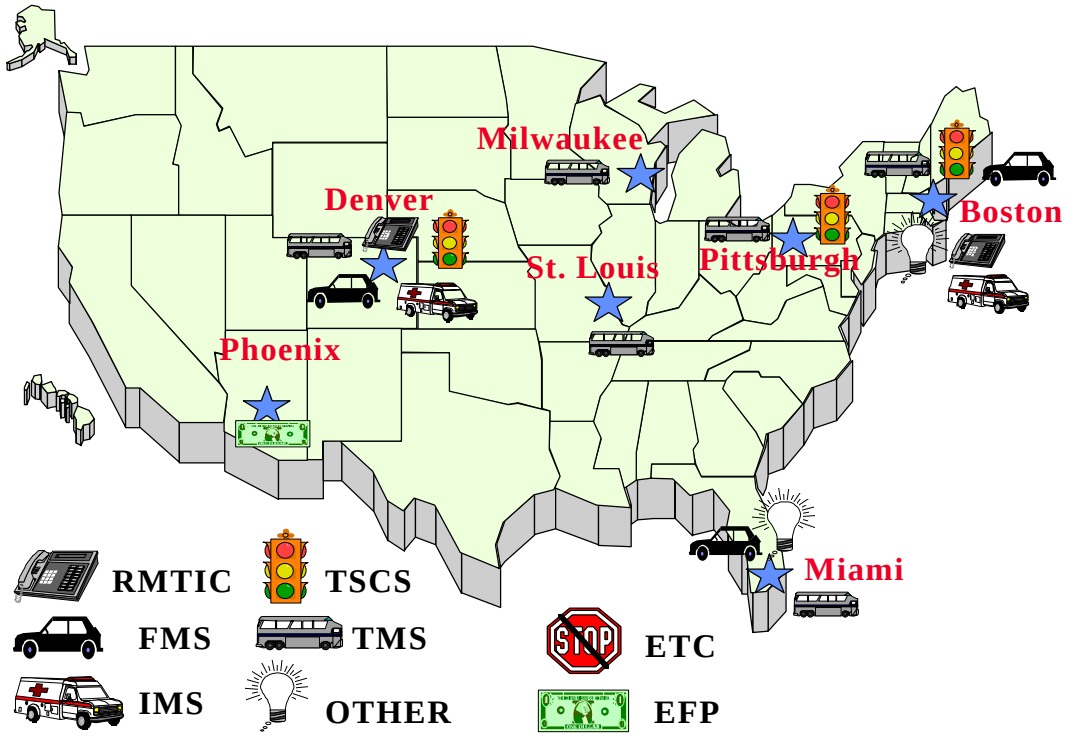
TRANSIT AGENCY INTERACTION
ON ITS-RELATED ACTIVITIES WITH OTHER AGENCIES



⇒ **Transit agencies in the seven metropolitan areas reviewed are not involved in any near-term development of a regional multimodal traveler information center.** Almost all transit agencies have a traveler information center (TIC). Many times the service is provided through non-automated phone systems. Expanded TICs are being developed by those transit agencies that are installing AVL technology within their fleet. Many of the transit agency representatives noted that they were reluctant to provide real-time information to outside distribution services because the information could be inaccurate by the time it is broadcast. While most agencies are considering some tie-in to regional traveler information networks,

most transit officials said that they would like their in-house operations staff to be comfortable with the new technology before it was used more extensively for traveler information. The majority of the metropolitan areas will or have deployed traffic operations centers (TOC) much earlier than RMTIC. Implementation of TOC is seen as a short-term activity and RMTIC are seen as a long-term activity.

TRANSIT AGENCY INVOLVEMENT IN CORE INFRASTRUCTURE ELEMENTS



RMTIC - Regional Multimodal Traveler Information Center (no RMTIC; only TOC or TIC)
FMS - Freeway Management System **IMS** - Incident Management System
TSCS - Traffic Signal Control System **TMS** - Transit Management System
EFP - Regional Electronic Fare Payment System
ETC - Electronic Toll Collection System (no ETC involvement)

⇒ **Transit agency involvement with localities using or considering traffic signal control systems (TSCS) is to obtain signal preemption or transit priority.** Half of the transit agencies are granted signal preemption, but only on a limited scale. Even more limited is the higher order priority capabilities. This is usually only granted to emergency services, but has been given to transit service along a few light rail corridors.

TRANSIT AGENCY INVOLVEMENT IN CORE INFRASTRUCTURE ELEMENTS				
Metropolitan Area	**Core Infrastructure Element**			
	RMTIC	**FMS**	**IMS**	**TSCS**
Boston *MBTA*	RMTIC (1999) Enhanced LR/HR OCC (1996)	SE Expwy HOV; I-93 inter-modal corridor (1997)	OCC with early warning and incident notification system (1996)	LR / T priority and preemption
Denver *RTD*	RMTIC (1998) AVL –enhanced TIC (1996)	I-25N HOV/ busway	Bus route surveillance with video cameras and CCTVs	Denver LR priority
Miami / Ft. Lauderdale *MDTA* *BCT*	MDTA/BCT-Planned connection with ICS TIC (1998)	MDTA - bus probes (1998) BCT - I-95 HOV	MDTA -Planned bus drivers to id incidents via radio BCT - None	MDTA - limited bus preemption BCT – None
Milwaukee *Mil. County Transit*	GCM Priority Corridor TIC (1997)	None	None Possible use of AVL buses as probes for IMS	None
Phoenix *RPTA* *Phoenix Transit*	None	None	None	Tempe bus preemption (1999)
Pittsburgh *PAT* *BCTA*	None	None	None	Busway signal preemption project
St. Louis *Bi-State*	No RMTIC LR - phone info system	None	None	None
Key: HR - heavy rail; LR - light rail; CR - commuter rail; T - trackless trolley; P - paratransit; OCC - operations control center				

⇒ **Current TMS are stand-alone systems.** Transit agencies that either implemented or are planning to implement TMS are not considering integrating the TMS with other ITS systems in the near future. Agency representatives foresee the integration of TMS as a long-range goal.

⇒ **Transit officials see the value of incident management systems (IMS).** Because buses use the roadway, many transit managers tie IMS to their agency' s ability to provide good customer service through maintenance of schedules and transit safety. Some state DOTs and transit agencies have held preliminary discussions regarding the use of the vehicle drivers as additional "eyes on the street" who identify and report incidents.

⇒ **No transit agency is involved in a regional electronic fare payment system (EFP).** Most transit properties have isolated payment systems. Within the seven areas reviewed, the magnetic stripe or "swipe" card is the most popular technology. Implementation of a region-wide multimodal EFP is a very long-term activity. The Bus Card Plus program in the Phoenix area is seen as the most advanced step toward a regional multimodal EFP.

TRANSIT AGENCY INVOLVEMENT IN CORE INFRASTRUCTURE ELEMENTS (Continued)				
Metropolitan Area	**Core Infrastructure Element**			
	TMS	**ETC**	**Regional EFP**	**Other**
Boston *MBTA*	LR/HR - AVL-AVI and rail technologies bus - fuel and maintenance automation and information system	None	None Magnetic stripe card possible ETC regional smart card	Parking management system and capacity messages on VMS; ADA- LED signs
Denver *RTD*	AVL on entire fleet Telephone info center and information kiosks	None	None Magnetic stripe cards (1996)	None
Miami / Ft. Lauderdale *MDTA* *BCT*	MDTA - AVL on entire fleet, automated fuel monitoring and vehicle maintenance system (1996) BCT - AVL on entire fleet (1996)	None	None MDTA - Magnetic stripe cards BCT - coin fares only	MDTA - Auto and busway trip times on road-side VMS(1998) BCT - ADA bus enunciator
Milwaukee *Mil. County Transit*	AVL on all buses and some supervisor and maintenance vehicles	None	None Debit cards for students	None
Phoenix *RPTA* *Phoenix Transit*	None Phoenix Transit AVL (2000) Automated fueling system	None	RPTA - magnetic stripe, Bus Card Plus, credit cards	None
Pittsburgh *PAT* *BCTA*	PAT bus - (proposed) voice and digital text communications, AVL and auto passenger counting BCTA - AVL, coordinated database communication	None	None PAT/BCTA possible regional smart card	None
St. Louis *Bi-State*	LR control and data system AVL on paratransit (1999)	None	LR - automated vendor machines, electronic fare boxes, smart cards (1998)	None
Key: HR - heavy rail; LR - light rail; CR - commuter rail; T - trackless trolley; P - paratransit; OCC - operations control center				

⇒ **Transit officials are looking towards other ITS-related components to address their needs.** Other ITS-related transit activities include the use of geographic information systems, technology to assist with compliance with the Americans with Disabilities Act (ADA), innovative marketing of transit system along congested roadways, and operations management at transportation transfer centers.

TRANSIT AGENCY FUNDING FOR ITS ACTIVITIES		
Metropolitan Area	**Funding Source**	**Activity**
Boston	MBTA internal funding	All ITS activities to-date
	SPR funds from State DOT	I-93 intermodal corridor
	SPR funds from MBTA	Planning (future)
	FTA Section 3 grant	Deployment (future)
Denver	Federal fund allocation by MPO	Planning (limited amount)
	FTA operational test funds	Planning AVL and schedule system
	RTD capital budget	
	State transit fund	
	State highway maintenance fund	I-25N HOV/busway
	Municipal transit assessments	Deployment and operations
	Undetermined source	On-going AVL operations
Ft. Lauderdale	FTA grants (one 8-years old)	AVL system ADA bus enunciator
Miami	FTA Section 9	AVL system MPO planning and deployments
	FTA Section 26 grant	Smart kiosks and other demonstration projects
	State highway and transit operations	
	PL and Section 8 transit funds	Dade County ITS Plan
	Undetermined source	Operations and maintenance
Milwaukee	FTA operational test funds	AVL system
	Municipal transit assessments	Operations
	State multimodal improvement fund and other state funds	Deployment and operations
Phoenix	PL and SPR funds	ITS Planning by MPO
	FTA Section 3 grant	Deployment
	FTA Section 9 grant	
	STP (MPO contribution)	Alternative fuel vehicles and other activities
	CMAQ (MPO contribution)	
	Municipal transit assessments	Operations
	State and Power Ball Lotteries	
Pittsburgh	Special project funds/ 20% state match	Busway signal preemption
	FTA Section 9 grant	Capital costs
	Internal budgets	Operations
	STP funds	Mobility Manager Project
St. Louis	Operating revenues FTA grants	Activity for each funding source was not specified

⇒ **FTA grants have provided the majority of transit funding for ITS planning and deployments.** Transit agencies have used a variety of state and local funding sources to obtain the required local match. Some goals of transit ITS projects were to reduce congestion, increase transit ridership, and improve air quality in the region, therefore these projects qualify for congestion mitigation and air quality improvement (CMAQ) funds.

CMAQ funds are considered very flexible. Some transit agencies have benefited from federal demonstration grants because of their willingness to implement experimental technology.

⇒ **Most transit agency administrators feel that with limited transit funding, the placing of ITS projects within their agency budgets forces other items to be dropped or reduced.** This zero-sum game with projects makes technology compete with "visible" capital improvements, such as new buses, trains, or facilities, and reduces the viability of ITS projects unless federal funding is specifically earmarked for ITS.

⇒ **The lack of funding for the operations and maintenance of the new systems is a major concern.** This will be an issue with all transit agencies reviewed because all were planning or deploying some ITS-related component. There is hope that involvement from the private sector can offset the operational costs of ITS applications. Developer impact fees, which are assessments levied by a local jurisdiction on real estate developers to mitigate effects of development on the jurisdiction' s infrastructure, were seen as one private source that has not been tapped for ITS transit applications.

Implications

The findings of the reviews of the metropolitan areas were analyzed to determine the extent to which transit agencies are involved in ITS activities and the implications of the level of involvement. Six primary patterns were uncovered:

⇒ **The transit industry is not exuberant about ITS deployments.** Ambassadors from transit agencies that have deployed ITS technologies are needed to market the value of ITS to other practitioners. Transit managers requested that their peers in the transit industry assist in marketing ITS and not those they classify as "highway people," individuals in the transportation field but outside the transit industry.

⇒ **The transit industry wants to know more about the uses and benefits of transportation technology before fully endorsing ITS.** Proof of benefits of an ITS application must be strongly promoted among decision makers before approval is given.

⇒ **The initiative for multimodal ITS projects must begin with transit agencies.** Because transit agencies have not been extremely successful in competing with highway projects, transit agency officials strive to integrate transit systems into highway projects and not wait for the highway officials to develop joint projects. Transit agencies dependent on other agencies, especially DOTs, to provide infrastructure used by transit, must seek a coordinated multimodal approach to ITS deployment.

⇒ **Integration of many ITS elements will be not be achieved in the short term without a fully multimodal focus that includes transit agency participation.** One intent of using ITS is to coordinate the operations of the different modes to create a more efficient transportation network. For example, a truly regional EFP is dependent on the ability to use

the same payment system on both highways and transit. Because transit agencies have the most prominent fare structure in each metropolitan area, transit agencies should be major participants in the development of regional EFP. True RMTIC are dependent upon the inclusion of information from the transit agencies. This currently presents a barrier to full integration because transit agency managers are reluctant to provide real-time information to centers where they cannot fully control the distribution of the information.

⇒ **If under pressure to expand and upgrade their capital stock, transit agencies in the seven metropolitan areas reviewed will spend little to deploy ITS technology unless such funds are earmarked for ITS deployment applications.** Because of the funding limitations, transit agency officials will not incorporate ITS into transit operations if they view the technologies as expensive, not readily available, lacking demonstrated benefits, or unreliable.

⇒ **There are particular characteristics that set apart innovative transit agencies, those willing to deploy ITS, from traditional "status quo" transit agencies.** Many of these agencies were originally forced by external circumstances to deploy ITS to create alternative ways to obtain service efficiencies and increase ridership. In air quality non-attainment areas or where major highway construction projects are underway, transit officials have taken a more prominent and mandated regional role in an attempt to mitigate the environmental and construction impacts. Generally, because managers of rail systems can more readily sell their ITS concepts as true alternative solutions to highway congestion, transit systems with rail are apt to be more innovative. Most innovative systems have used GIS for a number of years and are now expanding their system with the installation of AVL and GPS technology. Innovative transit agencies are usually sparked by an internal champion, usually a high level administrator in the operations branch. The champion is very knowledgeable of the ITS industry and ITS technologies being installed throughout the metropolitan region. Although most transit agencies are content to install their ITS technology independent of other agencies, the transit champions of ITS, however, have conceptualized how their agency' s ITS projects will be integrated into the entire regional system.

Proposed Activities

Based on the interview findings with transit officials, a number of activities to foster ITS deployments by transit agencies can be undertaken:

1. An information and technology transfer program that identifies "best practices" and other transit-specific information should be developed. Transit agencies are attempting to learn what other transit authorities and jurisdictions are doing with ITS technologies, but the transit officials interviewed felt that the current information channels are not effective.

2. A "Consumer Reports" type program should be developed for ITS technologies. The individuals involved with this program would provide information on standard-compliant products, and research and test new products.

