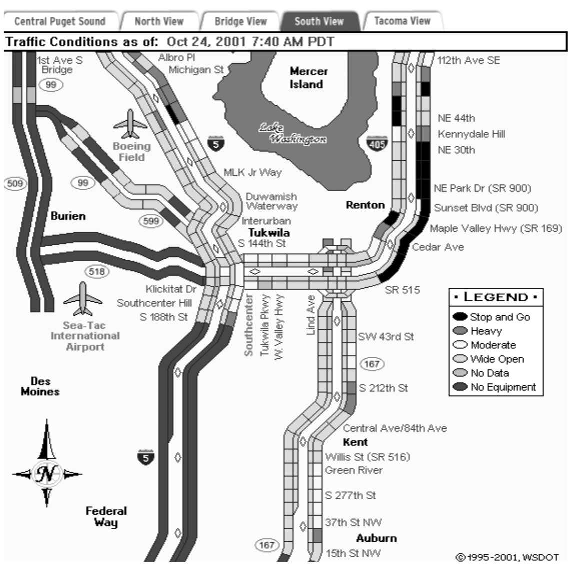
Metropolitan ITS Integration

A Cross-Cutting Study



Working Together to Improve Transportation

August 2002

Foreword

Dear Reader,

We have scanned the country and brought together the collective wisdom and expertise of transportation experts implementing Intelligent Transportation Systems (ITS) projects across the United States. This information will prove helpful as you set out to plan, design, and deploy ITS in your communities.

This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. The series contains a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- **Benefits Brochures** let experienced community leaders explain in their own words how specific ITS technologies have benefited their areas;

- **Cross-cutting Studies** examine various ITS approaches that can be taken to meet your community's goals;

- **Case Studies** provide in-depth coverage of specific approaches taken in real-life communities across the United States; and

- **Implementation Guides** serve as "how to" manuals to assist your project staff in the technical details of implementing ITS.

ITS has matured to the point that you are not alone as you move toward deployment. We have gained experience and are committed to providing our state and local partners with the knowledge they need to lead their communities into the next century.

The inside back cover contains details on the documents in this series, as well as sources to obtain additional information. We hope you find these documents useful tools for making important transportation infrastructure decisions.

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Contents

Background

From 1970 to 1996, the number of vehicles in the United States increased by 90%, and the number of vehicle miles traveled by 123%, yet the number of road miles increased by only 7% over that same period.[1] With demand on America's transportation network outpacing the capacity of the infrastructure, it is no wonder that congestion mitigation is one of the most hotly debated topics in metropolitan regions around the country.

The geographical expansion of metropolitan regions means that solutions to congestion must involve multiple jurisdictions. Travelers in metropolitan regions may utilize a wide range of travel modes, unaware that they are crossing jurisdictional boundaries served by different agencies.

Intelligent transportation systems (ITS) have been developed to help address the problem of demand outpacing capacity, but simply developing disparate ITS components does not go far enough. In an effort to provide the public with efficient, seamless transportation, agencies serving metropolitan regions have begun sharing information, infrastructure, and even control of ITS components across boundaries. Benefits of the resulting integrated systems include improved management of traffic operations systems, increased safety, and reduced travel delays.

The purpose of this report is to inform transportation managers and decision-makers of the value of ITS integration. The report is intended for operations and planning departments of transportation-related agencies, including:

- State and local transportation and public works departments
- Metropolitan planning organizations (MPOs)
- Transit properties
- Emergency response agencies

The U.S. Department of Transportation (U.S. DOT) engaged in an effort to track ITS deployment and integration in 78 of the Nation's metropolitan areas. This report examines four of those areas in detail: Atlanta; Minneapolis-St. Paul; Seattle; and Washington, DC. These four areas were selected because they have a high level of ITS integration, based on a review of the metropolitan ITS deployment tracking database, which is sponsored by the U.S. DOT and maintained by Oak Ridge National Laboratory. This study also examines 21 additional metropolitan areas that are making progress toward their ITS integration goals.

[1] "Why the USA's roads are crowded," *USA Today, Snapshot*, August 21, 1999.

Representatives from various agencies in each of the selected regions were interviewed about their respective region's ITS integration efforts. During each interview, the agency representative was asked to describe that agency's integrated system, explain the motives or goals driving the integration effort, point out challenges and successful practices encountered during the integration process, and identify benefits gained from integration.

This study also briefly examines examples of each of several types of integration "links" deployed throughout the U.S. The ITS integration experiences of these selected metropolitan areas have applicability nationwide.

What is ITS Integration?

ITS integration is the bridging of technical or institutional systems across system or jurisdictional boundaries. Integration may take a simple form, such as an agreement to share information between two or more agencies in a state, or a more complex form, such as the deployment of linked, interoperable systems for traffic control across a region.

Integration Links

The U.S. DOT has defined integration “links” connecting the various components of ITS metropolitan infrastructure. The U.S. DOT has defined nine ITS metropolitan infrastructure components:

- Freeway management
- Incident management
- Arterial management
- Transit management
- Electronic fare payment
- Electronic toll collection
- Emergency management
- Highway-rail intersections
- Regional multimodal traveler information.

These components are linked as shown in Figure 1, and represent a mix of physical and organizational elements. For example, the link between arterial management and freeway management systems can be the use of arterial traffic conditions to modify ramp meter timings. Note that not all ITS metropolitan infrastructure components are shown as linked in Figure 1 because only the 22 most common integration links are included in the metropolitan ITS deployment tracking database.

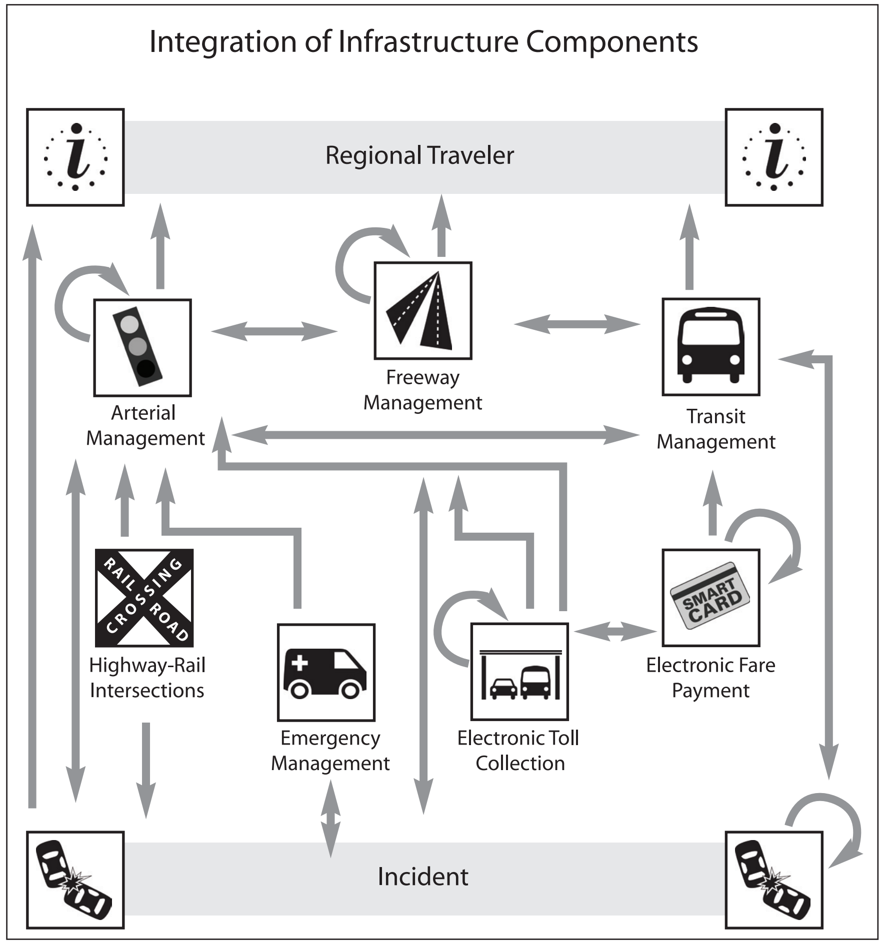

Figure 1 – ITS Integration Links[2]

Levels of Integration

The U.S. DOT has described three possible levels of integration for each link:

- Shared infrastructure—represents the integration of two or more agencies sharing physical infrastructure such as a communications backbone.
- Shared information—represents integration that enables agencies or systems to share transportation-related data, such as traffic management personnel sharing incident-related information with emergency responders.
- Coordinated control—represents the capability of different agencies to control the same system component or field device. Coordinated control is the most comprehensive form of integration.

