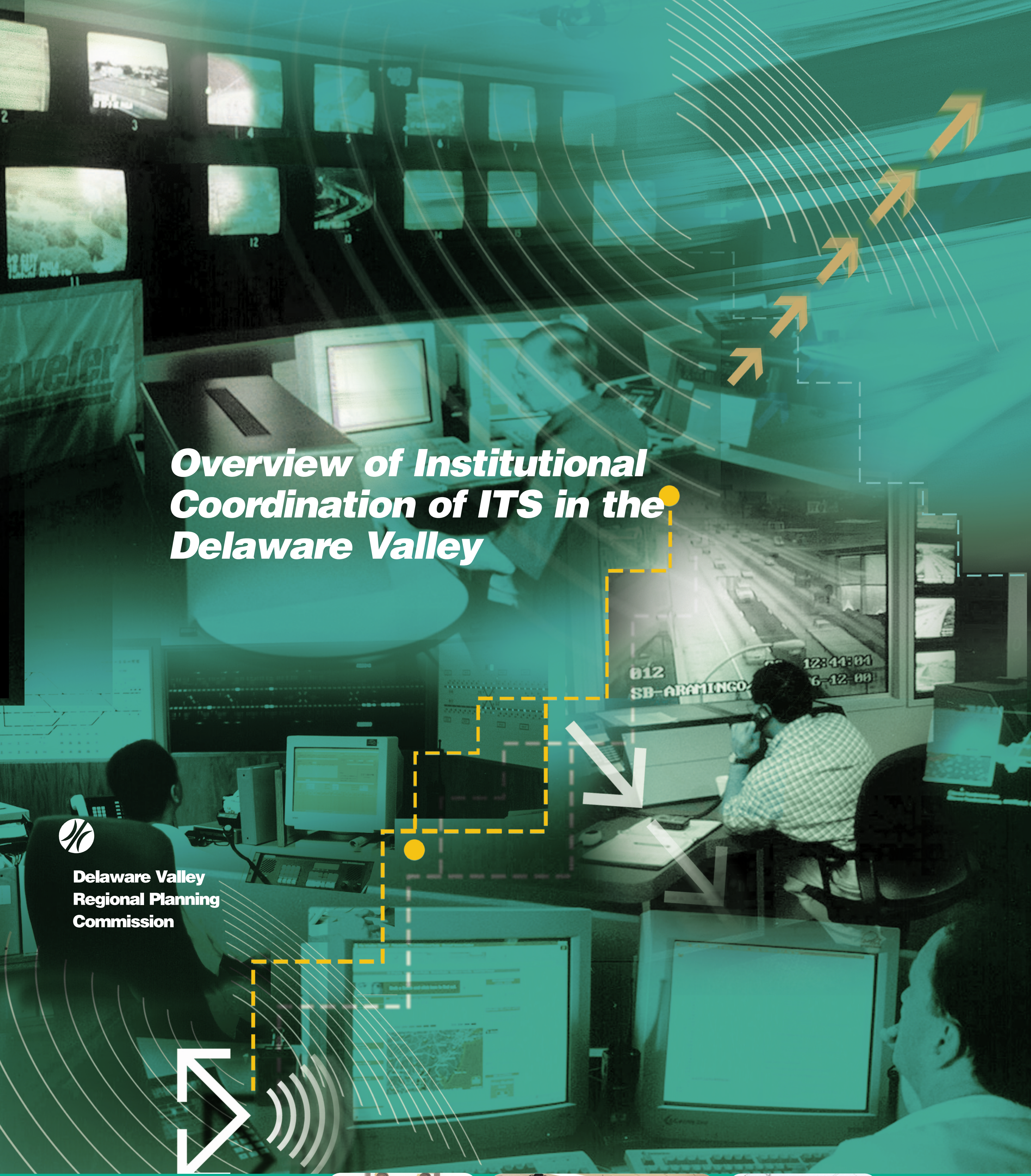

Overview of Institutional Coordination of ITS in the Delaware Valley

Delaware Valley
Regional Planning
Commission

September 2001

Overview of Institutional Coordination of ITS in the Delaware Valley

DELAWARE VALLEY REGIONAL PLANNING COMMISSION

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DELAWARE VALLEY REGIONAL PLANNING COMMISSION

Created in 1965, the Delaware Valley Regional Planning Commission (DVRPC) is an interstate, intercounty and intercity agency that provides continuing, comprehensive and coordinated planning to shape a vision for the future growth of the Delaware Valley region. The region includes Bucks, Chester, Delaware, and Montgomery counties, as well as the City of Philadelphia, in Pennsylvania; and Burlington, Camden Gloucester and Mercer counties in New Jersey. DVRPC provides technical assistance and services; conducts high priority studies that respond to the requests and demands of member state and local governments; fosters cooperation among various constituents to forge a consensus on diverse regional insures; determines and meets the needs of the private sector; and practices public outreach efforts to promote two-way communication and public awareness of regional issues and the Commission.

Our logo is adapted from the official DVRPC seal, and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole, while the diagonal bar signifies the Delaware River. THe two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for its findings and conclusions, which may not represent the official views or policies of the funding agencies.

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EXECUTIVE SUMMARY: OVERVIEW

This report represents the culmination of a multi-year project entitled *Institutional Coordination of ITS in the Delaware Valley* conducted by the Delaware Valley Regional Planning Commission (DVRPC). On one level, Intelligent Transportation Systems (ITS) represents a new array of technologies that can monitor highway and transit systems, identify incidents and other bottlenecks, and disseminate travel advisories to the public in a timely manner. On a deeper level, this technology is creating a new paradigm to manage the region's transportation system and with it, a host of new institutional challenges. Highway departments no longer merely design and construct highways, they now must manage a roadway network 24 hours a day. Investing millions of dollars to install technology to detect an incident quicker is not cost effective unless there are commensurate improvements to more expeditiously share information with emergency responders and the public. This report summarizes the efforts of DVRPC and the region's stakeholders to begin to address these institutional issues.

ITS represents a new array of technologies to monitor highway and transit systems.

ITS is creating a new paradigm to manage the region's transportation system.