3. Funding should be made more flexible to enable funding for operation and maintenance of technological systems. Funds should be earmarked for ITS transit deployments so competition for funds with non-ITS and highway projects would be reduced or eliminated.

4. Standards must be developed for transit-related technologies to build confidence in the future compatibility of the new systems.

5. Transit managers need to develop a network system within the transit industry to discuss ITS products, projects, and issues.

6. Communication and coordination networks among transit agencies, transit vehicle builders, and technology manufacturers must be developed. Currently standards exist for individual bus components, such as the 1994 SAE J1708 standard for bus vehicle area networks. To further this effort, the parties could work together to pre-wire buses and other vehicles for radio, passenger counting, and other vehicle systems to consolidate these systems into smaller spaces. This will reduce development costs to one-time fees, allow easier testing for transit systems, and provide space in vehicles for future technology add-ons without reducing passenger space.

8. THE IMPACT OF ENVIRONMENTAL FACTORS ON THE PLANNING AND DEPLOYMENT OF ITS

What impact do environmental factors have on the planning and deployment of ITS?

From June through October of 1995, members of the Volpe National Transportation Systems Center interviewed a broad cross section of state and local transportation officials to assess their deployment of intelligent transportation systems (ITS). The team conducted interviews in seven metropolitan areas: Boston, Denver, Miami, Milwaukee, Phoenix, Pittsburgh, and St. Louis. Interviewees represented various positions and levels within their organizations from executive directors and managers to engineers and planners. The team gathered information on the view of ITS by transportation officials, the extent to which ITS are being planned and deployed, the interaction among agencies responsible for ITS, and insights and suggestions on ITS in general. They then reviewed transportation documents, such as state and regional transportation plans, state and metropolitan TIPs, and state and regional ITS plans. This review is part of a larger effort by the U.S. Department of Transportation' s (U.S. DOT) Joint Program Office for ITS to assess the development and deployment of ITS products and services in metropolitan areas.

The interviewees identified a number of environmental factors in the planning and deployment of ITS. This paper will describe the environmental factors that have an impact on transportation officials who plan and deploy ITS. The focus of the paper will be an attempt to answer the question "What impact do environmental factors have on the planning and deployment of ITS?"

Overall Findings

Based on the environmental information obtained from the interviewees, eight findings were developed. The findings cover subjects such as participants who consider ITS for environmental issues, ITS applications included in documents as solutions for environmental concerns, funding, models available to calculate environmental benefits, and environment-related benefits calculated.

⇒ **Many officials believe ITS can be an effective tool to reduce environmental concerns, improve fuel usage, and enhance air quality.** In the absence of quantitative benefits, interviewees often cited air quality and environmental concerns as motivations to deploy ITS. Some agency officials specifically cited the need to comply with air quality regulations as a motivation. Of the 130 people interviewed, approximately half mentioned that environmental improvements can result from ITS deployments. Staff from state DOTs, county governments, and municipal governments are the most likely to list ITS as an effective tool to apply to environmental concerns; law enforcement and toll authority officials were the least likely.

⇒ **Officials in non-attainment areas are looking to ITS as potential solutions to their air quality problems**. Of the seven metropolitan areas reviewed, six were designated non-attainment areas by Clean Air Act Amendments (CAAA) standards. The metropolitan areas in non-compliance are Boston, Denver, Milwaukee, Phoenix, Pittsburgh, and St. Louis. Interviewees in all six of these areas cited air quality as an important motivation for the planning and deployment of ITS.

⇒ **Improving environmental quality is a goal of some ITS efforts.** As part of a large planning effort, the Massachusetts Highway Department (MHD) and the Massachusetts Turnpike Authority are participating in the I-95 Corridor Coalition which is the entity responsible for improving transportation along the I-95 Priority Corridor. The I-95 Priority Corridor project is a four-year effort to improve mobility, safety, and environmental quality in the Northeast.

The Wisconsin ITS Steering Committee, in its June 1994 document, "Intelligent Vehicle-Highway Systems Strategic Plan," describes how a statewide ITS program can contribute to WisDOT' s stated ITS mission: "To supply and support safe, efficient, and environmentally sound transportation services in all modes." This program will be implemented as one component of the Wisconsin transportation system. In addition, the Wisconsin ITS Steering Committee advances ITS to enhance personal mobility while reducing adverse environmental and energy impacts.

⇒ **Several specific projects demonstrate the impact of ITS on environmental quality.** In the Boston Metropolitan Area, the Central Artery/Third Harbor Tunnel (CA/T) Project staff was motivated by the need to use ITS technologies to comply with FHWA and Environmental Protection Agency (EPA) service resumption requirements and carbon monoxide (CO) exposure restrictions. They believed that the CA/T Project and use of advanced technologies would benefit the citizens and tourists in the Boston Metropolitan Area. According to CA/T Project staff, the ventilation in the new artery will disperse carbon monoxide into the air thus improving street level air quality. Also, noise and dust levels will be reduced.

In the fall of 1993, the Massachusetts Bay Transportation Authority initiated the Cabot Fuel Alley Automation System, commonly called the Gasoline Alley Project. This system protects against pilferage, addresses environmental concerns, flags excessive vehicle consumption, and provides more accurate and timely information. The system, which advanced from a pilot program to full-scale implementation, uses a personal computer and transponders on the buses to control and track the storage and dispensing of diesel fuel, motor oil, coolant, and transmission fluid for the bus fleet housed at the Cabot Garage. Additionally, all waste fluids are monitored. Every 15 minutes, each underground diesel storage tank alarm status is checked and reported to the site computer to identify possible leakage.

In the Phoenix Metropolitan Area, the 1994 update of the Maricopa Association of Governments Long Range Transportation Plan (LRTP) addresses all modes of transportation through the year 2015. The LRTP specifically states that "there is a need for better

coordination of traffic signals between jurisdictions and there are significant opportunities in real time signal operations." The need for such coordination is based not only on a need to ease congestion, but also because traffic signal coordination is believed to have a positive impact on air quality. According to the LRTP, because the Phoenix Metropolitan Area is an air quality non-attainment area, "Arizona law requires traffic signal synchronization within and across jurisdictional boundaries on roadways that carry more than 15,000 vehicle trips per day."

In the Miami Metropolitan Area, the Dade County MPO will use variable message signs (VMS) to provide Air Quality Index warnings to highway travelers. The MPO staff are planning to provide the Air Quality Index warnings based on urban ozone models. It is hoped that knowledge of the air quality will influence commuters to take alternative transportation on days when air quality is poor.

The 1991 Florida DOT policy toward interstates was developed, in part, to minimize environmental impacts of future highway improvements. The policy, intended to favor public transportation and high occupancy vehicles (HOV), mandates HOV lanes under certain circumstances. Most of the HOV lanes will be tied to intelligent freeway management systems (FMS). The policy states that "in urbanized areas with populations over 200,000 the ten lane maximum will include four physically separated, exclusive lanes (two in each direction) for through traffic, public transit vehicles, and other high occupancy vehicles" (2020 Florida Transportation Plan).

⇒ **ITS projects are not consistently included in State Implementation Plans (SIP).** In Phoenix, for example, officials stated that the FMS was not included in the SIP because the SIP is a legally defensible document and the question of whether the FMS will have positive benefits on air quality is debatable. In the Pittsburgh Metropolitan Area, officials are uncertain if ITS really improves air quality, hence ITS is not incorporated into the SIP. In Denver, on the other hand, the Denver Regional Element of the 1982 SIP contains many ITS-type projects, including the Traffic Signal Program, HOV developments, and ramp metering. These same components were included within the Air Quality Conformance Statement. Improved operation of traffic signals has been included as a transportation control measure in the Colorado SIPs for more than 15 years. The traffic signal program will continue to be included in future SIPs, because these projects use Congestion Mitigation and Air Quality Improvement Program (CMAQ) funding which specifically funds air quality improvements.

⇒ **CMAQ is the most popular source of federal funding for the deployment of ITS projects.** Staff in Phoenix report that the popularity of CMAQ funds for ITS is because use of these funds frees other funds for traditional projects. Agencies in the Pittsburgh Metropolitan Area report that the CMAQ program is a popular source of funds because of its emphasis on congestion relief and Pittsburgh' s status as a non-attainment area for air quality. Agencies throughout the metropolitan areas would like to see CMAQ funds become a source for operating and maintenance funds as well as deployment. Some specific uses of CMAQ funds include the I-93 HOV lane in Boston, the field equipment for the FMS in Phoenix, and the optimized traffic signal interconnection in the City of Milwaukee.

⇒ **Most agencies believe that currently available models are insufficient to measure the potential benefits of ITS technologies.** Modeling the impacts of ITS on air quality is extremely difficult because there are so many extraneous factors. However, many agency officials believe new models which can show the benefits of ITS are necessary before ITS will be widely accepted. According to one representative of the Boston Metropolitan Area, new air quality models are needed to show ITS impacts because the existing EPA MOBILE 5 model is inadequate.

⇒ **Quantitative benefits of ITS on environmental factors were found in some areas.** Results of a benefit-cost analysis completed for the St. Louis EDP study revealed the incident management plan for the freeway and arterial systems in the St. Louis Metropolitan Area will save an estimated $50 million per year in fuel and travel time. Arterial signal system upgrades are estimated to produce annual time cost savings of approximately $35 million and fuel cost savings of approximately $2 million. The analysis also suggested that travel speed improvements between 5 and 10 miles per hour would reduce carbon monoxide and hydrocarbon emissions by approximately 12 to 25 percent.

A FHWA study quoted in the Boston EDP study, "Intelligent Vehicle Highway Systems Strategic Deployment Plan for Metropolitan Boston," found that implementation of a FMS such as the one recommended by the MHD could result in substantial benefits. The analysis identified short term benefits as an average 22% reduction in excess fuel consumption, reductions of approximately 190 kilograms per day in volatile organic compounds, reductions of 1,000 kilograms per day in carbon monoxide, and reductions of 40 kilograms per day in nitrous oxides. Additional long range air quality benefits associated with the ITS deployments detailed in Metropolitan Boston' s Year 2000 Plan are reductions of 120 kilograms per day in volatile organic compounds, 820 kilograms per day in carbon monoxide, and 50 kilograms per day in nitrous oxide.

Two separate benefits studies that showed environmental impacts were conducted in the Denver Metropolitan Area. DRCOG personnel conducted extensive analysis on their six-year, 1,048 traffic signal system improvement program. The capital improvements and signal retiming program is estimated to reduce air pollutant emissions by 30,000 kilograms per day, decrease fuel consumption by 50,000 liters per day, and generate approximately $250,000 in daily user savings.

A benefit-cost analysis conducted by the University of Colorado at Denver for the CDOT Region 6 concluded that the Courtesy Patrol saved motorists between $1.8 and $2 million worth of time during the six-month study. The reduction of vehicle delays also had an impact on reducing air pollution, although the exact reduction was not specified.

Implications

The eight findings were based on the information provided by the interviewees specifically related to environmental items. The Volpe Center team developed four implications that place these findings in perspective with the wide range of information provided during the reviews.

⇒ **The deployment of ITS is more often based on congestion management and safety issues than on potential environmental improvements.** The majority of agencies plan ITS applications with the primary objective of reducing congestion and facilitating traffic flow improvements. Any environmental benefits that are achieved are secondary; they are the result of meeting this primary objective.

⇒ **Although CMAQ funds are used for ITS projects, environmental benefits of the projects have not been thoroughly identified.** Several interviewees stated that they were unsure of the environmental benefits of ITS. The necessary models and analytical tools to account for the environmental impacts of ITS are not available. Agencies use CMAQ funds for ITS deployments to the extent possible.

⇒ **Sometimes, environmental improvements are given more weight in order to gain political and public support.** Environmental concerns, air quality in particular, loom large on the political agenda of the areas reviewed. Any systems that can have a positive impact on air quality are viewed favorably by elected officials. Therefore, the benefits of ITS on environmental quality are sometimes highly touted, even in the absence of any quantitative analysis proving the benefits. Transportation officials in Phoenix believe that if they can demonstrate that ITS improves air quality then they can garner political support for ITS deployment. Another representative suggested that state officials are very concerned with air quality problems, and if transportation agencies can show that ITS will improve air quality, state officials will support it. Even in the Miami Metropolitan Area, which achieved attainment in April 1995, most of the interviewees regard ITS as a good public relations tool, particularly in the area of air quality non-attainment issues.

⇒ **Although many officials in non-attainment areas state that ITS is being considered to address CAAA mandates, the degree of ITS implementation in non-attainment areas is inconsistent.** The Phoenix and Boston Metropolitan Areas, for example, are both in non-attainment and have high degrees of ITS deployment. Pittsburgh and St. Louis, on the other hand, are in similar states of non-attainment, but have deployed far less ITS. There appears to be no consistent relationship between the level of ITS deployment and the severity of air pollution in a metropolitan area.

Proposed Activities

The goal of the metropolitan area reviews was to collect data on ITS deployment and agency interaction. The fact that data on the environmental factors that influence ITS was also collected was incidental to the primary purpose of the study. Also, no attempt was made to discriminate between attainment and non-attainment areas when selecting metropolitan areas for review. Based on the Volpe Center' s review of metropolitan areas, we propose two activities to further ITS activities related to environmental issues. The first suggestion would allow further understanding of the relationship between the environment and ITS. The second suggestion would benefit ITS practitioners.

Our first activity, if additional information on the impact of environmental factors on ITS is needed, is to conduct a more complete review of metropolitan areas that focuses solely on environmental issues. The study should compare ITS planning in metropolitan areas that are in compliance with the CAAA and those that are not. It should also examine which environmental factors, if any, besides air quality are considered motivation for the deployment of ITS.

One activity definitely needed is greater distribution of information. More information about environmental factors should be provided to state and local practitioners of ITS. These individuals are in need of data that will support the claim that ITS can have a positive impact on air quality and other environmental factors. Benefit-cost analyses, lessons learned from other areas, and new models which can calculate the environmental benefits of ITS are good examples of the kind of information requested by interviewees.