[2] Oak Ridge National Laboratory, *Measuring ITS Deployment and Integration, Version 2*, U.S. Department of Transportation, January 1999, p. 6.

Why Integrate?

Perhaps the most compelling rationale for ITS integration is that systems can be more effective when they operate in concert than when they work separately. Integration results in the potential for a synergistic boost to overall performance and effectiveness. For example, the process of coordinating traffic signals across jurisdictional boundaries can be automated by integrating the systems. Automation may save time for users and save money for the public agencies. It may also enable better traffic management during incidents, reducing secondary crashes and the costs associated with delays.

Integration can improve convenience and user satisfaction. Integrating multiple traveler information systems offers the potential to improve the quality of the service and make obtaining the information more convenient. This practice can help to distribute traffic more evenly, thus reducing delays during incident conditions. In a similar manner, a more convenient system for paying fares can entice more people to use transit.

Integration can improve interoperability among systems and add flexibility when choosing which systems to purchase. As interoperability increases, public agencies are less likely to be dependent on a single vendor for equipment such as traffic signal controllers. Increased competition is likely to result in better quality, lower equipment prices, and savings to the agency and the public.

Overall, ITS integration offers benefits to both the traveling public and participating agencies. In the same way that most travelers do not recognize jurisdictional boundaries, an integrated transportation system takes a network-wide view of travel conditions in which different jurisdictions share infrastructure, information, and control. Such an integrated system can make full use of the interoperability between components to help agencies achieve greater safety and efficiency goals, and to achieve economies of scale.

Benefits of Integration

Metropolitan ITS integration has produced many benefits, including improved customer satisfaction, safety, mobility, efficiency, productivity, reduced vehicle emissions, and fuel consumption. The benefits highlighted in this section offer a snapshot of integration outcomes reported by transportation agencies from across the country.

San Antonio, Texas—San Antonio Medical Center Corridor

As part of the Metropolitan Model Deployment Initiative (MMDI) in San Antonio, Texas, traffic management along the Medical Center Corridor was integrated among the freeway and parallel arterial streets. Simulation models revealed that delay would decrease 2.5% during minor incidents, 8% during moderate incidents, and 20% during major incidents.[3]

Phoenix, Arizona—Cross-Jurisdictional Traffic Signal Coordination

As part of the Metropolitan Model Deployment Initiative in Phoenix, Arizona, traffic signal timings were coordinated along a major north-south arterial street that traversed several different jurisdictions. A combination of direct measurement and simulation was used to show that vehicle speeds increased 6%, vehicle stops decreased 4.2%, crash risk decreased 6.7%, and fuel consumption decreased 1.6%.[4]

Houston, Texas—Houston TranStar

Integration among freeway management, arterial management, emergency management, and incident management systems is estimated to provide travel time savings of as much as 30 minutes for major freeway incidents. Total savings in travel time delay are estimated at 572,095 vehicle-hours annually.[5]

Route 7 Corridor, Virginia—Emergency Vehicle Signal Preemption Study

A simulation study of potential integration between emergency management and arterial management systems in Northern Virginia found faster travel times for emergency vehicles could be possible with only a minimal increase (less than 3%) in travel time for non-emergency vehicles when priority is requested by an emergency vehicle.[6]

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[3] *San Antonio's Medical Center Corridor: Lessons Learned from the Metropolitan Model Deployment Initiative,* U.S. Department of Transportation, December 2000.

[4] *Phoenix Metropolitan Model Deployment Initiative: Final Evaluation Report,* U.S. Department of Transportation, April 2000.

[5] Parsons Transportation Group, *Estimation of Benefits of Houston TranStar*, Texas Transportation Institute, February 1997.

[6] Bullock, Darcy, et al., *Evaluation of Emergency Vehicle Signal Preemption on the Route 7 Virginia Corridor*, Federal Highway Administration, July 1999.

ITS Integration Experiences

Many metropolitan areas in the U.S. have embarked on ITS integration efforts in response to their individual needs. This section describes the efforts of 24 metropolitan areas. For the initial group, which consists of four metropolitan areas that have achieved extensive ITS integration, a detailed ITS integration summary of each metropolitan area is provided. Metropolitan areas in the second group have also made progress toward ITS integration goals, and examples of integrated deployment in these areas are provided as well.

Atlanta, GA

Atlanta is the eleventh largest metropolitan area in the U.S. Its roadway network consists of 342 freeway centerline miles and 1,813 arterial centerline miles. Portions of this network are monitored using 66 closed-circuit television (CCTV) cameras and 317 video image detection cameras that automatically measure traffic speed. The Metropolitan Atlanta Regional Transportation Authority (MARTA) provides public transportation for the region. MARTA's fleet of more than 700 buses covers 150 routes and 1,500 route miles, and operates almost 30 million miles of bus service annually. Its metrorail system consists of 36 stations and over 40 miles of track.

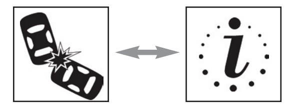
Atlanta's integrated intelligent transportation system, NaviGAtor, connects city, county, state, and transit agencies by sharing infrastructure, information, and control. The Atlanta metropolitan area addresses transportation management in a seamless and multimodal manner, connecting freeway, arterial, and transit systems. ITS integration supports the Highway Emergency Response Operator (HERO) program, which has a first-responder role for incidents, performs patrol duties, and provides assistance to disabled vehicles. The HERO program has proven exceptionally successful in keeping freeway traffic flowing safely during incidents.

ITS Activities

Much of Atlanta's ITS infrastructure development was initiated in preparation for the 1996 Olympic Games. In addition, Atlanta was also the site of several federally funded ITS field operational tests, as well as the Atlanta Traveler Information Showcase project.

Coordination of ITS projects, among the Georgia Department of Transportation (GDOT), MARTA, and other local agencies, occurs in a number of forums. The Atlanta Regional Commission (ARC) is the metropolitan planning organization for the Atlanta area and participates on an Advanced Transportation Management Systems subcommittee. ARC typically manages the planning process, but the Georgia chapter of ITS America also has been instrumental in bringing local transportation planners together and providing a forum for discussion. In 1999, Georgia created a new agency, the Georgia Regional Transportation Agency, to handle transportation planning and project coordination on a statewide basis.

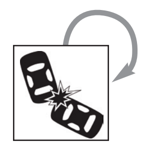
Atlanta, GA



Incident Management to Regional Multimodal Traveler Information

Information on incident location, severity, and type is displayed by regional multimodal traveler information media.

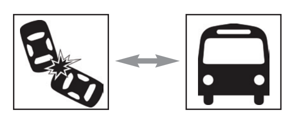
Shared Information



Multi-Agency Incident Management

Agencies coordinate incident detection, verification, and response by using common infrastructure and software.

Shared Infrastructure



Incident Management to Transit Management

A transit management system adjusts transit routes and schedules in response to data collected on incident severity, location, and type as part of an incident management system. In addition, a transit management system can control closed-circuit television cameras used for incident detection and verification.

Coordinated Control

ITS Integration Experience

The purpose of Atlanta's ITS integration efforts was to create a more efficient and user-friendly transportation system that would encourage the use of mass transit, especially during the 1996 Olympic Games. Atlanta's solution was to establish and integrate a network of sub-regional Transportation Control Centers (TCCs).

Transportation in the five-county Atlanta area is coordinated through a network of seven TCCs: one in each county, as well as the City of Atlanta and at MARTA, as illustrated in Figure 2. GDOT's Transportation Management Center (TMC) acts as the hub, with the remaining TCCs managing transportation in their respective jurisdictions.