FIGURE 1

AIR QUALITY DESIGNATIONS FOR METROPOLITAN AREAS					
Metropolitan Area	**Categories of Non-Attainment**				
	Ozone	**Carbon Monoxide**	**Particulate Matter**	**Sulfur Dioxide**	**Lead**
Boston	X	X			
Denver	X	X	X		
Miami [1]					
Milwaukee	X				
Phoenix	X	X	X		
Pittsburgh [2]	X	X		X	
St. Louis	X	X			X

Source: July 21, 1995 Federal Register
Notes:
[1] Redesignated Ozone attainment on April 25, 1995 (previously moderate)
[2] Pending Ozone redesignation as of July 21, 1995

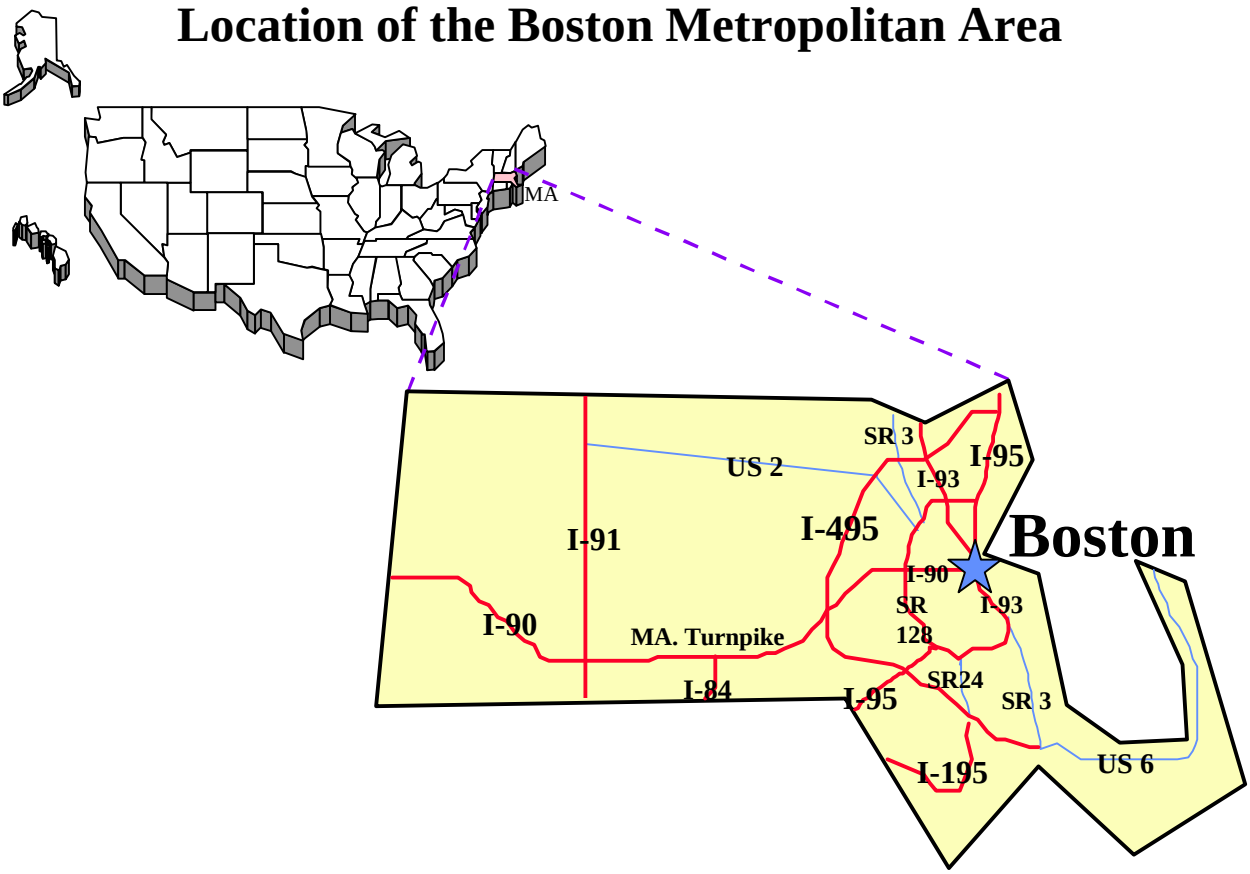
OVERVIEWS

1. THE BOSTON METROPOLITAN AREA

The Boston Metropolitan Area ranks among the 10 most populated metropolitan areas in the United States. The characteristics of the Boston Metropolitan Area, as well as the public agencies contacted during the interviews are described in this section.

AREA CHARACTERISTICS

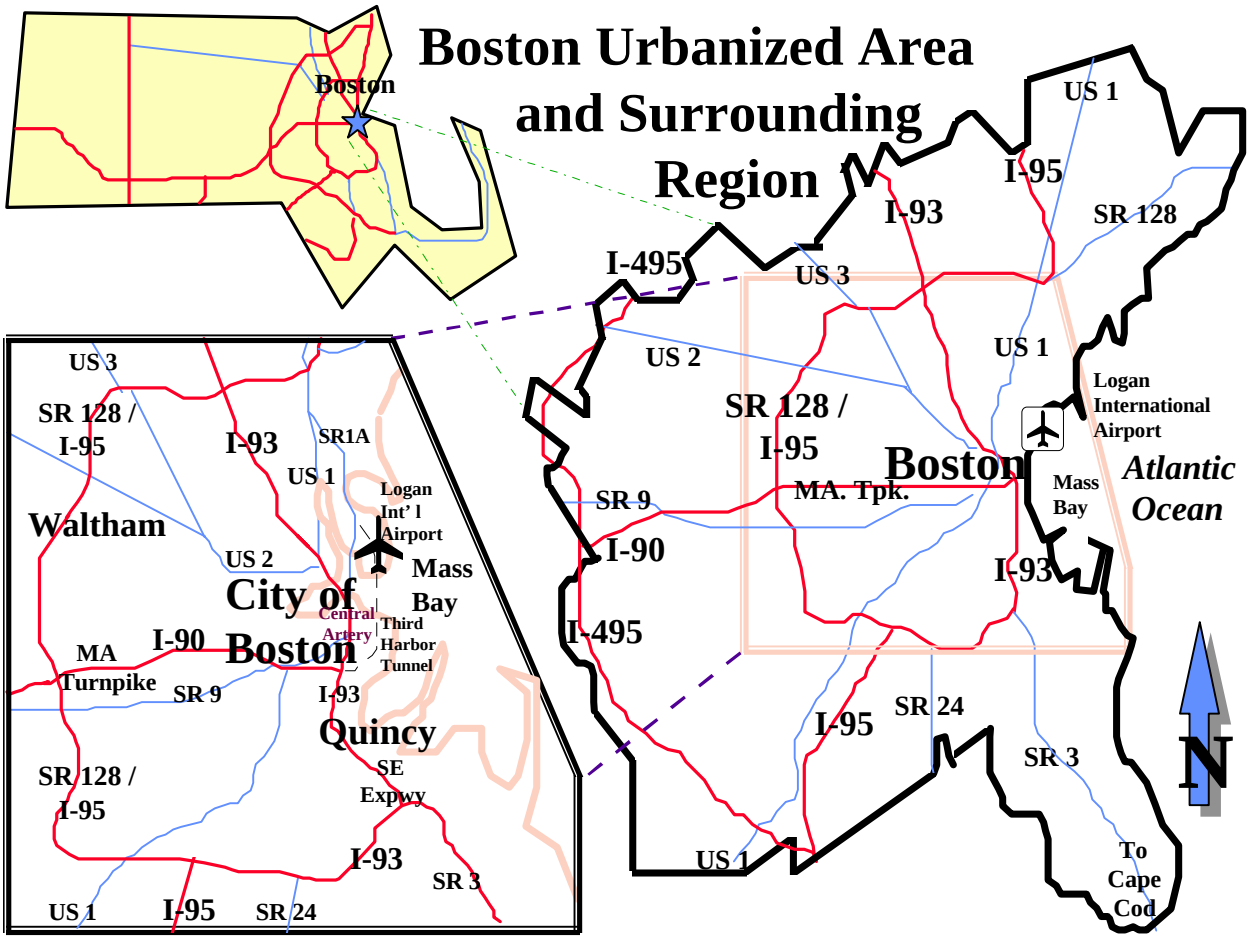
The Boston Urbanized Area (UZA) is 891 square miles and has a population of 2,775,370. It is the 10th largest UZA in the United States according to the 1990 Census. The Boston Metropolitan Area encompasses 101 cities and towns.



Three public transit authorities provide service in the Boston Metropolitan Area. The Massachusetts Bay Transportation Authority (MBTA), the largest transit agency in the Metropolitan Area, provides fixed-route bus service, light and heavy rail, and demand response service to a population of 2.6 million riders. The MBTA has a service area of 1,038 square miles and provides approximately 1.28 billion annual passenger miles. The Cape Ann Transportation

Authority (CATA) provides fixed-route and demand response service to a population of 50,893 riders. The CATA serves 80 square miles and provides 1.37 million annual passenger miles. The Brockton Area Transit Authority (BAT) provides fixed-route and demand response service to a population of 176,677 riders. BAT services an area of 114 square miles and provides 17.5 million annual passenger miles.

There are 8,647 total miles of roadway in the Boston UZA: 148 miles of interstate, 66 miles of freeways and other expressways, 761 miles of other principal arterials, 1,243 miles of minor arterials, 1,164 miles of collectors, and 5,265 miles of local roads. 2.4% of the total mileage in the Boston UZA serves as freeways (Highway Statistics, 1993).



PUBLIC AGENCIES INTERVIEWED

During the review of the Boston Metropolitan Area, a wide range of transportation professionals from transportation agencies throughout the Boston Metropolitan Area was interviewed. Each of the agencies has unique responsibilities for planning, operating, and maintaining the transportation system.

The **Executive Office of Transportation and Construction (EOTC)** is the Massachusetts agency that sets policy for and coordinates the transportation activities of the various state transportation departments, commissions, and authorities. EOTC is headed by the Secretary of Transportation and has oversight of the Massachusetts Highway Department (MHD), Massachusetts Aeronautics Commission (MAC), Massachusetts Bay Transportation Authority (MBTA), Massachusetts Port Authority (Massport), Massachusetts Turnpike Authority (MTA), and regional transit authorities.

The staff of the **Bureau of Transportation Planning and Development (BTP&D)** performs all transportation and ITS planning activities for the state, including the Boston Metropolitan Area. The BTP&D staff reside within the EOTC, however much of the work they perform is for the MHD. Federal Highway Administration (FHWA) planning funds flow from MHD to BTP&D. Metropolitan planning (PL) funds are distributed by the BTP&D to the regional planning agencies throughout the state. On a statewide basis, BTP&D officials develop the State Transportation Plan and long-range strategic plans and review the State Implementation Plan (SIP). They are also involved in projects specific to the Boston Metropolitan Area. They review and approve the Metropolitan Area Planning Commission' s (MAPC) Work Plan, and the Boston Transportation Plan. The BTP&D staff is responsible for reviewing and incorporating certain Boston regional projects in the State Transportation Plan and State Transportation Improvement Program (STIP).

The **Massachusetts Highway Department (MHD)** plans, designs, operates, and maintains interstate and state highways and bridges. MHD has direct responsibility for 2,909 miles of highway and 2,900 bridges. The ITS Programs Unit performs deployment studies, operational tests, and the design and implementation of ITS projects. Three sections comprise the ITS Program Unit: ITS Systems Operation, Emergency Management, and high occupancy vehicle (HOV) Operations. The ITS Programs Unit had its initial roots in the BTP&D, when BTP&D was part of the MHD. It was later moved to MHD' s Traffic Unit, and eventually was spun off into its own unit within MHD. The ITS Programs Unit does deployment of projects after they have been approved in the TP and the STIP. Deployments are coordinated with the MHD Traffic Engineer.

The **Central Artery/Third Harbor Tunnel (CA/T)** project team is a unit of the MHD. The team has full responsibility for planning, designing, and implementing 220 lane-kilometers of roadway, including 65 lane-kilometers of tunnels, which are part of the reconstruction of the Central Artery (I-93) and the construction of the Third Harbor Tunnel (I-90). The CA/T Project staff is responsible for planning and deploying ITS technologies throughout the project. The operation and maintenance of the CA/T Project may not reside within MHD, but may be given to the MTA.

Six agencies comprise the Boston Metropolitan Planning Organization (MPO): the MAPC, MHD, Massport, MBTA, MBTA Advisory Board, and EOTC. The MPO' sSubsignatory Committee (SSC), which is composed of senior staff from the MPO member agencies, oversees the day-to-day activities of the MPO. One major responsibility is to approve of the priorities of the projects included in the Transportation Improvement Program (TIP). The **Metropolitan Area Planning Commission (MAPC)** staff is responsible for comprehensive planning,

including transportation planning, for the 101 cities and towns in the Boston Metropolitan Area. Although they have no operating responsibility, they do have fiduciary responsibility for the Boston MPO and program funds through the TIP.

The **Central Transportation Planning Staff (CTPS)** act as in-house consultants to the six Boston MPO agencies. The CTPS staff does technical and policy analysis to support transportation planning in the Boston Metropolitan Area. The agency was created as an effort by several transportation agencies to pool planning resources and to promote cooperation and consistent planning practices. The work done by the CTPS staff falls into four major categories: travel demand modeling, operations planning and analysis, certification activities, and data and graphics resources. The staff members develop and analyze travel forecasts, provide transit service planning, and conduct feasibility studies. Representatives of CTPS write and analyze MPO certification documents. The Traffic Analysis and Design Division of CTPS performs most of the agency' s ITS planning duties. In addition to ITS research, the Traffic Analysis and Design Division works on corridor and subarea studies, analysis of various operation levels, forecasts and small-scale modeling, congestion and intermodal management systems, and HOV lane analysis.

The **Massachusetts Bay Transportation Authority (MBTA)** provides public transportation service by bus, rapid transit, light rail, trackless trolley, commuter rail, and ferry in the 78 cities and towns that make up the MBTA district. Commuter rail service also extends to 52 communities outside the MBTA district. A total of 1,038 square miles with 2.6 million people comprise the MBTA District. The MBTA operates approximately 900 buses. The Planning Department does most of the planning for ITS, while the Operations Directorates for bus, rail, and subway and the Construction and Design Directorate handle most of the ITS deployments.

The **City of Boston Transportation Department (BTD)** plans, operates, and maintains the local road network within the City of Boston. The BTD is responsible for "keeping local traffic local and regional traffic regional." The Office of the Parking Clerk (OPC) is the division within BTD that most often uses new technologies. The OPC, BTD' s Policy and Planning Division, and BTD Administration are all involved in ITS planning, while deployment is handled by the OPC, traffic engineers, and the Operations Division.

The **City of Quincy Traffic Department** plans, operates, and maintains all local streets within the City of Quincy. The Traffic Department is also responsible for the operations of the parking garages. The Traffic Department, which was previously part of the Department of Public Works, became a separate department in 1995.

The **City of Waltham Department of Public Works (DPW)** reviews and plans for all new development, including transportation. The Traffic Department within the DPW, plans, operates, and maintains the transportation system within the City of Waltham. DPW staff from the Traffic and Wires Departments operates and maintains traffic signals, supervises contractor installations, reviews consultant plans, and manages traffic flows.

The **Massachusetts Port Authority (Massport)** owns and operates Logan International Airport, the civilian air terminal at Hanscom Field, the Tobin Bridge, Conley and Moran container

terminals, and several seaport properties, including the Port of Boston and Black Falcon cruise terminal. Massport manages the taxi and limousine pools at the airport, the three express bus routes to the airport, and the parking and courtesy shuttles at the airport. The Information Services Department and the Logan 2000 Offices are planning for ITS applications, while the Transportation and Construction Department, specifically the Ground Transportation Division, deploys ITS and oversees contractor installation.

The **Massachusetts Turnpike Authority (MTA)** operates and maintains the 135-mile Massachusetts Turnpike (MassPike), which has been designated as I-90, and the Callahan and Sumner Tunnels, which pass under Boston Harbor. The MTA operates in the 32 cities and towns through which the turnpike travels. The MTA also operates and maintains rest areas and park-and-ride lots along the turnpike. The majority of ITS planning is accomplished by the Operations Department with the assistance of an inter-disciplinary team. Staff from the Administration, Finance, Marketing, and Legal Departments are all consulted regarding the practicality and viability of ITS projects. The Operations Department will be responsible for the deployment of ITS.