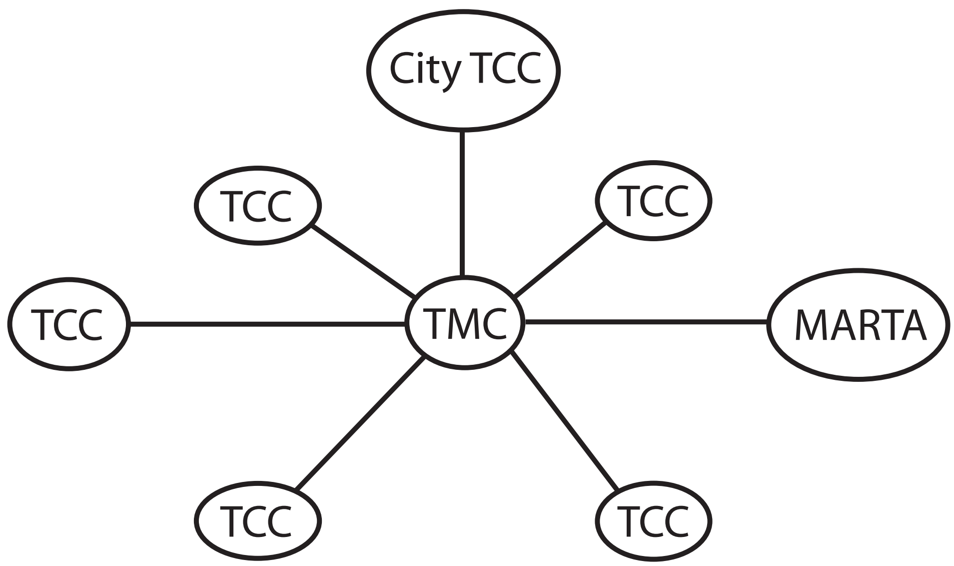


Figure 2 – Atlanta Traffic Management Center/ Traffic Control Center Network

GDOT operates and maintains most of the fiber-optic communication lines that connect the TCCs. All of the TCCs are equipped with the same hardware and traffic management software in order to ensure compatibility. Operators at each TCC use the traffic management software to enter incident advisories and alert the public and the other TCCs. In addition, the traffic management center operates and maintains a traveler information system tied directly to the traffic management software system. Incident advisories from anywhere in the TCC network are forwarded to the traveler information system and disseminated via various information devices and technologies.

MARTA invested in and maintains its own fiber-optic communication link to the region's TCC network. MARTA is integrated with GDOT via a workstation loaded with a copy of the traffic management software that allows the agency to report incidents and share control of video cameras on the highways. This integration benefits both GDOT and MARTA. MARTA bus drivers send incident reports via radio to their control center, where the information is entered into the TCC network. MARTA also receives incident advisories to help transit vehicles adhere to their schedules. If a MARTA bus is involved in an incident, MARTA can pan, tilt, or zoom GDOT's highway cameras to observe what is happening. However, GDOT has first priority for use of cameras that it "owns," and can override MARTA's control.

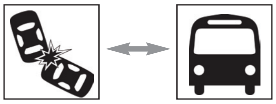
Atlanta's incident management program includes 31 HERO units. Each HERO truck roams the highways in the metropolitan area, staffed by an operator trained in first-response techniques. These units radio incident reports back to the traffic management center and respond to virtually any type of incident—from helping manage special event traffic to providing first aid to victims of crashes. In addition to their patrol and emergency response functions, HERO vehicles are equipped with such items as spare gasoline, oil, and other essential automotive fluids to help stranded motorists get on their way, as well as spare medical supplies for helping paramedics respond to crashes involving injuries. When additional emergency response units arrive, the HERO units hand over control but stay on the scene to direct traffic and help administer first aid.

Once a HERO unit reports an incident to the traffic management center, the information is entered into GDOT's freeway management system, which is connected directly to the region's traveler information system. This system uses the Internet, state-owned kiosks, cable television, and other media. Georgia's NaviGAtor website provides a traffic congestion map, incident advisories, and video snapshots of the roadways.

Lessons Learned

- ITS efforts in Atlanta are managed by a relatively small group of personnel from various agencies that meets often. Bureaucracy is kept to a minimum, and communication is frequent. Integration promotes interagency teamwork and leads to a more efficient use of resources, as demonstrated by the cooperation among emergency response agencies, GDOT, and MARTA.
- GDOT implemented its own communications network among control centers, and provided the option for other agencies to connect to it in the future. MARTA and the City of Atlanta have joined the network. Others are welcome to join, provided that they can install, operate, and maintain their own link.
- The HEROs and NaviGAtor are both highly visible public programs that help make the Atlanta transportation system operate more smoothly and become more user-friendly.

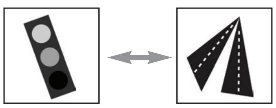
Minneapolis-St. Paul, MN



Incident Management to Transit Management

A transit management system adjusts transit routes and schedules in response to data on incident severity, location, and type collected as part of an incident management system.

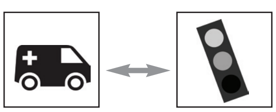
Shared Information



Arterial Management to Freeway Management

An adaptive traffic signal control system coordinates arterial traffic signals and freeway ramp meters to better manage traffic flow.

Shared Infrastructure



Emergency Management to Arterial Management

Video cameras used for arterial management can be controlled by law enforcement to capture more information during incidents.

Coordinated Control

Minneapolis-St. Paul, MN

The Minneapolis-St. Paul area is the fifteenth largest in the U.S. The transportation infrastructure in Minneapolis-St. Paul includes a bus transit system, 880 transit vehicles, 346 freeway centerline miles, and more than 2,060 arterial centerline miles.

ITS Activities

The Minneapolis-St. Paul metropolitan area is engaged in several ITS research, development, and deployment activities. The primary vehicles for ITS deployment and integration in the area are the Minnesota Department of Transportation (Mn/DOT) traffic management center program and the ORION program. In addition, the statewide Guidestar program has performed needs assessments, research and development, and full-scale operational testing of ITS strategies and technologies. ITS integration supports multi-agency freeway and incident management, and streamlined traffic control in freeway and parallel arterial corridors.

ITS functions include freeway and parking management, traveler information, traffic management using adaptive traffic signal control, transit fleet management information, and computer-aided dispatch for emergency response. These systems are coordinated and managed from Mn/DOT's traffic management center.

ITS Integration Experience

Mn/DOT began its traffic management efforts in the early 1970s, when the agency recognized the need to work with other transportation agencies, law enforcement, and transit. By educating jurisdictions and agencies about the benefits of ITS and by involving them cooperatively in the development of new approaches, Mn/DOT has taken the lead in the region.

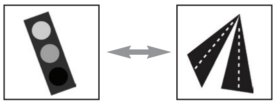
One example of this cooperation is the sharing of camera use with the Minnesota State Patrol (MSP). The traffic management center controls 223 closed-circuit television cameras. When trying to recruit MSP's participation, Mn/DOT demonstrated the value of the video information from these cameras to the MSP, enabling the agencies to reach an agreement regarding shared use and control. The MSP, which is located in a separate facility from Mn/DOT, can request that Mn/DOT reorient individual cameras to support operations during the morning and evening commute periods. Outside of these commute periods, MSP has primary control of the cameras, and operates them around the clock. Shared use enables both MSP and Mn/DOT to respond to incidents more quickly. As of 2002, a new traffic management center is under construction that will co-locate freeway management, MSP, Mn/DOT maintenance dispatch, and arterial traffic signal operations.

The Integrated Corridor Traffic Management (ICTM) project is another example of successful ITS integration. The project uses an adaptive traffic signal control system to coordinate arterial traffic signals and freeway ramp meters to better manage traffic flow on an eight-mile corridor leading to the Minneapolis-St. Paul airport. The ICTM project covers the I-494 freeway, four parallel arterial streets, and seven perpendicular arterial streets along the freeway corridor. Through cooperation among Mn/DOT, Hennepin County, and the cities of Edina, Richfield, and Bloomington, the ICTM project has succeeded in establishing common operations and maintenance practices across agencies, which can share resources and expertise.

Lessons Learned

- By demonstrating the benefits of ITS and making offers of resource sharing, an environment was created in which agencies work together with a common goal. In addition to its partnership with the Minnesota State Patrol, Mn/DOT installed closed-circuit television cameras along streets operated by local jurisdictions and has offered to provide these jurisdictions with operations and maintenance support.
- Life cycles for ITS projects are shorter than those of traditional transportation projects. Agencies must consider these shorter life cycles while planning their systems. Shorter life cycles can compound the complexities arising from technology and ITS integration. Integration can add complexity to an ITS program by raising concerns about funding, operations, and maintenance.
- Project support needs to come from all levels within an organization, a principle demonstrated in the ICTM project. Involvement of public relations, operations and maintenance staff, as well as senior staff with decision-making powers, enabled the project to resolve a wide variety of issues. Involvement of senior staff ensured that decisions could be made in a timely manner. Involvement of operations and maintenance staff ensured that their expertise would be shared among agencies. All levels of personnel within the agencies were informed about the latest discussions and activities. In particular, the efforts of a few motivated individuals have carried the project through to completion. Agreements among the agencies regarding provision of support and cooperation were formed on the basis of trust. Furthermore, a bond of obligation and responsibility was achieved because project leaders met with potential participants, understood their objectives and concerns, and designed an operations and maintenance strategy that would benefit all the project partners.
- A slow but steady transition from information sharing and cooperation, through co-location, to coordinated control, can occur when agencies have a common vision of regional traffic management and are patient and open to new ideas. Among these ideas might be the development and implementation of a single regional traffic management plan. While such an approach may be viewed by some as an unwelcome surrender of local control, the benefits of regional integration can far outweigh the drawbacks.