The **Massachusetts State Police (MSP)**, both statewide and within the Boston Metropolitan Area, is responsible for maintaining public safety along the freeway and highway system and ensuring smooth traffic flow with limited congestion.

2. THE DENVER METROPOLITAN AREA

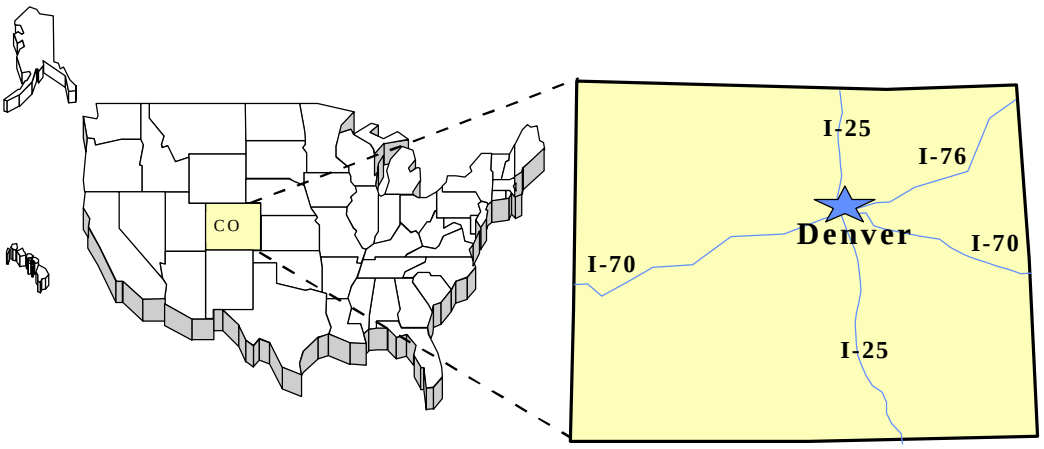
The Denver Metropolitan Area was selected for review of ITS deployments because of the varied ITS activities that are planned and are being deployed. In July 1995, a team from the Volpe Center interviewed 17 people representing eight transportation agencies in the Denver Metropolitan Area. This section reviews the area' s demographic, geographic, and political composition as it relates to transportation, and describes the public agencies represented by the interviewees.

AREA CHARACTERISTICS

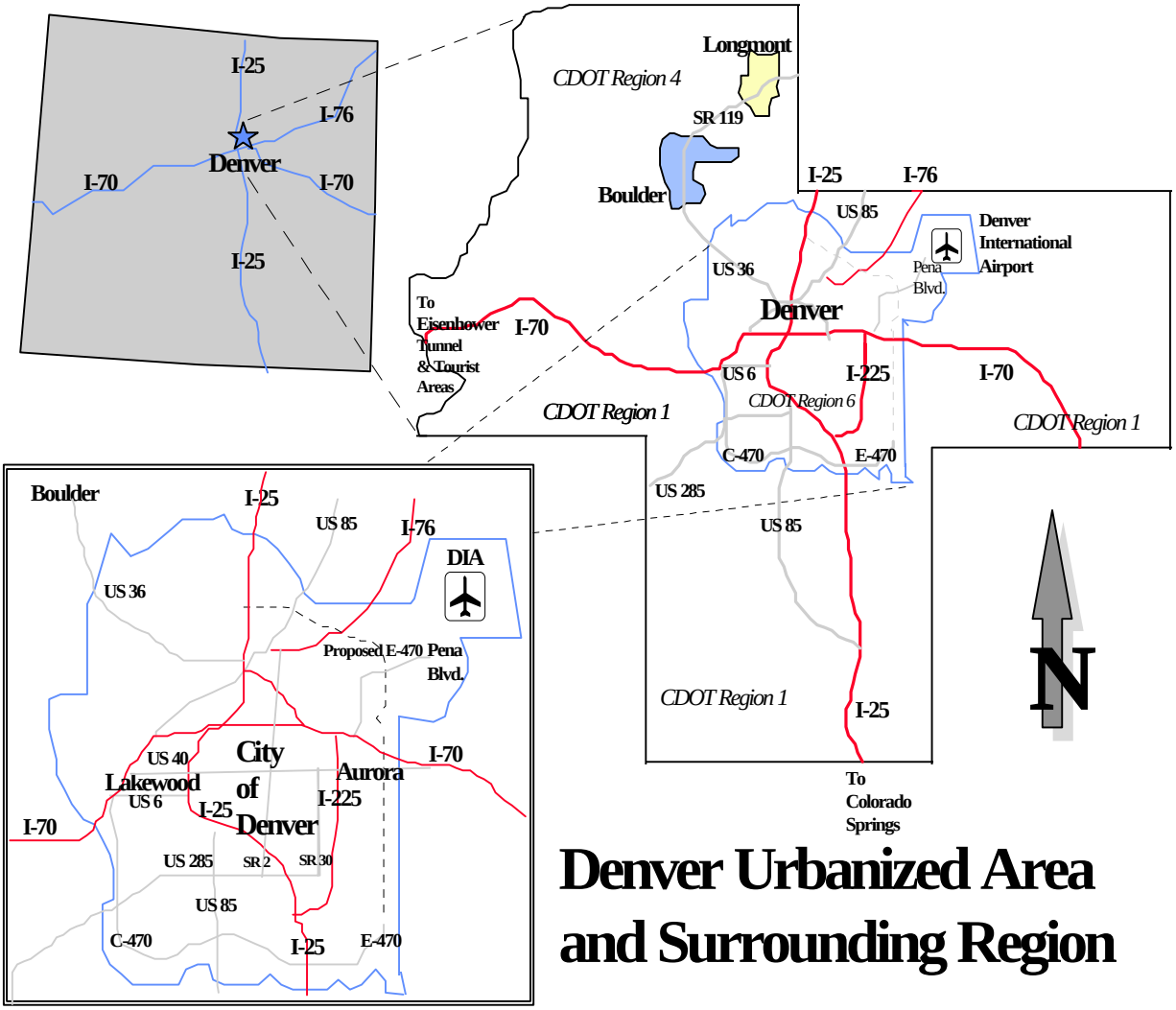
The Denver Urbanized Area (UZA) is 459 square miles and had a 1990 population of 1,517,977, making it the 22nd largest UZA in the United States. The Denver UZA covers six counties, Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson. The UZA is bordered to the west by the Rocky Mountains and to the east by plains.

The Regional Transportation District (RTD) provides transit services. The RTD provided 237.3 million total passenger miles in 1993 (Section 15, 1993).

Location of the Denver Metropolitan Area



There are 6,550 total miles of roadway in the Denver UZA: 98 miles of interstate; 106 miles of other freeways and expressways; 405 miles of other principal arterials; 552 miles of minor arterials; 576 miles of collector roads; and 4,813 miles of local roads. Although only 3.1% of the total mileage in the Denver UZA is freeway, the freeway serves 38.0% (13.5 million miles) of the total daily vehicle miles of travel (VMT) in the metropolitan area. The total VMT is 35.5 million ("Highway Statistics, 1994").



Denver Urbanized Area and Surrounding Region

PUBLIC AGENCIES INTERVIEWED

During the course of the Denver Case Study, a wide range of transportation professionals from transportation and related agencies throughout the Denver Metropolitan Area was interviewed. Each of the agencies has unique responsibilities for planning, operating, and maintaining the transportation system.

The **Colorado Department of Transportation (CDOT)** maintains and operates all of the freeways in the Denver Metropolitan Area. The CDOT headquarters (HQ), located in the Denver Metropolitan Area, sets CDOT policy and performs statewide planning, coordination and development functions. The appointed Colorado Transportation Commission (CTC) approves overall policy, projects, and funding. To coordinate and lead the statewide ITS effort, the CDOT Executive Director created the ITS Program Office in 1994. The ITS development and operation responsibilities previously were divided between the various sections within the Transportation

Development Division and the CDOT Regional Offices. While the Regional Offices are involved in many aspects of the ITS operations, the ITS Program Office assumed many of the central coordination functions involved in planning, developing, and deploying ITS in both Denver and throughout the State of Colorado.

Construction, operations, and maintenance of the physical system are responsibilities of the three CDOT Regional Offices that have jurisdictions within the Denver Metropolitan Area. The Region 6 jurisdiction is located in and around the core city and, therefore, directs the greatest influence of the three CDOT Regions over the Denver transportation system. The Region 4 jurisdiction is north of the City of Denver and includes the cities of Boulder and Longmont. The Region 1 jurisdiction is to the east, south, and west of the City of Denver and includes the I-70 Eisenhower Tunnel mountain pass to Vail and other ski and tourist resorts.

The **Denver Regional Council of Governments (DRCOG)** is an association of 48 city and county governments in the Denver Metropolitan Area. The eight-county DRCOG region contained a 1995 population over two million. The DRCOG, established in 1955, serves as the Denver Metropolitan Planning Organization (MPO). As the MPO, it has the responsibility for identifying future transportation needs and for recommending an integrated, multimodal metropolitan transportation plan to meet these needs, as well as identifying priorities for implementation contained in the Denver Regional Transportation Improvement Program (TIP). The DRCOG, responsible for the development of the TIP, effectively has some authority in determining the distribution of federal transportation funds to those projects that comprise the TIP. The DRCOG is also heavily involved in the regional coordination of the traffic signal network.

The **Regional Transportation District of Denver (RTD)** provides transit services to a 2,406 square mile, six-county regional service area that contains a population of almost 1.9 million. In addition to regional coverage, the RTD runs local routes in Denver, Boulder, and Longmont. The RTD operates a transit fleet of 769 buses, 11 light rail vehicles, and 56 demand responsive (paratransit) vehicles. In addition to the 156 bus routes, the RTD opened the 5.3-mile, 14-stop Metropolitan Area Connection (MAC) light rail line in downtown Denver in October 1994. This agency is planning for future expansion of the light rail system in seven principal corridors, including a 24-mile Air Train to the Denver International Airport (DIA) to the east, a 16-mile extension to the City of Golden in the west, and a 13-mile extension to the municipalities of Englewood and Littleton to the southwest.

The **City and County of Denver** is 153.4 square miles in area with a 1990 population of over 468,000 and a population density of 3,051 per square mile. The City of Denver has a strong mayoral government. The Transportation Division of the Public Works Department plans, implements, and operates the transportation system within the city, except on the freeway system, which is controlled by the CDOT. The Street Maintenance Section of the Operations Division is responsible for daily maintenance of the transportation system. The Transportation Engineering section of the Transportation Division initiates most projects that include ITS technologies. The Director of Transportation Engineering directs traffic design and right-of-way use, which are instrumental controls in the implementation of ITS.

The **City of Aurora** is located east of the City of Denver. Aurora is 135.5 square miles in area with a 1990 population of 222,103 and has a population density of 1,639 per square mile. The city government is responsible for the planning, implementation, operation, and maintenance of the transportation system within Aurora, except for the two freeways that pass through the city. The Traffic Services Division of Public Works is responsible for all intersections, signals, and signs. The Traffic Services Division also performs all planning and deploying of new transportation technologies for the city.

The **City of Lakewood** is located west of the City of Denver. Lakewood is 40.8 square miles in area with a 1990 population of 126,481 and a population density of 3,100 per square mile. The city maintains all roads within its borders, including the three state highways which are owned by the CDOT. The Traffic Engineering Department is responsible for planning, installation, operation, and maintenance of all signals, signs, intersections, and other transportation facilities. This department is also responsible for the planning and implementation of ITS for Lakewood. Due to its expanding role, the City reorganized the Traffic Engineering Department from a division of the Public Works Department to a designated department. The City' s Traffic Engineer reports directly to the Mayor and the City Council.

The **E-470 Public Highway Authority**, a toll authority, was established in 1988. Elected officials from each of the local governments where the Authority is or will operate comprise the Board of Directors. The eight-member Board vests all legislative power of the Authority. There are plans to build 48 miles of interstate standard highway to be paid by tolls, vehicle registration fees, and development impact fees. In June 1991, the Authority opened 5.5 miles for operation. Staff plans to construct an additional 30 miles starting in the fall of 1995 and is scheduled to open between May 1998 and May 1999. Construction on the final 12-mile segment will be beyond the year 2000. E-470 is a small operation, with approximately 16 staff members. Staff or private contractors handle all transportation functions. Any of the staff directors, including the Executive Director, can initiate, plan, and deploy the use of ITS technology.

The **Colorado State Patrol (CSP)** is the primary agency responsible for responding to incidents and other emergencies on the transportation network. The CSP' s major duty is to provide and maintain the safety of the transportation system throughout the state, especially along the highways and freeways. Within the Denver Metropolitan Area, the CSP has limited authority on the freeways within the City and County of Denver, which are under the jurisdiction of the City of Denver' s Police and Fire Departments. The local municipalities throughout Colorado are generally responsible for enforcement and emergency response on the freeways within their borders. The CSP is involved in highway management, including the mitigation of traffic congestion. The Communications Branch is responsible for operations planning for the CSP and running the CSP communications centers. The Communications Coordinator, based at the CSP HQ, conducts both the planning and deployment of ITS technology for CSP. The CSP was originally part of the CDOT and therefore, the two agencies maintain an excellent relationship.

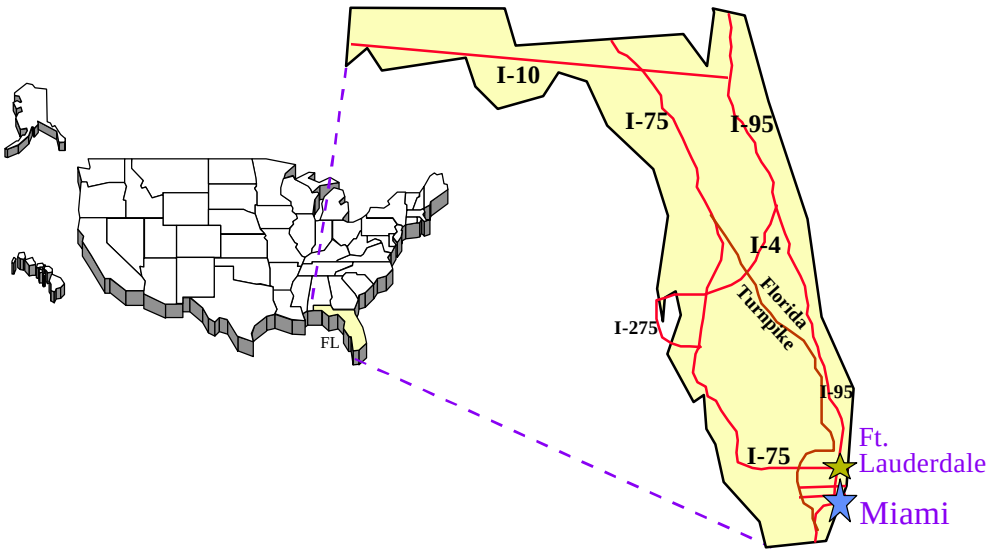
3. THE MIAMI/FT. LAUDERDALE METROPOLITAN AREAS

The Miami and Ft. Lauderdale Metropolitan Areas were reviewed because the planned ITS activities are being deployed over multiple metropolitan areas, encompassing the jurisdictions of more than one metropolitan planning organization (MPO). In October 1995, a team from the Volpe Center interviewed 18 people representing ten transportation agencies in the Miami and Ft. Lauderdale Metropolitan Areas. This section reviews the area' s demographic, geographic, and political composition as it relates to transportation, and provides descriptions of the public agencies interviewed.