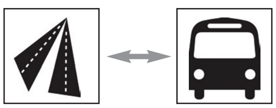
Seattle, WA



Arterial Management to Freeway Management

A freeway management center monitors travel times, speeds, and conditions on arterial streets, which are used to adjust ramp meter timings, lane control signals, or highway advisory radio advisories on freeways.

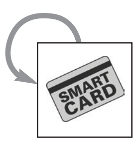
Shared Information



Freeway Management to Transit Management

Freeway conditions are transmitted to a transit management system, which uses the information to better manage routes and dispatch additional buses.

Shared Information



Multi-Agency Electronic Fare Payment

Electronic fare payment systems are linked across multiple transit providers to simplify user experience, improve service, and reduce costs.

Shared Information
Shared Infrastructure

Seattle, WA

Seattle is the thirteenth largest metropolitan area in the U.S. Its roadway network consists of 381 freeway centerline miles and 2,100 arterial centerline miles. Portions of the network are monitored by loop detectors and 181 closed-circuit television cameras. King County Metro Transit's fleet of 1,300 buses provides public transportation in the Seattle area, while Pierce Transit and Community Transit provide commuter service to neighboring Pierce and Snohomish counties.

Seattle's ITS integration efforts are focused on making transportation more efficient by sharing traffic information between agencies, providing real-time multimodal traveler information to the public, simplifying fare payment systems for transit to use a single smart card, and providing prioritized movement to emergency vehicles. Integration of the region's intelligent transportation systems has been accomplished through several projects. The Seattle Smart Trek project helped implement a central clearinghouse of regional transportation information known as the "ITS Backbone." The ITS Backbone provides data processing and exchange among public agencies and private sector organizations in the area.

ITS Activities

ITS infrastructure in Seattle is the result of years of investment, several field operational tests (FOTs), and participation in the Metropolitan Model Deployment Initiative. King County Metro Transit invested in one of the nation's first automatic vehicle location (AVL) systems in 1990 to help manage its fleet. At the same time, the Washington State Department of Transportation (WSDOT) began investment in its own fiber-optic communications network. The North Seattle Advanced Traffic Management Systems (ATMS) field operational test was the first step in linking jurisdictions in order to share traffic information, while the Seattle Wide-Area Information For Travelers (SWIFT) field operational test demonstrated the use of advanced traveler information technologies and public-private partnerships. Smart Trek—Seattle's name for its portion of the Metropolitan Model Deployment Initiative—brought these efforts together and further expanded the region's ITS infrastructure.

WSDOT takes the lead role in multimodal ITS integration projects in the region, while Metro Transit is generally the leader for the region's transit projects. WSDOT and Metro Transit are the two largest transportation agencies in the region and have the staff and other resources needed to plan and manage large projects.

ITS Integration Experience

Integration in Seattle began in 1989 when WSDOT first proposed the concept of "borderless travel." WSDOT's objective was to coordinate traffic signals and ramp meters so that jurisdictional boundaries would be invisible to travelers by properly coordinating traffic signals and ramp meters. In addition, regional planners wanted to improve the transportation system's performance by encouraging people to carpool and use public transit. These converging forces led to adoption of two goals: development of a regional traffic management system and provision of comprehensive transportation information throughout the region.

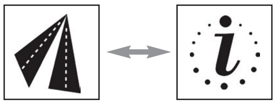
The Seattle area makes extensive use of the Internet for sharing information between public agencies and the traveling public. This strategy has proven successful because the Internet is widely available, and Web-based systems are relatively easy and inexpensive for an agency to maintain as compared to dedicated communication lines. Providing information via a website also minimizes the number of special software applications required for data exchange. For example, Metro Transit monitors conditions on the region's freeway system by accessing WSDOT's traveler information website. The site offers a color-coded freeway map indicating traffic congestion levels, and provides access to video snapshots from cameras located throughout the region. Metro Transit can use this information to reroute buses or dispatch additional service. Similarly, Metro Transit provides static transit schedules and real-time bus locations over the Internet, thus enabling the other transit agencies in the region to coordinate their services.

Another regional integration effort is the SmartCard project, a partnership among seven public transportation agencies. This project will implement a regional electronic fare system that employs a single card, in place of the various pre-paid fare media currently used by transit passengers. When the system is deployed, transit users will be able to pre-pay for transit services that include bus, vanpool, commuter and light rail, and passenger and auto ferries. The system is expected to simplify and enhance the transit rider experience by allowing for seamless multimodal travel. It is also expected to improve agency operations by allowing for better information regarding ridership and by reducing the costs associated with administering multiple systems.

Lessons Learned

- Project management has a large impact on a project's success. One successful management tool used by the Seattle integrators was to build multi-agency ITS project teams composed of agency representatives with decision-making authority. This system helped make meetings more effective and ensured that the participating agency was committed to the project. Another successful practice was to use frequent telephone and e-mail communication to keep the team focused on the project while minimizing travel time.

Washington, DC



Freeway Management to Regional Multimodal Traveler Information

Information about freeway travel conditions is collected from a variety of sources and displayed by real-time multimodal traveler information media.

Shared Information

- During the North Seattle ATMS project, WSDOT learned that ITS integration should be performed in incremental steps. Jurisdictions are often apprehensive about coordinating control. They are, however, eager to share information. The solution employed by WSDOT was to start by sharing data but maintaining segregated control. Once trust in the system was established, integration progressed toward coordinated control. This approach helped avoid alienating potential partners and also reduced the complexity and cost of the project.
- A key tenet of Seattle's ITS activities is to view travelers as clients. Outreach and continuous efforts to improve service proved to be of fundamental importance. The better the clients perceived the service to be, the more inclined they were to use it.
- Integrated operations and coordination do not necessarily require dedicated communication lines and customized software. For example, instead of investing in the development of complicated software to provide regional traveler information, WSDOT and Metro use the Internet because it is an inexpensive and widely available medium for communicating and sharing information. A relatively simple website allows agencies to share information.
- Many current and potential transit riders are intimidated by the complexity associated with using multiple fare systems, and some are fearful of carrying cash. An integrated fare system using a single pre-paid card is expected to alleviate many of these concerns and give riders a simpler way to budget for transportation needs.

Washington, DC

The Washington, DC metropolitan area is the fourth largest in the country. The area encompasses a unique set of jurisdictions, including Federal, regional, state, and local agencies, and the District of Columbia. The transportation infrastructure in the Washington area includes a rail transit system, more than 1,400 transit vehicles, 330 freeway centerline miles, and more than 1,600 arterial centerline miles. Motorists in the Washington area already experience the nation's second longest commute time, and traffic volume in the region is expected to grow by 70% by 2025.

ITS Activities

The Washington, DC metropolitan area is the only one of the four regions examined in depth in this report that extends to more than one state. ITS integration efforts in the Washington region took a big step forward in 1996 with the creation of the Partners In Motion initiative. This six-year endeavor is a partnership of 37 public and private sector organizations. The goal of Partners In Motion is to create a traveler information system that provides on-demand, real-time, and route-specific information for all modes of transportation in the region.

A central clearinghouse for traffic and transit information uses information gathered from more than 20 public agencies. The clearinghouse collects information from a wide variety of sources—public agency traffic cameras, privately installed cameras, aerial surveillance, and volunteer cellular phone callers—and creates a database of real-time travel conditions. This information is disseminated to travelers using variable message signs (VMSs), radio, kiosks, the Internet, and static displays.

ITS Integration Experience

The task of creating an integrated traveler information system was especially challenging because the numerous agencies involved had little previous history of working together on such an effort. Several agencies in the region already had some form of traveler information dissemination, and Partners In Motion sought to integrate and enhance these systems. The first step was to establish a working relationship among agencies. Stakeholder agencies had conflicting positions based on their interests and backgrounds: highways versus transit, operations versus planning, state versus local, ITS versus infrastructure improvements, and public sector versus private sector. Partners In Motion reconciled these diverse interests by focusing on the functionality of the system.

Partners In Motion provided a major impetus to ITS deployment efforts in Washington, DC by bringing agencies and jurisdictions together. The activities of Partners In Motion and selected meetings of operations personnel from key transportation agencies helped convince regional leaders of the need to undertake ITS coordination under the auspices of the National Capital Region Transportation Planning Board (TPB), the region's metropolitan planning organization. The TPB created regional task forces on ITS policy and technical issues. These task forces play important roles in identifying and coordinating the implementation of transportation technology to address regional transportation problems. They also advise the metropolitan planning organization's board on ITS issues. After overseeing an ITS Early Deployment Study, the ITS Technical Task Force created subgroups for specific issues and projects. Overall, the TPB and its member agencies have found that subgroups benefit regional initiatives by facilitating ITS information sharing, coordination, and deployment.

Lessons Learned

- Having one agency take the lead in signing contracts helps to expedite the project, as does allowing relationships with the lead agency to start out on an informal basis with numerous project partners. Partners In Motion had one lead agency—the Virginia Department of Transportation—sign an agreement, on behalf of the entire region, that specified how costs and revenues would be shared. The agreement was based on letters of support from the other participating public agencies, rather than on formal memoranda of understanding. The willingness of these agencies to consider new types of partnerships and contractual agreements, such as public-private partnerships, helped bring the project to fruition.

- The Partners In Motion project demonstrated that involvement and championing by the public sector is important and that the needs and interests of stakeholders must be addressed continually.

Austin, TX

The Austin Capital Metropolitan Transportation Authority posts transit routes and digital maps to a traveler information website. This service provides up-to-date transit schedules, replacing schedule books that used to be issued on a quarterly basis. The project has been in operation since 1996.

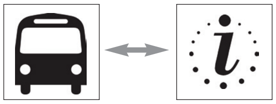
The service lists the schedules for approximately 400 transit buses and paratransit vehicles. State and Federal funds covered implementation costs of $90,000 and a one-time website design cost of $40,000. Future plans include implementing an automated trip-planning system whereby citizens would input their desired beginning and ending locations, and the system would provide a transit route showing them how to reach their chosen destination.

Hartford, CT

The Connecticut Department of Transportation (ConnDOT) operates a Transportation Management System (TMS) whose other primary partners are the Department of State Police, as well as major cities such as Bridgeport, Hartford, Norwalk, and Stamford, and their police departments. The program was implemented to reduce congestion and improve incident response. Cameras and traffic detectors have been installed on 80 miles of freeway. These sensors enable ConnDOT staff to detect and respond to incidents. Data are received at the traffic management center automatically from loop detectors, closed-circuit television cameras, 911 calls, and freeway service patrol vehicles. All information is processed by the TMS and then distributed to the Statewide Communications Center at the State Police post in Bridgeport. Both ConnDOT and the State Police receive data feeds from the incident management system and can share video feeds with cities. Traffic signal timings and messages displayed on variable message signs installed along arterial streets are also modified in response to freeway incidents.

One of the key benefits of this program is that freeway and incident management information is available to multiple agencies and municipalities in the state. In addition, Web-accessible video and traffic data are available to other locations and to the general public. This program also enables faster incident detection and response. The program has been in operation since 1993 and was initially implemented with two cameras and a number of traffic detection

Austin, TX

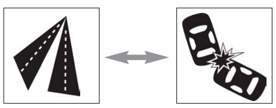


Transit Management to Regional Multimodal Traveler Information

Transit routes, schedules, and fare information are displayed on regional multimodal traveler information media.

Shared Information

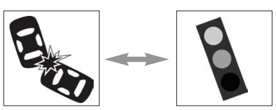
Hartford, CT



Freeway Management to Incident Management

An incident management system monitors freeway conditions to detect and respond to incidents.

Shared Information



Incident Management to Arterial Management

Traffic signal timings are adjusted and traveler information is provided based on information about incidents.

Shared Information

sensors. Future plans include installation of additional cameras, traffic detectors, highway advisory radio (HAR), and a computer-aided dispatch system.

To date, program construction has cost approximately $30 million and ConnDOT estimates that an additional $60 million in construction projects are underway. Congestion Management and Air Quality (CMAQ) and National Highway System (NHS) funding was used for the program. All partners are very pleased with the program and there is enthusiastic support from local municipalities. Plans through 2005 include adding 170 freeway miles to the system.

Orlando, FL

The Florida Department of Transportation manages the Freeway Incident Management Center (FIMC) in the Orlando area. Through a series of loop detectors installed on almost 35 centerline miles of freeway, the I-4 Surveillance Motorist Information System collects incident, congestion, and volume data and transmits the data to the FIMC. The FIMC processes the data, and forwards this information to an arterial management system. This system modifies traffic signal timing and variable message signs to adjust traffic flow along arterial segments that run parallel to affected freeway sections

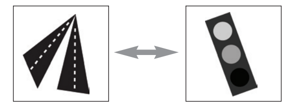
Boston, MA

The Massachusetts Bay Transportation Authority (MBTA) collects data from its electronic fare system to confirm the validity of complaints received regarding overcrowding on transit buses. The information is also used by the metropolitan planning organization in its congestion management process. For all future new transit bus acquisitions, the MBTA plans to include specifications that will link the bus overhead destination sign to the electronic fare box. Other plans include automatic vehicle location and global positioning system (GPS) installations on transit buses to improve routing and scheduling.

Baltimore, MD

Maryland's Coordinated Highways Action Response Team (CHART) program provides traveler information in a wide variety of ways. This program provides information directly to a multi-jurisdictional traveler information program, Partners in Motion, which then disseminates this information via the Internet, cable television, e-mail, traveler advisory telephone, and broadcast media. In addition, CHART distributes information directly through its own website, variable message signs, traveler advisory telephone, and highway advisory radio. Information on the website includes roadway speeds, incident locations, live video of travel conditions, and road weather conditions.

Orlando, FL

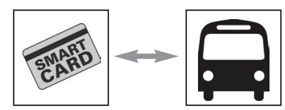


Freeway Management to Arterial Management

Freeway travel time, speed, and condition data are used to adjust arterial traffic signal timing or messages.

Shared Information

Boston, MA

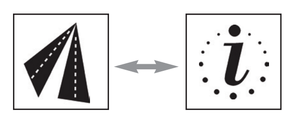


Electronic Fare Payment to Transit Management

Ridership details collected as part of an electronic fare payment system are used in transit service planning.

Shared Information

Baltimore, MD

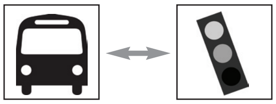


Freeway Management to Regional Multimodal Traveler Information

Freeway travel time, speed, and condition information are displayed by regional multimodal traveler information media.

Shared Information

Grand Rapids, MI

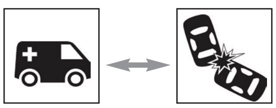


Transit Management to Arterial Management

Traffic signal timings are adjusted in response to receipt of a transit vehicle priority signal.

Coordinated Control

Kansas City, MO

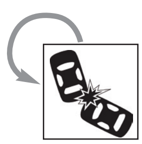


Emergency Management to Incident Management

Emergency management vehicles notify an incident management system of incidents in order to improve incident response and clearance.

Shared Information

St. Louis, MO



Multi-Agency Incident Management

Agencies participating in formal working agreements or incident management plans coordinate incident detection, verification, and response.

Shared Information

Grand Rapids, MI

The city of Grand Rapids, Grand Rapids Fire Department, and Grand Rapids Transit (GRATA) have installed a signal priority/pre-emption system. The system has been installed on traffic signals at 15 intersections, mostly in the downtown area. These intersections are used by 20 to 25 buses daily. Buses are granted priority 15 to 20 times per day, especially during morning and evening peak periods. The system has been operational since December 1999.

The need for the system was identified during planning for a major multi-year reconstruction of the downtown expressway. The priority/pre-emption system enabled travel time delay to increase by only five to ten minutes, despite an intensified construction schedule that included complete closure of the expressway from January through July 2000.

During installation of the priority/pre-emption system, traffic signal equipment at several intersections had to be updated. GRATA paid for necessary upgrades to the signal controllers and for in-vehicle equipment. Equipment cost per vehicle was approximately $1,400. Senior agency management was convinced of the system's utility after seeing similar projects in Charlotte, North Carolina, and Bremerton, Washington. An expansion of the system to include police and emergency medical vehicles is under consideration.