AREA CHARACTERISTICS

The South Florida region is comprised of three contiguous urbanized areas (UZA) - Miami, Ft. Lauderdale, and Palm Beach. For purposes of this study, the Miami and Ft. Lauderdale Metropolitan Areas were reviewed, but the smaller and northernmost Palm Beach Metropolitan Area was not.

Location of the
Miami and Ft. Lauderdale Metropolitan Areas



The Miami UZA is 353 square miles in area and has a population of approximately 2.0 million, making it the 16th most populated UZA in the United States. The Ft. Lauderdale UZA is 327 square miles and has a population of approximately 1.3 million, making it the 26th largest UZA

in the country. The combined Miami and Ft. Lauderdale Urbanized Areas are 680 square miles and has a population about 3.3 million, approximately the same population as the Washington D.C. UZA.

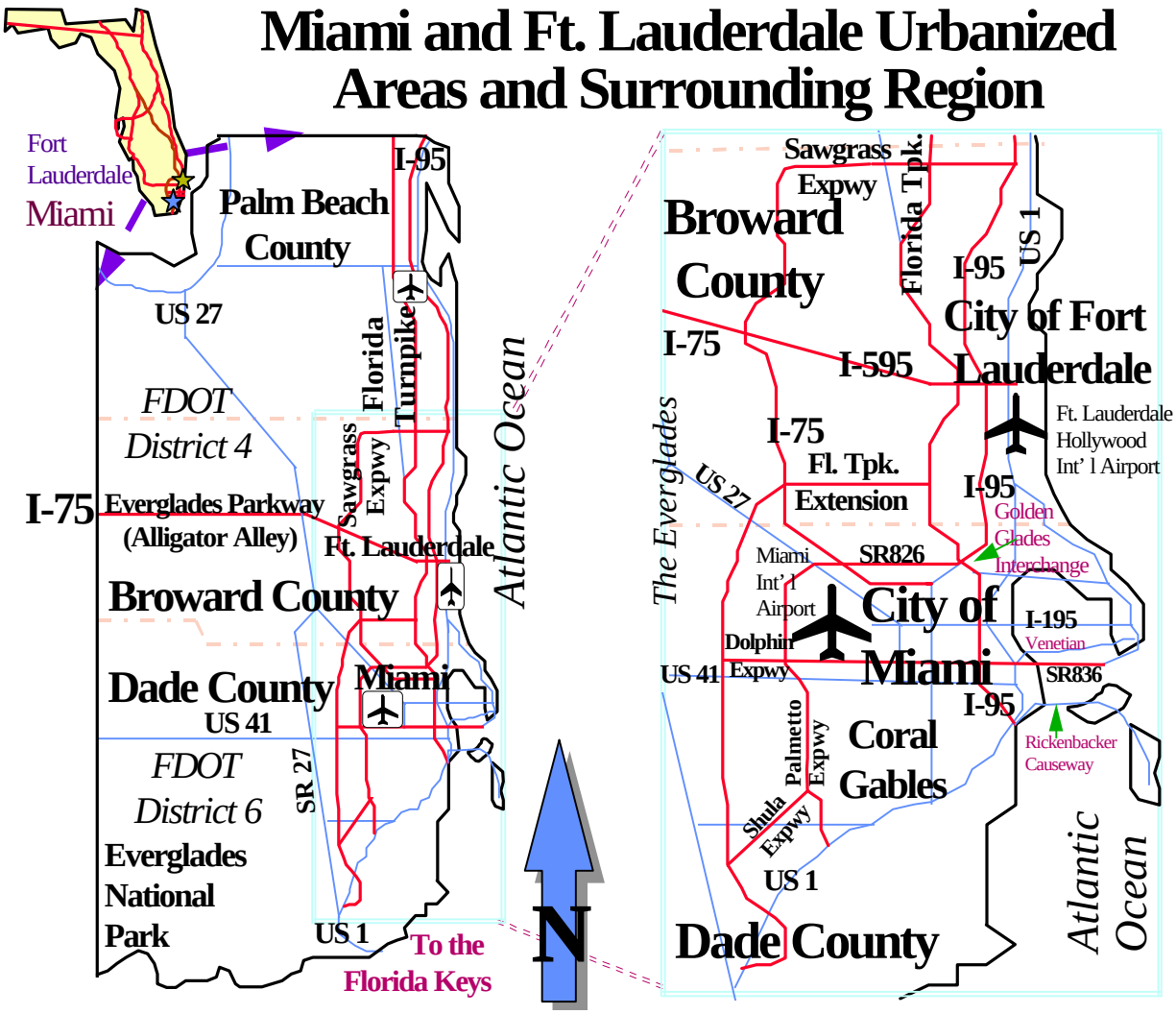
The transit system is comprised primarily of three organizations: the Metro-Dade Transit Agency (MDTA) , the Broward County Mass Transit Division (BCT) , and the South Florida Tri-County Commuter Rail Authority (Tri-Rail). Statistics for the transit providers, including total fleet size and passenger miles, is:

Transit Service in South Florida UZAs				
	MDTA	**BCT**	**Tri-Rail**	**Total**
Modes	Bus, Heavy Rail, Automated Guideway	Bus	Commuter Rail	---
Service Area	285 square miles	310 sq. miles	1,340 sq. miles	---
Fleet Size	970 vehicles	408 vehicles	31 vehicles	1,409 vehicles
Passenger Miles	412.6 million miles	102.2 M miles	88.6 M miles	603.4 M miles

Note: Tri-Rail service statistics includes service to Dade, Broward, and Palm Beach Counties.
Source: Section 15 Report for 1993 National Transit Database

In the Miami and Ft. Lauderdale UZAs, as of 1994, there were 9,813 total roadway miles. The metropolitan roadway system carried a total daily vehicle miles of travel (VMT) of 64.4 million in 1994. Although only 2.2% of the total mileage in the Miami and Ft. Lauderdale UZAs are freeway, the freeway serves 32.1% of the VMT for the two UZAs ("Highway Statistics, 1994"). Roadway mileage comparisons for the two UZAs are provided:

Road Mileage and Daily Vehicle Miles of Travel in South Florida UZAs			
Mileage by Road Classification	**Dade County (Miami)**	**Broward County (Ft. Lauderdale)**	**Total of Miami and Ft. Lauderdale UZAs**
Interstate	24	55	79
Other Freeway	86	54	140
Principal Arterial	210	199	409
Minor Arterial	391	255	646
Collector	441	512	953
Local	4,455	3,131	7,586
Total Mileage	**5,607**	**4,206**	**9,813**
Total VMT	**35.1 million**	**29.3 million**	**64.4 million**



PUBLIC AGENCIES INTERVIEWED

During the course of the Miami and Ft. Lauderdale Case Study, a wide range of transportation professionals from transportation and related agencies throughout the two metropolitan areas were interviewed. Each of the agencies has unique responsibilities for planning, operating, and maintaining the transportation system.

The **Florida Department of Transportation (FDOT)** maintains and operates all of the freeways throughout the State of Florida. Coordination of the Statewide ITS Program is assumed by the Central Traffic Engineering Office, located at FDOT headquarters (HQ) in Tallahassee. The Central Traffic Engineering Office staff are involved with ITS technology exchange to the FDOT district offices and other public agencies. The Central Office has also taken the lead in the development of the statewide ITS plans. Staff at the Central Office perform ITS planning, design, and implementation. However, an administrator stated that the eight FDOT district offices conduct most of the ITS deployment activities, and the deployment responsibilities at the state level are still being resolved.

Construction, operations, and maintenance of the major roadways are the responsibilities of three FDOT District Offices that have jurisdiction within the Miami and Ft. Lauderdale Metropolitan Areas. **District Four** incorporates five Florida counties from Indian River County in the north to Broward County in the south. **District Six** includes Dade and Monroe Counties. The **Florida Turnpike District Office** is also known as the **FDOT' s District Eight** Much of Southeast Florida' s planning is out of District Six' s Office, which houses the ITS Program Manager for Districts Four, Six, and Eight. Decentralization within the FDOT occurred in the early 1990' s, giving the district offices greater roles in both planning and deploying ITS and other transportation functions. One interviewee from the FDOT noted that the ITS Units at the district offices offer a hybrid of staff skilled in either operations and construction.

The **Florida Turnpike District Office** is responsible for all planning, construction, operations, and maintenance along the 321-mile Florida Turnpike running through 13 counties. The Turnpike District, created in 1959, has also assumed management of the 23-mile Sawgrass Expressway in Broward County. The Turnpike District' s ITS efforts are coordinated through its ITS Program Manager, who is responsible for developing ITS procurement documents, coordinating projects at the field level, and managing system component testing, including a fiber optic backbone for the Turnpike. The Turnpike District works on ITS endeavors with the Central Traffic Engineering Office, other FDOT Districts, MPOs, counties and municipalities, and the Florida Department of Environmental Protection.

The **Dade County MPO**, also known as the Miami Urbanized Area MPO, is the designated agency to coordinate federal, state, and local transportation solutions for the 27 municipalities in Dade County. The Dade County MPO is an organization within the Dade County Government. Its mandate is to develop a long-range multimodal transportation plan and a short-term implementation program. Staff at the Dade County MPO act as liaisons between local governments, elected officials, and the general public. The MPO is solely a planning agency and does not become involved in with implementation. Two staffmembers are charged with the responsibility to incorporate appropriate ITS components within regional plans.

The **Broward County MPO** is a division of the Strategic Planning and Growth Management Department within the Broward County Government. The MPO is staffed by the county' s long- and short-range planners that work in the Transportation Planning Division. The MPO conducts countywide planning endeavors and provides technical coordination for activities involving highway, aviation, seaport, and mass transit operations in Broward County and 28 municipalities. The MPO does no implementation of ITS elements. The Broward County Department of Public Works and the BCT are responsible for ITS implementation.

The **Metro-Dade Transit Agency**, an agency within the Dade County Government, provides transit service to all of Dade County and the southernmost part of Broward County. By county charter, the MDTA is entirely responsible for transit operations in Dade County which involves 783 buses operating 70 bus routes, 25 automated guideway cars covering three routes along an elevated 2-mile track in Downtown Miami, and 136 heavy rail cars operating on a 21-mile elevated rail line. The heavy rail system is known as Metrorail and the automated guideway system is known as the Metromover. There is no specific unit within the MDTA that plans and

deploys ITS. One high-level administrator acts as the overall coordinator of MDTA ITS activities within the agency, with other county departments, and with other agencies outside of the county. ITS planning and deployment efforts within the MDTA have gravitated to departments and functional areas that are most logical to direct these efforts. Deployment is coordinated with the ITS Technical Committee created by the Dade County MPO.

The **Broward County Mass Transit Division (BCT)** is a division within the Community Services Department of the Broward County Government provides transit services throughout Broward County, to a park and ride lot in northern Dade County, and a mall in southern Palm Beach County. BCT uses their own fleet of 211 buses and contracts for another 200 more vehicles to provide service on 37 fixed bus routes, numerous special shuttle bus routes, and paratransit service. Planning, including ITS efforts, is initiated by the staff in the Planning and Schedules Division. Staff in the Operations Division handles deployment, including projects that have ITS applications. While no individuals from the **South Florida Tri-County Commuter Rail Authority (Tri-Rail)** were interviewed, it should be noted that this is a key agency in the region, providing commuter rail service from Palm Beach County to Dade County. All of the county transit divisions provide services that link to Tri-Rail' s 67-mile long rail system.

The **Dade County' s Public Works Department (PWD)** handles the transportation system within Dade County. Staff at the PWD is charges with installing, operating, maintaining, and modifying all county signals, as well as the stripping, signing, and repairs of all municipal and county roads. The PWD is composed of a number of divisions. Work involving ITS is primarily concentrated in the Traffic Signals and Signs Division and the Highway Division. The Traffic Signals and Signs Division maintains the Dade County Traffic Control Center (TCC), from which all traffic signals in the county are operated. The Highway Department works on roadway construction, maintenance, and operations, including freeway management system (FMS) projects and the coordination of many projects with the automated traffic management systems (ATMS) being developed by the FDOT. While these two divisions are doing much of the ITS deployment, operations, and maintenance, and some ITS planning is being done by the PWD and the Dade County Planning Department, interviewees said that the majority of planning for ITS is performed by the Dade County MPO.

The **Broward County' s Department of Public Works (DPW)** is responsible for the transportation network within Broward County. The Broward County MPO has the principal ITS planning responsibilities, but ITS planning is also fragmented among other county agencies. ITS implementation responsibilities are conducted by several county offices, including the DPW, the MPO out of the Strategic Planning and Growth Management Department, the BCT out of the Community Services Department, and even the Aviation Department. ITS deployments in the county are performed by the BCT and the Traffic Engineering Division of the DPW' sOffice of Transportation. The Traffic Engineering Division is responsible for installing, operating, and maintaining all 1200 city and county traffic signals and flashing signs, and implementing all major roadway projects, including those involving ITS components

The **City of Miami** is 35.6 square miles in area with a 1994 population of 373,024 and a population density of 10,478 per square mile. The City of Miami' s principal responsibility is community planning. The county has the majority of responsibilities for the transportation

system. The Miami representative explained that Dade County is a Constitutional Charter County with all powers for local self-government, including specified authority over surface, air, and water transportation granted to the county. It' s unique government structure, in which the cities own and maintain non-arterial and local roads, but have no other authority. Municipalities can plan and deploy as long as they have support from the county, which is generally the case. However, since most of the funds are derived from the county, it is more often reasonable for the county to deploy ITS and other projects than the cities. The City of Miami has *defacto* authority over transportation issues through zoning regulations and other land use issues.

The **City of Ft. Lauderdale**, the largest municipality in Broward County, is 31.4 square miles in area with a 1994 population of 162,842 and a population density of 5,186 per square mile. The City of Ft. Lauderdale and Broward County have a relationship similar to that between the City of Miami and Dade County. Although the City of Ft. Lauderdale staff have limited authority over the transportation system, they have extensive interest in every aspect of transportation in the City. The City of Ft. Lauderdale' s Traffic Engineering Department is responsible for the minor local streets and parking in the municipality, and requests for road closures and technology applications. Local traffic control devices are operated by the Broward County DPW and state road devices are controlled FDOT.

The **City of Coral Gables** in southern Dade County is 11.8 square miles in area with a 1994 population of 41,750 and a population density of 3,538 per square mile. Most of the transportation system within Coral Gables is under the jurisdiction of Dade County. The Coral Gables DPW' s limited transportation system authority includes right-of-way maintenance, construction permitting, and intra-city public transportation, and cooperative efforts with Dade County on signal coordination and street closures. The Planning Division and DPW perform planning for ITS applications, including with street closures. The Coral Gables DPW works in conjunction with Dade County MPO on ITS deployments.