Kansas City, MO

For the past 25 years, Johnson County, Kansas has operated a dispatch center used by the fire department of the city of Overland Park and 12 other agencies. Fire department and emergency medical service vehicle operators report to the dispatch center incident information that they observe en route to or at the scene. This dispatch center then shares that information with the Missouri Department of Transportation and Missouri Department of Public Works. The agencies also share a common radio communications frequency.

St. Louis, MO

For over 30 years, the Illinois DOT (IDOT), Missouri Department of Transportation (MODOT), Illinois State Patrol (ISP), and the city of St. Louis have worked together, sharing information about incidents that occur on their roadways. IDOT receives information from its freeway service patrol, as well as from its incident detection and closed-circuit television network. IDOT automatically transmits information about incidents to ISP dispatch, which is located in the same building. IDOT also notifies MODOT Maintenance Dispatch and Customer Service divisions of incidents on the bridges connecting the two states. IDOT can also request dispatch of MODOT service patrol resources or activation of

MODOT variable message signs. IDOT provides information on the type of incident, its location and direction, lanes involved, duration, injuries, special circumstances such as involvement of hazardous material vehicles, and whether variable message signs and highway advisory radio units have been activated.

Phoenix, AZ

Maricopa County, Arizona—in partnership with all 18 major cities in the Phoenix metropolitan area—participates in the AZTech program, Phoenix's name for its portion of the Metropolitan Model Deployment Initiative. Information is received automatically from vehicle detection sensors and loop detectors installed on 105 miles of arterial streets. This information is transmitted to traffic signal systems over fiber-optic communication lines. The traffic signal systems, each separately owned, send their collected information to a central traveler information database managed by a contractor who, in turn, distributes the information to various government agencies, commercial establishments, and individual travelers.

The sensor and detection system generates speed and volume data that are matched to incident data provided by the 18 participating cities. A $7.5 million Federal grant was combined with $28.2 million from other participating partners to completely fund the initiative. Future plans call for equipping 400 miles of arterial roads by 2003.

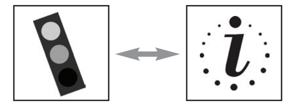
Benefits include increased open communications between departments managing area roadways, better signal timing coordination between municipalities, increased coordination of road closure projects, traffic signal system upgrades, and a single data server source for real-time traffic data. System availability averages approximately 95%.

Buffalo, NY

The Niagara International Transportation Technology Coalition (NITTEC) is composed of 14 agencies in New York and Ontario, Canada. NITTEC has installed two closed-circuit television cameras, 23 variable message signs, seven road weather information units, and a number of highway-advisory radio units on about 100 centerline miles of freeway. Data received from the system, as well as data from police agencies and local traffic reporters, are sent to the Traffic Information Center (TIC). When an incident occurs, the TIC notifies the proper police agency for response. Incident information is forwarded to broadcast media via telephone and facsimile. Highway advisory radio units operated by both the New York State Department of Transportation and the New York State Thruway Authority are also updated.

The cost to deploy variable message signs was approximately $2 million, and ongoing operational costs are $200,000 per year.

Phoenix, AZ

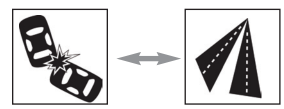


Arterial Management to Multimodal Traveler Information

Arterial travel time, speed, and condition information are displayed by regional multimodal traveler information media.

Shared Information

Buffalo, NY

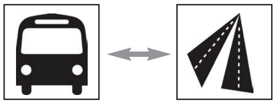


Incident Management to Freeway Management

Incident severity, location, and type data are used to adjust ramp meter timings, lane control signals, or highway advisory radio messages.

Shared Information

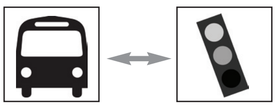
Cincinnati, OH



Transit Management to Freeway Management

Transit vehicles act as probes to determine travel conditions on freeways.

Shared Infrastructure

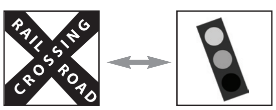


Transit Management to Arterial Management

Transit vehicles act as probes to determine travel conditions on arterial streets.

Shared Infrastructure

Oklahoma City, OK

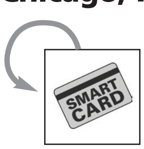


Highway-Rail Intersections to Arterial Management

Traffic signal control devices on arterial streets are interconnected with rail operations for the purpose of adjusting traffic signal timing in response to train crossings.

Coordinated Control

Chicago, IL



Multi-Agency Electronic Fare Payment

Operators of different public transit services share common electronic fare payment media.

Shared Infrastructure

Cincinnati, OH

The Southern Ohio Regional Transportation Authority (SORTA) provides information by radio to advise the traffic management center of incidents and delays on both freeways and arterial streets. SORTA also issues advisories when its buses are rerouted. The system has been in place since the traffic management center opened, and SORTA has dedicated a frequency on its radio system to communicate with the traffic management center. Information is also provided to cities in the region through the traffic management center's closed-circuit television cameras. The program focuses on providing information about areas where no other surveillance is in place, especially arterial streets. The system enables cities to update their traffic signal timings in response to current conditions.

Oklahoma City, OK

Since 1990, the city of Norman, Oklahoma, has used information about train movements to control traffic signal control timings on its arterial streets. As a train approaches, sensors send a signal via a communications cable to the traffic signal controller to implement a prepared alternate phasing plan, including time to clear the crossing. There are approximately 26 trains per day that activate the system. The primary rail carrier is the Burlington Northern Santa Fe (BNSF) Railroad. The BNSF line that runs through the city is a high-speed rail line, with trains authorized for speeds up to 55 miles per hour. Through regular contact between the city and the railroad, the system receives preventive maintenance, and city inspection of the system is coordinated with BNSF.

Chicago, IL

The Chicago Transit Authority has implemented an electronic fare payment system that enables Chicago area commuters to use one fully operational, intermodal, multi-agency, contactless smart card. Transit users are able to reduce the travel time of their commutes by using a state-of-the-art chip card that stores value for future rides and provides smoother access to rail, bus, and suburban bus. Commuters can wave their cards near a card reader in gates and turnstiles as they pass through the entry points. The stored-value card can be used on more than 1,800 buses and at 143 rail stations.

This project is part of an existing $106 million fare card contract with a private sector vendor. The new technology also allows transit customers to reclaim stored value if their cards are lost or stolen.

Detroit, MI

Southeast Michigan Area Rapid Transit (SMART) deployed two systems that support a regional multimodal traveler information system. First, a passive display of transit times and schedules is shown on the Road Commission for Oakland County's (RCOC) Traffic Management Information System. Second, an enhanced Route Schedule Adherence Module is being implemented that will enable SMART transit drivers to adjust their point-to-point travel sequences in order to adhere to posted arrival and departure times.

The RCOC system queries the SMART system; updates are issued every two minutes for reported accidents or unusual congestion along transit bus routes. Automatic vehicle location equipment is installed on 300 fixed-route vehicles and 100 paratransit vehicles. To implement the project, SMART incurred expenses of $75,000 for end-to-end interfaces, hardware, troubleshooting, and communications.

Memphis, TN

The city of Memphis, Tennessee performs maintenance on all Shelby County traffic signals. In 1999, the city and county begun an ambitious project to install a fiber-optic network that spans jurisdictional lines and interconnects the signals. The network enables Memphis to implement a program of coordinated signal timing throughout the city.

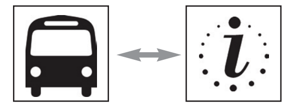
San Antonio, TX

In-vehicle navigation units on paratransit vehicles in San Antonio, Texas automatically calculate a new recommended route when they receive information from a transit management center jointly operated by the Texas Department of Transportation (TxDOT) and the city. These units have been in place since 1997. During procurement of the system, VIA Metropolitan Transit specifically sought in-vehicle units that provide this function.

The cost of the system was shared equally by TxDOT and VIA. VIA maintains the in-vehicle units, and TxDOT procures and implements updates to the system's base map. The system is installed on all 105 VIA-owned vans.

TxDOT is one of four partners in the Advanced Warning to Avoid Railroad Delays (AWARD) program. The program was developed through San Antonio's portion of the Metropolitan Model Deployment

Detroit, MI

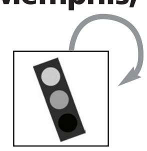


Transit Management to Regional Multimodal Traveler Information

Transit schedule adherence information is displayed on regional multimodal traveler information media.

Shared Information

Memphis, TN

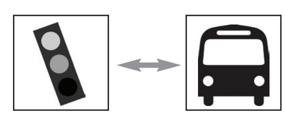


Multi-Agency Arterial Management

Agencies operating traffic signals along common corridors share information, and possibly control of traffic signals, in order to improve traffic flow on arterial streets.