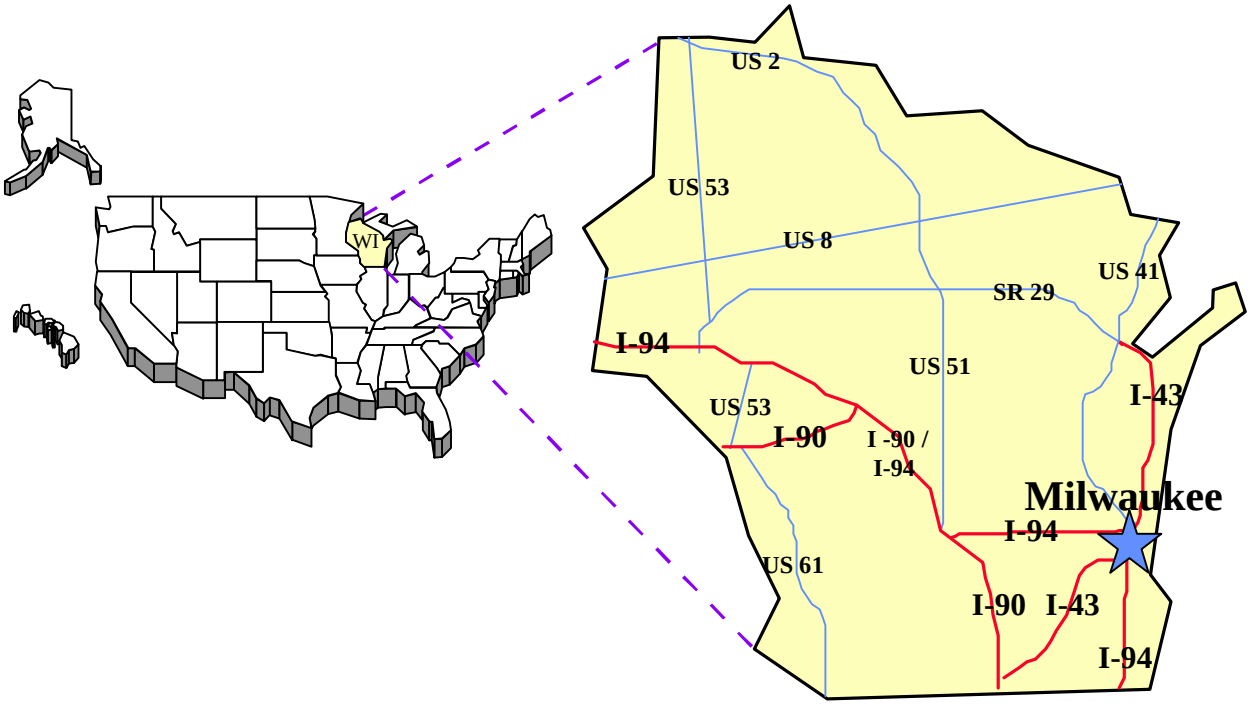
4. THE MILWAUKEE METROPOLITAN AREA

The Milwaukee Metropolitan Area ranks among the 30 most populated metropolitan areas in the United States. The characteristics of the Milwaukee Metropolitan Area, as well as the public agencies contacted during interviews of this area are described in this section.

AREA CHARACTERISTICS

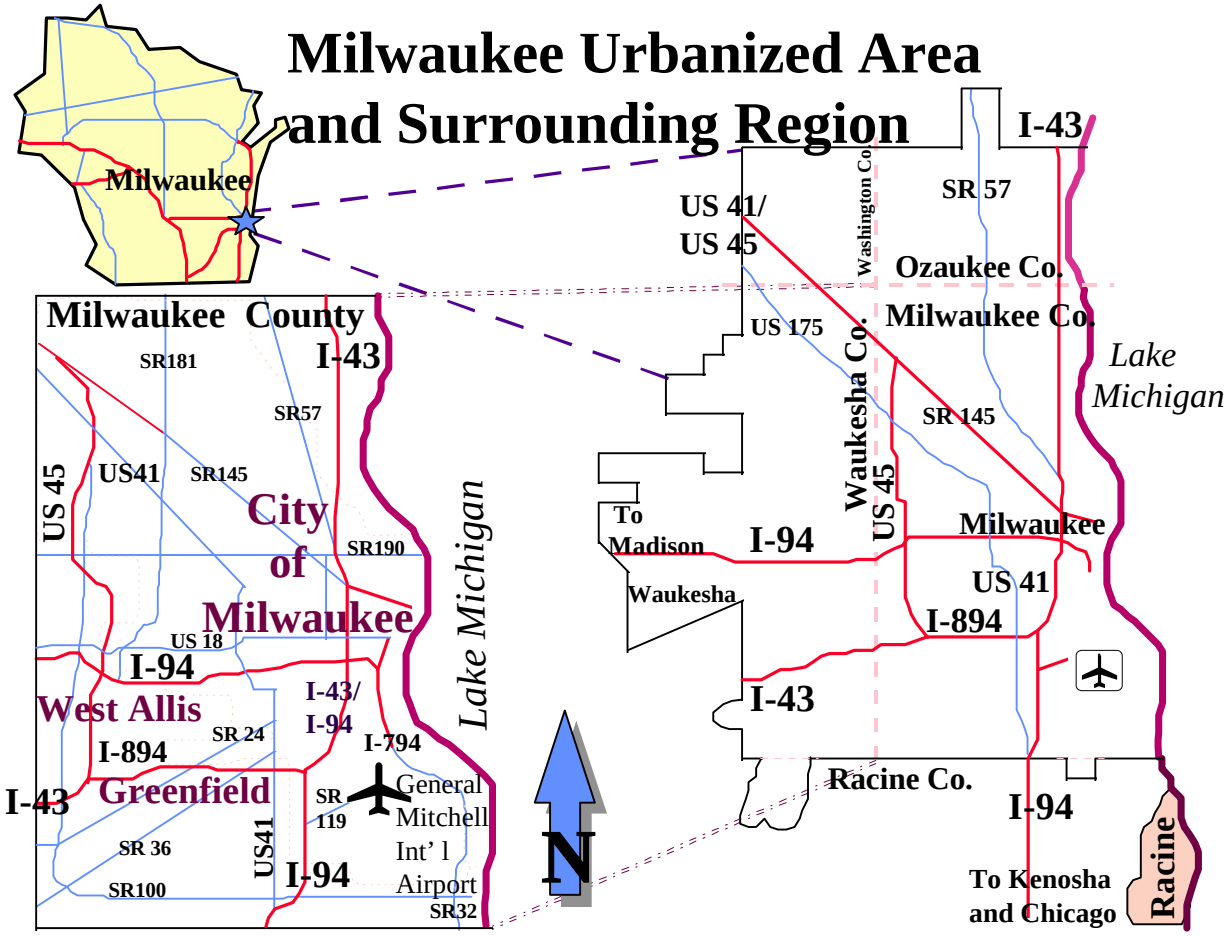
The Milwaukee Urbanized Area (UZA) is 512 square miles, or about 17% of the total land area of Southeastern Wisconsin. The urbanized area has a population of 1,226,293 people, or 71% of the total population of the Southeastern Wisconsin region and 77% of the jobs of that region. The Milwaukee Urbanized Area encompasses Milwaukee County, as well as portions of Waukesha, Washington, and Ozaukee counties, and is the 27th largest UZA in the United States according to the 1990 Census.

Location of the Milwaukee Metropolitan Area



The Milwaukee County Transit System is the only transit agency operating in the Milwaukee Metropolitan Area. This agency provides fixed route and demand response service to populations throughout the Metropolitan Area. These transit services provide over 150 million total annual passenger miles to transit users.

There are 4,898 total miles of roadway in the Milwaukee UZA: 75 miles of interstate, 10 miles of freeways and other expressways, 370 miles of other principal arterials, 839 miles of minor arterials, 311 miles of collectors, and 3,293 miles of local roads. The percentage of total mileage in the Milwaukee UZA that is freeways is 1.7%. Total daily vehicle miles of travel (VMT) is 24.8 (Highway Statistics, 1993).



PUBLIC AGENCIES INTERVIEWED

During the course of the review, a wide range of transportation professionals from throughout the Milwaukee Metropolitan Area was interviewed. Each of the agencies has unique responsibilities for planning, operating, and maintaining the transportation system.

The **Wisconsin Department of Transportation (WisDOT)** has jurisdiction over 12,000 miles of the Wisconsin state trunk highway and interstate systems. Representatives of this agency are responsible for the design, maintenance, and operation of these highways. The lead agency within the WisDOT for planning ITS is the Division of Highways. The five other agencies, State

Police, Department of Motor Vehicles, Planning, Business Management, and Transportation Assistance are represented on an interdepartmental ITS Steering Committee.

The **Southeastern Wisconsin Regional Planning Commission (SEWRPC)** collects and analyzes data and prepares system plans for the 147 villages, cities and towns within its jurisdiction. The SEWRPC is made up of Kenosha, Milwaukee, Ozaukee, Racine, Walsworth, Washington, and Waukesha counties. No separate division exists within the SEWRPC that is specifically devoted to ITS. Rather, the agency as a whole has been championing ITS for twenty years. The SEWRPC serves on the steering committee that makes recommendations to the WisDOT about ITS.

The **Milwaukee County Transit System** operates under the control of the Milwaukee County Department of Public Works. This agency is responsible for implementation and operation of all transit services in Milwaukee County. Planning for ITS is a joint effort by department heads in the Transportation and Schedule and Maintenance units, which are part of the Operations Department, while deployment of ITS is handled primarily by the Transportation Department. The Transit System operates over 600 transit vehicles in 19 municipalities in Milwaukee County and has two routes in Waukesha County. The Milwaukee County Transport Services, Inc., (MTS), a private, non-profit company under contract with the County, staffs the Milwaukee County Transit System. The Milwaukee County Transit System has a representative on the ITS advisory committee to the WisDOT. There is no specific ITS unit in the Milwaukee County Transit System.

The **Milwaukee County Department of Public Works (DPW)** is responsible for maintaining highways, bridges, airports and the transit system. The County has no specific ITS division, although representatives from the Milwaukee County DPW sit on several state planning committees and advise the WisDOT on ITS and other areas. Wisconsin is one of the few states, along with Texas and California, that hires the County to take care of the maintenance of its tollways and freeway system. The WisDOT plans and implements the system, and the County maintains it.

The **City of Milwaukee Traffic Engineering and Electrical Services Division** operates and maintains all of the City' s streets and state designator roads and has limited responsibility over state highways. This division is also responsible for street lighting and traffic, maintaining 690 signals at City intersections, and lighting state and County roads, for which they are reimbursed. There are an additional 50-75 state or county operated signals throughout the city. The Electrical Services Division is responsible for researching and planning for developments or changes in traffic operations, although little formal long- or short-range planning occurs.

The **City of Greenfield Engineering Department** reviews plans for capital improvements and new construction in the City and handles major maintenance projects on local streets. The Engineering Department also reviews and comments on projects in other jurisdictions, including the WisDOT' sITS projects.

The **City of West Allis Engineering Department** is responsible for maintaining and operating all of the City' s streets except two portions of the state' s trunk highway and one county road.

The **Wisconsin State Patrol** is part of the WisDOT and works closely with the WisDOT Division of Highways. They provide emergency services and are involved in any planned new construction in the state. There is no specific ITS activity within the State Patrol.

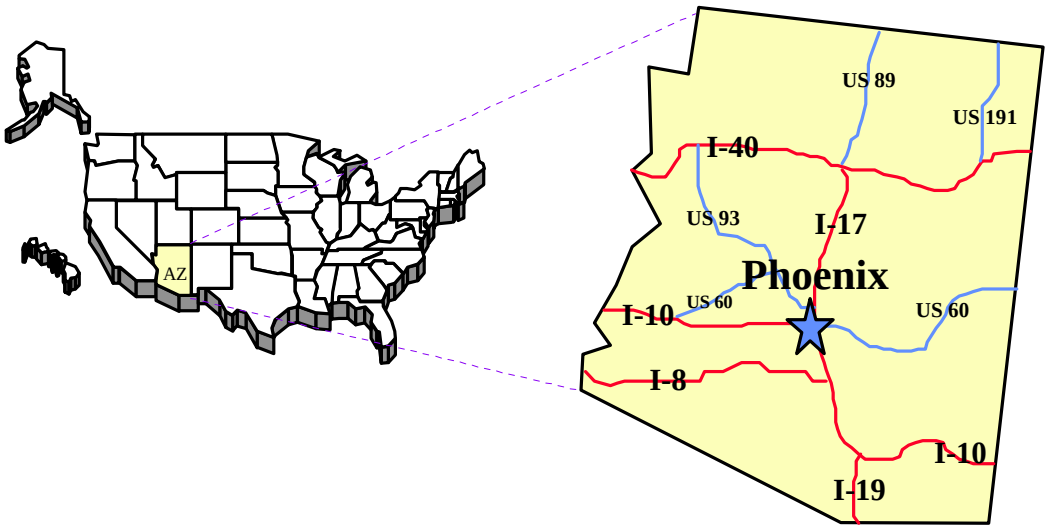
5. THE PHOENIX METROPOLITAN AREA

The Phoenix Metropolitan Area ranks among the 10 most populated metropolitan areas in the United States. The characteristics of the Phoenix Metropolitan Area, as well as the public agencies contacted during the interviews are described in this section.

AREA CHARACTERISTICS

The Phoenix Urbanized Area (UZA) is 741 square miles and has a population of 2,006,239. It consists of the 24 cities and towns within Maricopa County, as well as the Gila Indian Reservation, the Salt River Pima Maricopa Indian Community, and the Fort McDowell Indian Community. It is the 14th largest UZA in the United States according to the 1990 Census.

Location of the Phoenix Metropolitan Area



The transit system in the Phoenix Metropolitan Area is comprised of ten transit agencies, providing fixed route and demand response service to populations throughout the Metropolitan Area. These transit services provide over 143.3 million total annual passenger miles to transit users. (Section 15, 1993) Officials at the transit agencies attempt to make transit in the metropolitan area appear seamless. The buses are painted the same color with the name "Valley Metro" painted on the side. Buses from different agencies accept the same forms of payment and transfers, and use the same radio communications system.

The urban transit system in the Phoenix Metropolitan Area is based exclusively on transit buses. There is no urban passenger rail system in the Phoenix Metropolitan Area.

There were 9,330 total miles of roadway in the Phoenix UZA in 1994: 52 miles of interstate, 63 miles of freeways and other expressways, 624 miles of other principal arterials, 608 miles of minor arterials, 666 miles of collectors, and 7,317 miles of local roads. 1.2% of the total mileage in the Phoenix UZA was freeways and 22.6% of total daily vehicle miles of travel (VMT) was served by freeways. The metropolitan roadway system carried a daily average VMT of 45.9 million in 1994 (*Highway Statistics*, 1994).

PUBLIC AGENCIES INTERVIEWED

During the course of the Phoenix Case Study, a wide range of transportation professionals from transportation agencies throughout Maricopa County was interviewed. Each of the agencies has unique responsibilities for planning, operating, and maintaining the transportation system.

The **Arizona Department of Transportation (ADOT)** maintains and operates all of the freeways in Maricopa County. Support is centralized at headquarters, while operations is decentralized among the district offices. Staff at the Phoenix Maintenance District planned and are in the process of deploying a freeway management system (FMS), which will be operational in August 1995. No specific department has been designated to manage the planning and deployment of ITS overall, but because of their close association with the FMS, the District staff serve as the ITS experts for the ADOT with assistance from Central Planning and the research staff at ADOT headquarters.

The **Maricopa Association of Governments (MAG)** is a Council of Governments and is the metropolitan planning organization (MPO) for the Phoenix Metropolitan Area. The MAG is composed of 24 cities and towns, two tribal communities, Maricopa County, and the ADOT. The Regional Public Transportation Authority (RPTA) is a voting member of MAG's Management Committee. MAG officials are responsible for fiscal planning for surface transportation and freeway location decisions in the Phoenix Metropolitan Area. The MAG is also the lead agency on air quality planning. The MAG Transportation and Planning office is housed within Maricopa County offices, while transit planning services are contracted through the RPTA. ITS activities are handled by MAG's Long Range Planning section.

There are 10 public transit operators in the Phoenix Urbanized Area. The three large, fixed route operators that comprise the majority of service are the **City of Phoenix Public Transit Department**, which operates, through private contractors, 39 motor buses and 61 demand response vehicles; the **Phoenix Transit System**, which directly operates 282 motor buses as a contractor for the City of Phoenix Public Transit Department; and the **Regional Public Transportation Authority (RPTA)**, which operates 17 motor buses, 33 vanpools, and 14 demand response vehicles. In 1985, a Freeway Sales Tax Referendum created the RPTA, an agency that purchases $3.5 million worth of services per year from the City of Phoenix and another contractor in the eastern portion of the metropolitan area.

The seven remaining transit agencies offer mainly demand response service with some fixed-routes. Maricopa County Special Transportation Services operates 47 demand response vehicles. Glendale Dial-A-Ride directly operates 12 demand response vehicles. Peoria Transit directly operates four demand response vehicles. Sun Cities Area Transit System, Inc. directly operates 12 demand response vehicles. Surprise Dial-A-Ride Transit System directly operates two demand response vehicles. The City of Mesa (Mesa SunRunner) operates 23 motor buses and 22 demand response vehicles. The City of Scottsdale Transit Department operates ten motor buses.

The City of Phoenix Public Transit Department is responsible for operating fixed-route bus service in the City of Phoenix and for coordinating service to other municipalities within the metropolitan area. The City of Phoenix Public Transit Department has contracts with several of the private operators previously mentioned. Other contracted companies include Mayflower/Laidlaw, which operates 30 buses on eight fixed routes, and Arnett Transportation Services which operates the Downtown Area Shuttle with nine buses and dial-a-ride service. The City of Phoenix Public Transit Department carries 82% of the ridership in the area.

The **Maricopa County Department of Transportation (MCDOT)** provides transportation services within the jurisdiction of Maricopa County. MCDOT staff provides systems planning, operations, and maintenance for some highways within the County. They operate and maintain urban and rural roadways that are outside incorporated areas, and in some isolated locations within municipalities. Specific ITS projects are planned for and deployed by the MCDOT Traffic Engineering Department in a cooperative effort with the Planning Department. Many projects are undertaken in league with other transportation agencies.

The **City of Phoenix Street Transportation Department** is responsible for planning, implementing, operating, and maintaining the transportation system within the Phoenix City Limits, with the exception of the freeway system. The City of Phoenix Information Technology Department is responsible for the overall planning of new technologies for all other city departments. The operating responsibility for ITS projects on the arterial system is principally borne by the municipalities, while ADOT is responsible for freeway operations. The City of Phoenix Street Transportation Department has implemented or assisted in the implementation of fire and police dispatching systems, the 911 Program, and the City' s optical fiber communications system.

The **City of Tempe Transportation Division** handles all of the planning, implementation, operations, and maintenance of the transportation system in the City of Tempe. ITS planning and deployment is also managed by the City of Tempe's Transportation Division.

The **City of Glendale Traffic Engineering Department** implements, operates, and maintains the transportation system within the City of Glendale. They have no transportation planning division and rely on Maricopa County or contractors performing individual studies for planning assistance. Glendale operates its own Dial-a-Ride service, but this is handled by the Glendale Transit Division and not the Traffic Engineering Department. Once the City of Glendale begins to work on ITS projects, the Traffic Engineering Department will handle planning and deployment.

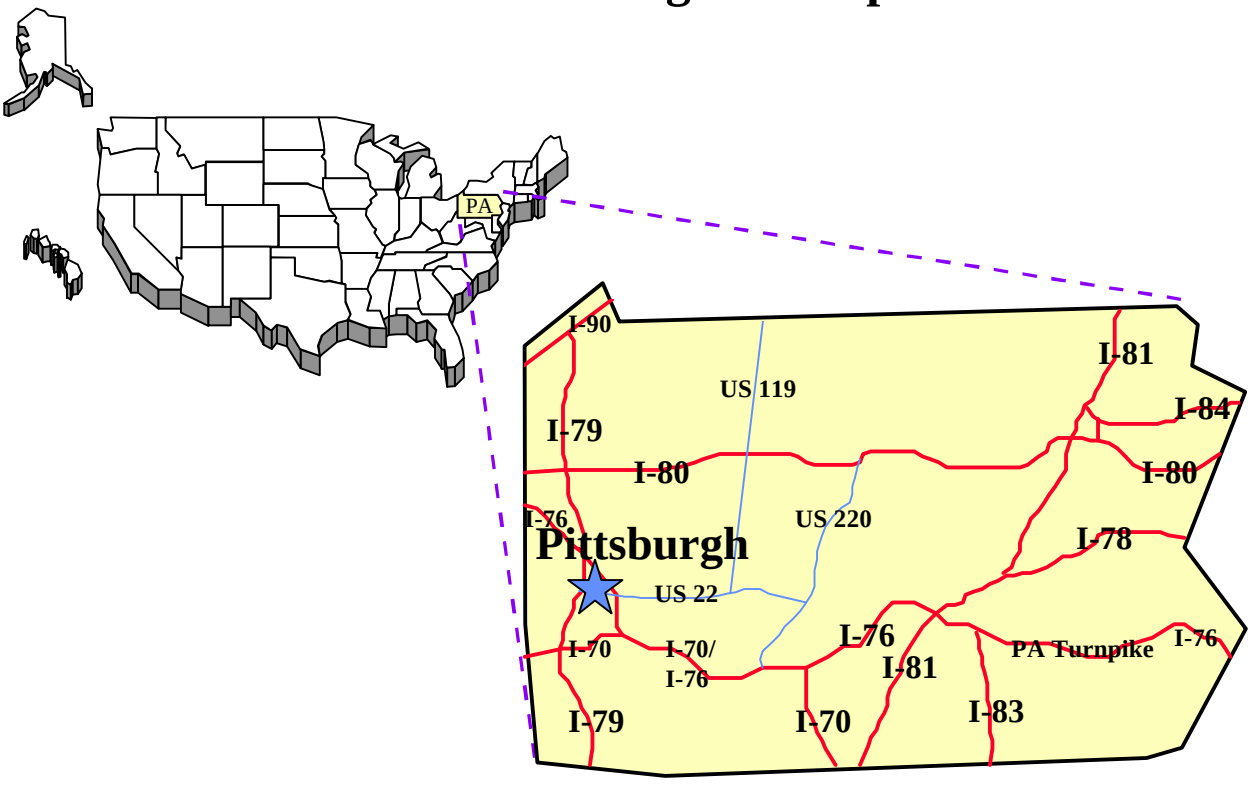
6. THE PITTSBURGH METROPOLITAN AREA

The Pittsburgh Metropolitan Area is among the top 20 most populated areas in the United States. The characteristics of the Pittsburgh Metropolitan Area, and the agencies interviewed during the course of the study are described in this section.

AREA CHARACTERISTICS

The Pittsburgh urbanized area comprises six counties in southwestern Pennsylvania: Allegheny, Armstrong, Beaver, Butler, Washington, and Westmoreland. The population of the Pittsburgh Metropolitan Area was estimated at 1.8 million in 1993, ranking 19th among all urbanized areas in the United States. The metropolitan boundaries include 1,112 square miles (National Transit Database, 1993).

Location of the Pittsburgh Metropolitan Area



The Pittsburgh Metropolitan Area' s unique geography shapes its transportation system and traffic patterns. The central city is situated at the point where two rivers – the Allegheny and the Monongahela – flow together to form the Ohio River. Consequently, travel into and out of the City of Pittsburgh depends heavily on an extensive network of bridges and tunnels. Few, if any,

alternate routes exist from the City of Pittsburgh to outlying destinations, particularly in terms of freeway service. The City of Pittsburgh, located in Allegheny County, remains the economic hub of the area.

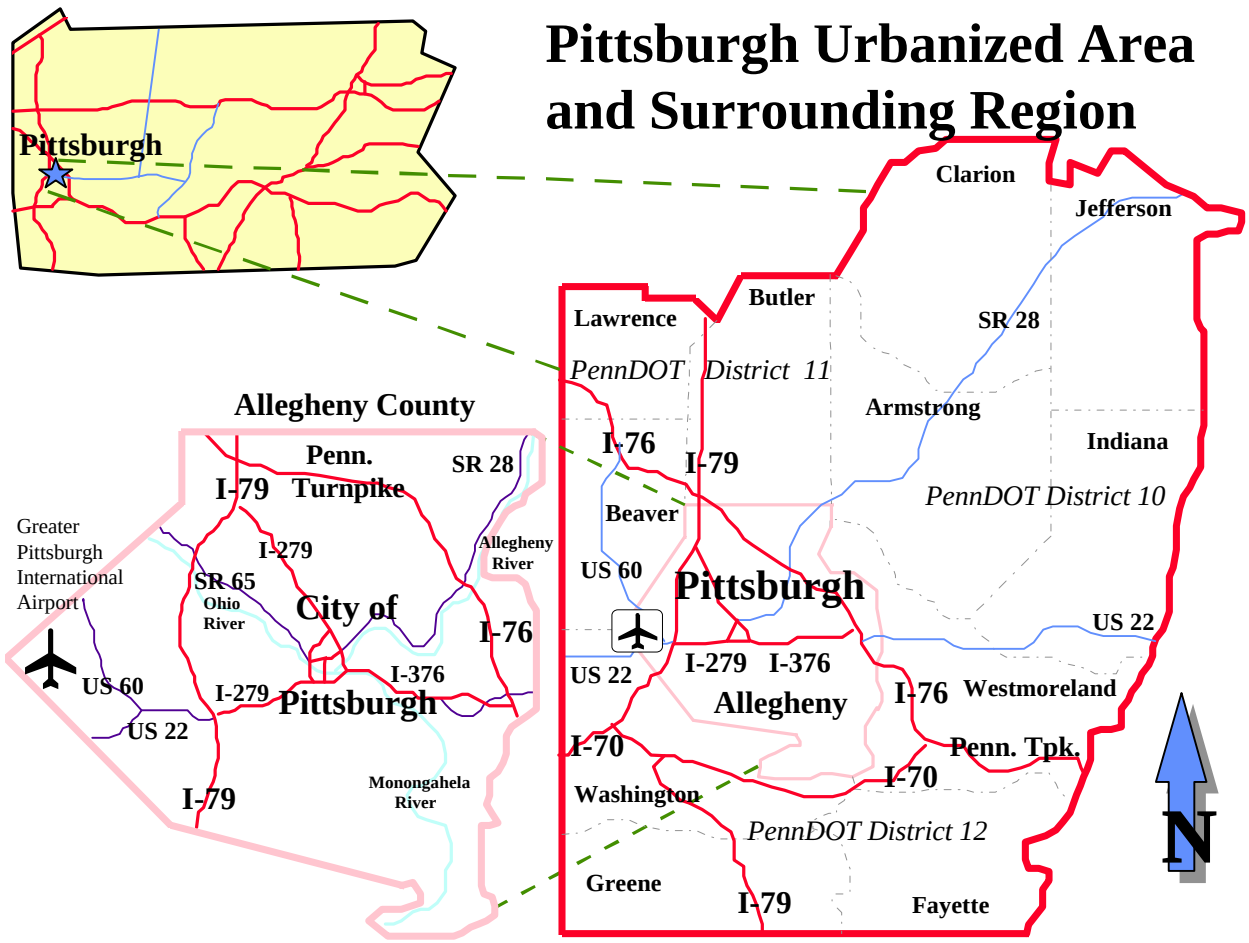
The Port Authority of Allegheny County provides fixed-route and paratransit service to a service area of 930 square miles in the Pittsburgh Metropolitan Area. The Port Authority operates a fleet of 889 motor buses and 476 demand-response vehicles. The Port Authority handled nearly 376 million passenger-miles of travel in 1993, with a total annual ridership of 75 million. Its light rail system, with 71 vehicles, carried 8.8 million passengers over a 48-mile network in 1993 (National Transit Database, 1993).

In addition to the Port Authority of Allegheny County, six smaller transit authorities provide service to outlying areas:

- The Beaver County Transit Authority in Beaver County
- The Butler Transit Authority in Butler County
- The Mid-County Transit Authority in Armstrong County
- The Mid-Mon Valley Transit Authority in Washington County
- The Westmoreland County Transit Authority in Westmoreland County
- The City of Washington, through a private company, GC&C Bus Lines

In 1993, the Pittsburgh urbanized area included a total of 8,086 centerline miles of roadway. Of this total, 166 miles were designated as Interstate highways. Pittsburgh' s total Interstate mileage ranks 15th out of the nation' s 50 largest metropolitan areas. An additional 115 miles were classified as other freeways and expressways, while 510 miles were classified as principal arterial roads. The metropolitan roadway system carried a daily average of more than 34 million vehicle-miles of travel in 1993, with 9.3 million vehicle-miles of travel on the Interstates and freeways alone (Highway Statistics, 1993).

The Pittsburgh Metropolitan Area comprises six counties, which include 415 municipalities. These local governments are responsible for the construction, maintenance, and operation of the local streets within their jurisdiction, including the operation of traffic signal control. The involvement of these local governments in transportation planning and implementation varies according to each municipality' s size, staff, and revenues, but tends to be limited. Indeed, both the Pennsylvania Department of Transportation District Office and the Southwestern Pennsylvania Regional Planning Commission (SPRPC) reported that no municipality in the area outside of the City of Pittsburgh maintains an ongoing transportation planning capability.



PUBLIC AGENCIES INTERVIEWED

During the course of this case study, a wide range of transportation professionals from agencies throughout the Pittsburgh Metropolitan Area was interviewed. Each of these agencies has unique responsibilities for planning, operating, and implementing the transportation system.