Shared Information
Shared Infrastructure
Coordinated Control

San Antonio, TX



Arterial Management to Transit Management

A transit management system adjusts transit routes and schedules in response to travel times, speeds, and conditions on arterial streets.

Shared Information

Initiative. The system includes Doppler radar and acoustic sensors placed at selected locations along the railroad tracks to detect the presence, length, and speed of trains before they approach the crossings. When a train passes the sensor, software computes the speed and length of the train, and estimates the time necessary to clear the crossing.

The resulting information is transmitted to the TransGuide Control Center via modem and then routed to the regional traffic management system. An alarm alerts an operator to review data generated by the train's passage. The operator can also activate a closed-circuit television camera to further evaluate the event. The operator has the ability to modify messages displayed on variable message signs to adjust traffic flow routings until the train clears the crossing.

The system has been in place since July 1998. Deployment costs were $350,785; annual operations and maintenance costs are $33,808. The initial program funding enabled the acquisition of six closed-circuit television cameras for the project.

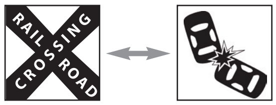
El Paso, TX

In 1980, TxDOT and the city of El Paso, Texas initiated a program to provide freeway condition information to emergency medical services, the police department, and city traffic operations. The city uses closed-circuit television cameras and video detection to monitor and record arterial travel conditions. When an incident occurs, the information is used to update variable message signs and to modify traffic signal timing sequences until the situation returns to normal. More than 260 intersections are under video observation. In 1999, TxDOT converted from copper communications cables to a fiber-optic network, in order to connect with the TxDOT network. The upgrade project cost $3.5 million.

Houston, TX

The Houston Metro transit agency is one of the four central partners in the Houston TranStar traffic management center. Integration between Metro and other incident management agencies consists of verbal communication among staff located at the center. Metro dispatchers in the TranStar control room can monitor the incident management computer system and view closed-circuit television images. Through Houston Metro's "drivers on watch" initiative, transit vehicle drivers report information on road conditions and incidents to their dispatcher via the transit radio communications system. The dispatcher then shares the information with TxDOT, Harris County, the city of Houston, and other agencies represented in the control room. Drivers are requested to report any crashes, illegal activities, or situations that require city and/or county maintenance attention.

San Antonio, TX

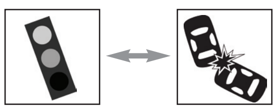


Highway-Rail Intersections to Incident Management

An incident management system is notified when a highway-rail grade crossing is blocked, so incident response can be improved.

Shared Information

El Paso, TX

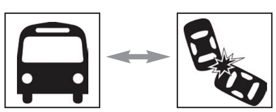


Arterial Management to Incident Management

An incident management system monitors real-time arterial travel time, speed, and conditions to detect incidents on streets in order to improve incident response.

Shared Information

Houston, TX



Transit Management to Incident Management

Transit agencies notify an incident management system of incident location, severity, and type.

Shared Information

Drivers communicate with dispatchers at two levels. In order to prioritize calls from TranStar's hundreds of vehicles, drivers send digital messages from menu-driven in-vehicle units. Dispatchers then select priority messages for verbal contact over the agency's two-way radio system. Using this system, dispatchers are prepared with appropriate questions once voice communication is established.

Virginia Beach, VA

The Virginia Beach Fire Department (VBFD) and Virginia State Police (VSP) have radio links to the Virginia Department of Transportation (VDOT) traffic management center, located in nearby Hampton Roads. The effort to link the agencies by radio was initiated at the suggestion of a VBFD firefighter and was accomplished using existing equipment and only a few hours of labor. The traffic management center communicates with the VBFD dispatch, fire stations, and fire trucks.

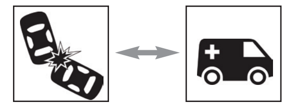
Of the 20 VBFD fire stations, only five dispatch vehicles use area freeways. When VBFD receives a fire call, the agency contacts the traffic management center to request information regarding conditions along the planned response route. The traffic management center provides incident location, direction, and route information, and occasionally asks for information on routes surrounding an incident that it does not monitor. Based on information received from the traffic management center, the fire truck may change its route or approach. Occasionally, VBFD dispatch even changes the station from which a truck is dispatched.

The VDOT traffic management center also communicates with Virginia State Police dispatch and patrol cars. When VDOT detects an incident, it automatically contacts VSP dispatch. VSP often contacts the traffic management center for verification of incidents it has detected. VSP officers also contact VDOT to request traffic management assistance. This system of communication was established in 1997, out of concern on the part of VDOT about erroneous reporting of incident locations.

Chicago, IL

The Gary-Chicago-Milwaukee (GCM) Gateway project involves agencies from the states of Indiana, Illinois, and Wisconsin. Information on lane closures, travel time, and construction projects is shared among the three partnering jurisdictions. The information is also shown on the states' respective websites, where it is accessible by all travelers in the region.

Virginia Beach, VA

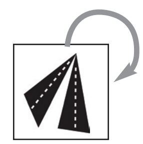


Incident Management to Emergency Management

Information on incident severity, location, and type is used to notify emergency management vehicles for improved emergency response.

Shared Information

Chicago, IL



Multi-Agency Freeway Management

Agencies operating freeways within the same region share freeway travel time, speed, and condition data.

Shared Information

Successful Practices

ITS integration can be achieved at three levels—shared infrastructure, shared information, and coordinated control—depending on the needs of a metropolitan area or geographical region. Integrated ITS deployment depends on four key steps, which can be sequential or overlapping:

- Planning
- Design
- Implementation
- Operations and maintenance.

The following successful practices were observed through interviews with agency representatives and research into agency activities.

Once immediate needs have been satisfied, regional partners should then investigate how the specific project or program might address broader needs and goals.

Planning

Needs and Vision

It is important to tie selection of ITS integration to overall area transportation needs and goals. The focus should be on current and future ITS programs, as well as on the impact of these programs on broad transportation goals. For example, while the Minneapolis-St. Paul area has established a long-term vision, immediate and pressing problems are being addressed by several projects under the ORION program. Once immediate needs have been satisfied, regional partners should then investigate how the specific project or program might address broader needs and goals.

Decision-makers and agencies must be informed of the potential benefits of ITS integration.

Outreach and Public Relations

Outreach and public relations are critical for gathering support for any ITS effort. Decision-makers and agencies must be informed of the potential benefits of ITS integration. Successful outreach and public relation activities include:

- Demonstrating potential benefits that can foster resource sharing. For example, the Atlanta NaviGAtor system started documenting findings in the early phases of the system's deployment. These early findings convinced decision-makers at several agencies to continue their participation.
- Sharing credit for success with all partners.
- Building public support for the program through public education.

The Atlanta, Minneapolis-St. Paul, Seattle, and Washington, DC areas each have outreach and public relations programs that clearly state that theirs is a partnership-based approach with active and successful involvement of all partner agencies. All four areas have gained public involvement and support through information dissemination via various

Taking the time and effort needed to develop close working relationships with agencies is a worthwhile investment.

A consensus-based approach is important, but a decisive ITS "champion" can prove invaluable to success.

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media. Participating agencies should make a commitment to support outreach needs by evaluating the effectiveness of outreach programs. Programs that are found to be ineffective should be reevaluated or discontinued.

Interagency Cooperation and Coordination

Taking the time and effort needed to develop close working relationships with agencies is a worthwhile investment. For example, the Washington, DC metropolitan region ITS Task Force achieved this objective by first meeting informally and then forming subgroups to focus on specific ITS activities. The ITS Task Force and its constituent committees are now driving integrated ITS deployment in the region.

Championing the Effort

A consensus-based approach is important, but a decisive ITS "champion" can prove invaluable to success. Seattle and Atlanta have individuals who have taken the initiative for integrated ITS deployment. Their proactive and forward-thinking approach has led to ITS deployments in these cities being showcased nationwide. Clearly defining partners' roles and responsibilities—as well as addressing information and resource sharing issues as early as possible—can reduce ambiguity and minimize the likelihood of conflict later in the project. Maintaining communication among stakeholders throughout the program through frequent meetings and exchange of ideas helps maintain focus and consensus.