The **Pennsylvania Department of Transportation (PennDOT)** is responsible for the operation and maintenance of the Interstate and state highways in the Commonwealth of Pennsylvania. In addition, PennDOT oversees the use of federal highway funds for projects on local roads. PennDOT also retains broad responsibility for the oversight of the air, transit, and marine transportation systems in the state. Statewide, PennDOT manages more than 40,000 miles of roadway, focusing on the Interstate and National Highway Systems (NHS), as well as the principal arterials and major bridges. In the Pittsburgh Metropolitan Area, PennDOT manages the major freeways and owns approximately 20 major bridges and tunnels.

PennDOT is a decentralized organization. The Central Office in Harrisburg, the State Capital, determines the agency' s overall budget and priorities, while most of the day-to-daydecisions rest in the hands of 11 "engineering districts." Each ofPennDOT' s District Offices follow a

common organizational framework which includes three divisions: Design/Services, Construction, and Maintenance. The maintenance division includes the traffic unit. However, unlike most other groups within the districts, the traffic unit' s activities cut across division boundaries and include the design and construction, as well as the maintenance, of traffic-related projects. The traffic unit has primary responsibility for ITS planning and deployment within each District Office.

Within PennDOT' s Central Office, ITS responsibility primarily belongs to the Bureau of Highway Safety and Traffic Engineering. A traffic engineer in that unit, reporting to the Bureau director, has been designated as the lead individual for ITS within PennDOT. The Office of Planning also plays a key role in the shaping of PennDOT' s ITS strategy, particularly with regard to multi-state initiatives such as the I-95 Corridor Coalition. Staff members from other PennDOT divisions, including the Bureau of Public Transportation, are responsible for ITS applications within their specific domains.

The **Southwestern Pennsylvania Regional Planning Commission (SPRPC)** is the designated metropolitan planning organization (MPO) for a six-county region. The SPRPC is responsible for the preparation of the region' s long-range plan, transportation improvement program (TIP), management systems, and other formal planning mechanisms mandated under the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). The SPRPC also manages major investment studies for the region and develops measures to improve air quality as mandated by the Clean Air Act Amendments (CAAA) of 1990. Unlike many other MPOs, the SPRPC focuses primarily on transportation issues, and plays a minor role in economic development. The SPRPC has not assigned responsibility for planning and deployment of ITS projects to any single group or staff person.

Members of the SPRPC include representatives of the six county governments, PennDOT, two transit authorities, the City of Pittsburgh, the Pennsylvania Department of Environmental Resources, and the Governor' s Office. Non-voting members include representatives of the Pennsylvania Department of Community Affairs, the U.S. Department of Housing and Urban Development, the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), and the U.S. Environmental Protection Agency.

The **Port Authority of Allegheny County (Port Authority)** is the exclusive operator of public transit in Allegheny County, which includes the City of Pittsburgh and the urban core of the metropolitan area. As PATransit, the Port Authority operates both fixed-route and paratransit services. The Port Authority reports that more than half of the workers in downtown Pittsburgh commute via transit. This mode split ranks second only to San Francisco among the nation' s largest cities.

The Port Authority is responsible for issuing permits to paratransit operators, except for taxicabs. The Port Authority also operates the light rail system, as well as two historic inclines. No single division within the Port Authority has responsibility for ITS, although the operations group tends to play the largest role in ITS planning and deployment.

The **Beaver County Transit Authority (BCTA)** operates 13 intercity coaches on fixed routes, primarily on the Beaver Valley-to-Pittsburgh corridor. The BCTA functions more like a small intercity carrier than a local transit authority. Its average trip length is about 18 miles, compared to three-to-four miles for most small city transit operators. The BCTA also operates 27 vehicles on paratransit service. For both fixed-route and paratransit services, the BCTA owns the vehicles and handles all scheduling and dispatching, while private contractors operate the vehicles.

Allegheny County plays the most active role in transportation planning and management among the counties in the area, due to both its size and its network of roads and bridges. Allegheny County includes the City of Pittsburgh and the majority of the metropolitan area' s population. It owns about 400 miles of highway, making it the only county in Pennsylvania to own roadways.

The Department of Planning determines the County' s capital budget, represents the County' s interests in the development of the metropolitan TIP and the state' s 12-year plan, promotes the development of alternative modes such as bicycling and magnetic levitation, and plans major projects involving county-owned highways and bridges. The County is not pursuing ITS actively at this time, but it is likely that the Planning Department will be the lead on ITS in the future.

The Department of Aviation owns and operates the Pittsburgh International Airport (PIA), as well as the smaller Allegheny County Airport. The Authority for the Port of Pittsburgh operates the region' s inland port.

The **City of Pittsburgh** is the core city in the metropolitan area. Several agencies within the City have responsibilities related to ITS planning and implementation. The Department of City Planning is responsible for transportation planning, zoning, and land use. This department represents the City' s interests in the development of the regional TIP and long-range plan. The Department of Design, Engineering, and Construction (DEC) is responsible for implementing major capital projects in the city, including street and bridge construction and reconstruction. The traffic division of this department maintains traffic signal control systems (TSCS). The Department of Public Safety (DPS) includes three bureaus: the city police, the fire department, and emergency management services. The emergency management bureau operates the City' s 911 service and a dispatch center for fire, medical, and police units.

The **Pennsylvania Turnpike Commission (PTC)** is the only agency authorized to collect tolls for the use of highways in the Commonwealth. It is an independent agency with a board of directors appointed by the governor, and operates a 506-mile turnpike system across the Commonwealth. The PTC historically has had limited involvement in metropolitan transportation planning issues. Within the PTC, responsibility for ITS falls under two units: communications, and traffic and highway safety.

The **Pennsylvania State Police** are responsible for the enforcement of traffic laws and the management of incident scenes along the Interstate highways in Pennsylvania. In the Pittsburgh Metropolitan Area, three State Police troops are assigned to specific highways: one to Interstates 79 and 279; one to the Penn-Lincoln Parkway; and one to the Turnpike. The State Police also

assist PennDOT with commercial vehicle enforcement activities. The local police of individual jurisdictions are responsible for traffic enforcement and incident management along U.S., state, and local roads.

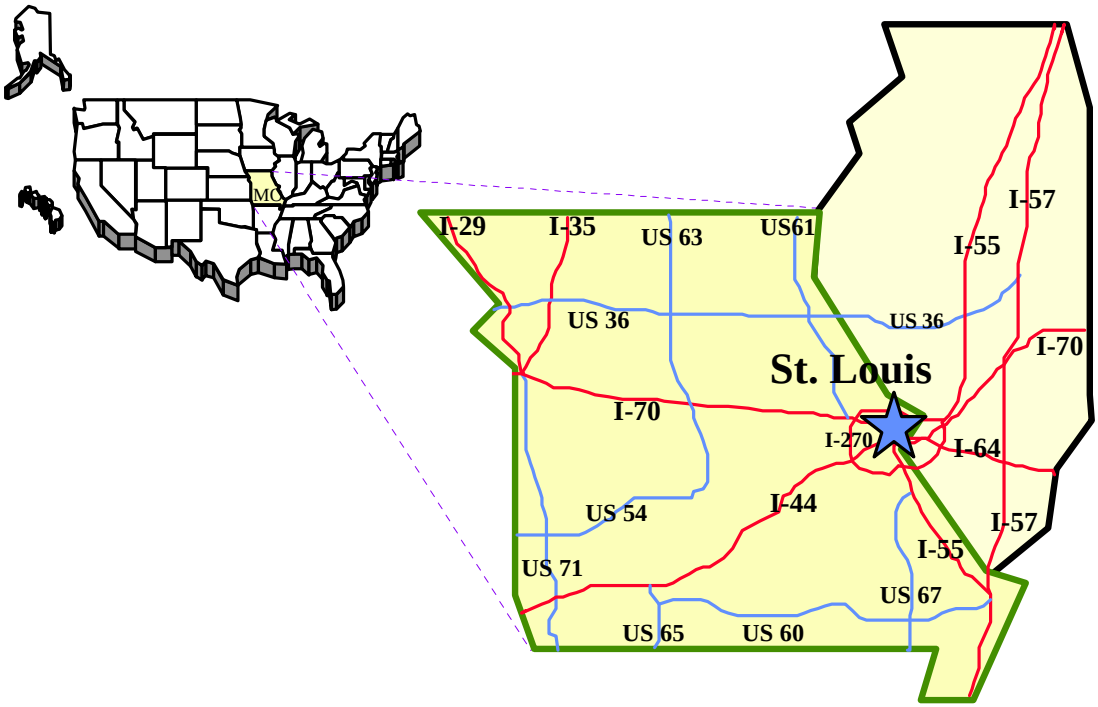
7. THE ST. LOUIS METROPOLITAN AREA

The St. Louis Metropolitan Area is among the top 20 most populated areas in the United States. The characteristics of the St. Louis Metropolitan Area, and the agencies interviewed during the course of the study are described in this section.

AREA CHARACTERISTICS

The St. Louis urbanized area (UZA) straddles the Mississippi River along the Illinois-Missouri border. The UZA comprises the city of St. Louis, as well as portions of seven counties: four in Missouri (St. Louis, Franklin, Jefferson, and St. Charles) and three in Illinois (Madison, Monroe, and St. Clair). The metropolitan area' s population was estimated at 2.0 million in 1993, ranking it 16th among all UZAs in the United States. The metropolitan boundaries encompass 872 square miles (*Highway Statistics*, 1994).

Location of the St. Louis Metropolitan Area



The Bi-State Development Agency provides fixed-route and paratransit service to a service area of 3,580 square miles in the greater St. Louis Metropolitan Area. Bi-State operates 574 motor buses and 46 demand-response vehicles. Bi-State handled nearly 176 million passenger-miles of travel in 1993, with a total annual ridership of 41 million (National Transit Database, 1993). The

agency operates the 18-mile MetroLink light rail system, which carried more than 30,000 passengers per day at the end of 1994 (*Transportation Redefined*, 1995).

In 1994, the St. Louis UZA included a total of 8,271 miles of roadway: 245 miles of Interstate highways, 50 miles of other freeways and expressways, 611 miles of other principal arterials, 751 miles of minor arterials, 865 miles of collectors, and 5,749 miles of local roads. 3.5% of the total roadway mileage in the St. Louis UZA was freeways and 41.9% of daily vehicle miles of travel (VMT) was served by freeways. The metropolitan roadway system carried a daily average VMT of 53.6 million in 1994 (*Highway Statistics*, 1994).

PUBLIC AGENCIES INTERVIEWED

During the course of the St. Louis Case Study, a wide range of transportation professionals from transportation agencies throughout the St. Louis Metropolitan Area and the state were interviewed. Each of these agencies has unique responsibilities for planning, operating, and maintaining the transportation system. This section provides a brief overview of the agencies that were interviewed for this case study, and of the roles and responsibilities of each of these agencies.

The **Missouri Highway and Transportation Department (MHTD)** maintains and operates all of the freeways in the St. Louis Metropolitan Area. The MHTD consists of a Central Office, which is located in Jefferson City, Missouri, as well as 10 offices located throughout the state. Most policy and funding decisions are made in the Central Office, while operations, maintenance, and planning are conducted by the division offices for their respective geographic regions. The MHTD is working with a private telecommunications company on a major project to install fiber optic cable throughout the state. In addition, the MHTD Central Office oversaw the development of an Early Deployment Planning (EDP) study for the St. Louis Metropolitan Area.

The MHTD St. Louis District Office is responsible for oversight of the state-owned and interstate highways in the St. Louis Metropolitan Area. Most of the planning work and construction oversight conducted for the regional highway network is performed by the District Office. The District Office is also responsible for operations and maintenance. Staff from the District Office have been active participants in the development of the EDP Process for St. Louis and in the St. Louis Incident Management Coalition.

The **Illinois Department of Transportation (IDOT)** District 8 office is responsible for operating and maintaining the highways in 10 counties, including three in the St. Louis Metropolitan Area. The IDOT works with the MHTD District Office to coordinate ongoing construction and maintenance activities. IDOT staff participated in the development of the EDP study for St. Louis and in the St. Louis Incident Management Coalition. In addition, the IDOT operates emergency patrol vehicles in the St. Louis Metropolitan Area and has a traffic-actuated signal control system.

The **East-West Gateway Coordinating Council** is the metropolitan planning organization (MPO) for the St. Louis Metropolitan Area. The East-West Gateway Coordinating Council, a voluntary association of local governments, is the only organization of local governments which encompasses the entire Missouri-Illinois St. Louis region. The Council is composed of over 200 villages and cities, and eight counties in the St. Louis Metropolitan Area. The Council' s 21-member Board of Directors consists of the metropolitan area' s chief local elected officials, as well as selected citizens and the Chairman of the Bi-State Development Agency. The two state transportation agencies, the MHTD and the IDOT, are non-voting members of the Board. The Council has been designated by the Governors of Missouri and Illinois and U.S. DOT as the MPO for the St. Louis region to represent the interests of local government and citizens in the planning process. The Council is responsible for the development of the Transportation Improvement Program (TIP) for the St. Louis Metropolitan Area.

The **Bi-State Development Agency (Bi-State)** is the transit operator in the St. Louis Metropolitan Area. In 1963, Bi-State purchased and consolidated the St. Louis Metropolitan Area' s 15 privately owned transit firms through a $26.5 million bond issue. Bi-State now provides transit service in six counties in Missouri and Illinois, operating a fleet of over 700 buses and vans and 31 MetroLink light rail vehicles. MetroLink opened for operation in 1992, and is a state-of-the-art system with highly automated operations. Bi-State included numerous ITS components in the design of MetroLink.

The **City of St. Louis Traffic and Maintenance Department** owns and operates the roadway network in the City of St. Louis (with the exception of state-owned routes) and is responsible for operating and maintaining these roadways. There are a total of 630 signalized intersections in the City of St. Louis. The City currently has three signal system improvement projects in the planning and design phase to upgrade signals along selected high-traffic corridors.

The **City of Collinsville** is a bedroom community bordering the City of St. Louis in Illinois. Collinsville falls under the jurisdiction of the IDOT' s District 8 office. The majority of the streets that run through Collinsville are owned by the State or the County.

The **City of St. Peters**, Missouri is approximately 20 minutes driving time from the City of St. Louis. The City and St. Charles County own the majority of the roads in St. Peters, and the City is responsible for operating and maintaining the majority of the roadways. Representatives from St. Peters view the City as a progressive community that is actively involved with ITS. The City will sponsor a telecommuting center, has been using closed circuit television (CCTV) cameras at one intersection to monitor congestion, and has plans to install a fiber optic network. Many of the City' s residents commute to St.Louis for work.

The **St. Louis Police Department** is responsible for all law enforcement in the St. Louis Metropolitan Area and has a Traffic Division that is responsible for overseeing special events and emergency situations. The St. Louis Police have been active participants in the St. Louis Incident Management Coalition and in statewide commercial vehicle operations (CVO) ITS initiatives.

The **Missouri State Patrol (MSP)** is the lead law enforcement agency in the State of Missouri. The Patrol' s activities are coordinated with local law enforcement officials. The State Patrol works in conjunction with the MHTD to provide construction advisories, and participated in the ITS/CVO Institutional Issues Study.