Technical/Concept of Operations

Including a diverse set of functional disciplines in the initial stages will help ensure that all issues related to the project's success are addressed. Joint operations can be enhanced by maintaining an open attitude regarding overall results and by sharing resources. Facilitating the sharing of limited initial resources and operational capabilities builds larger and longer-term capabilities. The use of an open architecture to plan and design the system allows for interoperability and compatibility with other systems, and accommodates future changes in hardware and operating procedures. Establishing control and operations procedures for ITS devices and systems will ensure that operations are not hampered by a lack of key personnel. Finally, performing a "reality check" on the proposed solution through peer review and comparison to solutions implemented in other parts of the country will detect fatal flaws early in the project. Care should be taken that each system in the region is compatible at the operational level with other systems.

Program Management

Forming separate groups within the program development team to address different aspects of or systems within a program will likely prove helpful. For example, the ICTM project in Minneapolis-St. Paul formed subcommittees within the management committee to address issues including public relations, evaluation, operations, and maintenance. Successful techniques include: forming focus groups of key stakeholders to help identify needs and requirements; creating peer review groups to ensure clarity and completeness of the needs and requirements; and developing thorough implementation plans that include policies, procedures, and roles within the project, including operations and maintenance.

A rushed approach during the design stage can lead to substantial loss in time and resources during the implementation phase.

Design

System Considerations

With regard to system design, it is important that solutions address specifically identified problems and needs, as well as operations and maintenance issues and requirements. Project managers need to allow adequate time for planning, requirements definition, and development of specifications. A rushed approach during the design stage can lead to substantial loss in time and resources during the implementation phase. Standards should be used wherever they are available. Significant effort should also be expended to ensure design compatibility with other systems at the technical and operational levels, and to specify performance standards for all system components.

System managers should, wherever possible, seek to employ commonly used interfaces and standards.

Architecture

The ability to efficiently and effectively design and implement technical links between separate systems is a fundamental component of successful integration. To accomplish this goal, system managers should, wherever possible, seek to employ commonly used interfaces and standards. It is essential that a regional architecture be developed that allows different components to be integrated easily. The U.S. DOT sponsored the development of a tool for this purpose called Turbo Architecture, and has made it available to transportation agencies and authorities.[7]

Personnel Considerations

Transportation managers should conduct a realistic assessment of staffing requirements and current capabilities. Acquiring help from the private sector can contribute to the project's success. It will also prove valuable to begin training of deployment, operations, and maintenance

[7] To order a copy of the Turbo Architecture software, contact the McTrans Center for Microcomputers in Transportation at the University of Florida, (352) 392-0378, fax (352) 392-3224, or mctrans@ce.ufl.edu, http://mctrans.ce.fl.edu.

A training course on how to use Turbo Architecture is offered by the National Highway Institute. Access the website address http://www.nhi.fhwa.dot.gov/137029.html for more information.

Giving first priority to implementing the parts of the system that are likely to have immediate benefits will enhance the ability to build and maintain support for the entire system.

Integration should be accomplished incrementally, building slowly toward the final goal.

staff as soon as details about the proposed solution have been determined. For example, the ICTM project in Minneapolis-St. Paul trained private sector partners in the operation and maintenance of the adaptive traffic signal control system.

Implementation

Schedule Considerations

For implementation activities, it is essential to adopt a realistic implementation schedule and define clear, frequent milestones to assess progress of work against schedule. Identifying critical activities—such as design document review, system integration, and testing—and providing adequate time to complete each are important parts of any implementation plan. The schedule and implementation plan should be developed as a result of a comprehensive consensus-building process. However, this consensus should not be achieved at the risk of slippage in schedule. Programming for delays in software development and integration is advisable, given the high likelihood that such delays will occur. Finally, giving first priority to implementing the parts of the system that are likely to have immediate benefits will enhance the ability to build and maintain support for the entire system.

Funding Considerations

Given that sufficient funding must be available to see any implementation through to its completion, a realistic assessment of funding needs should be conducted. Such research will serve to identify alternative and innovative funding sources where possible, and offer options regarding how to apply them depending on the needs of a specific component or system.

Deployment Practices

Following a logical system engineering process and maintaining detailed documentation will significantly enhance possibilities for successful deployment. The intended final system configuration should be kept firmly in mind throughout. Integration should be accomplished incrementally, building slowly toward the final goal.

Vendor Selection

As in any system procurement, using appropriate procurement vehicles, obtaining references, and thoroughly researching previous implementations by prospective contractors and vendors can substantially reduce risk during implementation. Quite often, obtaining an independent review of the capabilities of the proposed systems and equipment can be useful. Requiring contractors to conduct acceptance tests on each major component, as well as the overall system, should be incorporated into all major procurements.

Operations and Maintenance

Inputs during Planning, Design, and Implementation

Involving operations and maintenance personnel in all stages of the project—from planning, through design and implementation, and into operations—will result in a better deployment and a system that is more easily operated and maintained over the long term. Involving operations and maintenance personnel early in the process will help to avoid problems later on, such as inadequate training, difficult system access, and unnecessary traffic disruption. For example, the operations and maintenance committee for the ICTM project in Minneapolis-St. Paul was actively involved in all stages of the project.

Involving operations and maintenance personnel early in the process will help to avoid problems later on.

Training

Operations and maintenance training should be conducted in the early stages of the project. In addition, operations and maintenance staff must be involved in operations and maintenance testing, especially during the final development test and the final acceptance test at the field site. The provisions for involving agency staff should be included in equipment procurement contracts, as contractors often do not allow non-contractor staff to handle their equipment.

Budget

Having operations and maintenance budgets and agreements in place before systems come online can significantly reduce the possibility for future problems by setting clear expectations and identifying needed resources.

Future Directions

Metropolitan areas that have integrated their ITS components have experienced significant benefits. Agency working relationships have improved, there is a push towards identifying area-wide solutions, and there is greater sharing of expertise and capabilities.

There are several emerging opportunities for integrating ITS both within metropolitan regions and with other regions. Once a metropolitan region has integrated its own systems, it may choose to establish partnerships with adjacent metropolitan areas and with other metropolitan areas in the state. Experiences with metropolitan integration show that these multi-regional partnerships can be accomplished, and that national standards such as National Transportation Communications for ITS Protocol (NTCIP) and Transit Communications Interface Protocol (TCIP) can make the task easier. Overviews for these two families of standards were published in 1996, and specific standards are continually being balloted and published.

The Atlanta metropolitan area set a new benchmark in achieving integrated ITS deployment under severe time, political, and technological constraints in preparation for the 1996 Olympic Games. The Atlanta NaviGAtor system has continued to expand and provides the basis for Georgia's vision of ITS deployment throughout the state.

The state of Minnesota is building on the experiences with ITS integration in Minneapolis-St. Paul to implement a statewide network of traffic management centers. Real-time information and shared facilities will ease transfer between modes. Partnerships with public, private, non-profit, and academic organizations will result in increased coordination, greater funding levels, and flexibility for transportation infrastructure and services.

The Seattle metropolitan area has developed a strategic plan with several ambitious goals: improved operations and maintenance; enhanced people movement through transportation demand management and ITS; protection of neighborhoods and the environment; and improved freight movement through a prioritized application of funding and technology.

The Washington, DC metropolitan area is progressing toward a more integrated transportation system that is expected to provide increased mobility through promotion of all modes. Safety, efficiency, and mobility are expected to be enhanced through application of ITS across agency and jurisdictional boundaries.

Conclusion

The challenge of meeting the transportation needs in the nation's metropolitan areas has led public and private sector organizations to pursue ITS integration. ITS integration allows a higher level of benefit to the traveling public than stand-alone ITS components could provide.

The extent of ITS integration is more a factor of institutional considerations than technological constraints. The willingness of different public and private entities to work cooperatively determines the extent of integration along a spectrum from shared information to coordinated control of system components.

Integration comes about when those responsible for the management of transportation systems see value in it. Those locations where integration has begun to make measurable progress have been able to promote its benefits.

For More Information

The entire metropolitan ITS deployment tracking database is available online at www.itsdeployment.its.dot.gov. This website contains the results of surveys of metropolitan areas taken in 1996, 1997, 1999, and 2000. Users can view survey results by metropolitan area, view blank surveys, and review the precise definitions used to determine how much ITS has been deployed in each metropolitan area. For 2000, detailed reports have been prepared for each metropolitan area, as well as a national report; all can be downloaded from this website.

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For a current listing of available documents, please visit our website at:

www.its.dot.gov

"AZTech [Phoenix's metropolitan ITS integration effort] has built a lot of positive working relationships and rapport between these municipalities so that you can look at the big picture rather than just what your own needs might be."

–Brian Latte, Signal Systems Engineer, City of Chandler, Arizona

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