As DVRPC initiated its effort, it immediately became clear that while many agencies were implementing ITS projects, there was no regional mechanism for agencies to communicate among themselves. Just as critical was the need for highway and transit agencies to reach outside their own communities to other organizations, such as emergency management agencies and information service providers who disseminate travel information to the public. This project is addressing these problems by establishing an on going coordination process, documenting existing and planned ITS deployments, sponsoring outreach education programs and training courses, and initiating other regional efforts to foster greater ITS institutional coordination.

This report describes efforts to begin addressing institutional issues created by ITS.

Furthering this approach to regional institutional coordination was a series of federal initiatives. The Transportation Equity Act for the 21st Century (TEA-21) directed the United States Department of Transportation (US DOT) to develop, implement and maintain a National ITS Architecture with supporting standards and protocols to promote the widespread use of ITS technology, ensuring interoperability and efficiency to the maximum extent possible. The legislation further directed the US DOT to ensure that any ITS project using Highway Trust Funds must conform to the National ITS Architecture. The objective of the architecture is to provide a common framework for planning, defining, and integrating ITS systems. DVRPC

Philadelphia Regional Intergrated Multi-Modal Information Sharing (PRIMIS) is the cornerstone of ITS information sharing in the region.

The report presents an overview of the status of ITS in the Delaware Valley and a synopsis of the accomplishments of the Institutional Coordination of ITS in the Delaware Valley project.

assumed the responsibility for developing the Delaware Valley Regional ITS Architecture.

While many ITS stakeholders recognized the need for a means to foster information sharing and operational coordination among regional organizations, there was no consensus on how to accomplish this goal. DVRPC became a catalyst by developing a number of coordination scenarios based upon experiences in other regions and then conducting an analysis of their applicability to the Philadelphia area based upon extensive research of how local agencies operate. Out of these discussions evolved a concept entitled Philadelphia Regional Integrated Multi-Modal Information Sharing (PRIMIS). Its initial stages are now funded by the region's Transportation Improvement Program (TIP). As presently envisioned, PRIMIS is a three-phase approach for agency-to-agency information sharing.

This project was a cooperative effort guided by an ITS Technical Task Force and an ITS Coordinating Council. The former is a technical level group composed of over 35 stakeholders, who meet monthly and represent a wide range of agencies including departments of transportation, toll authorities, transit authorities, police and fire departments, transportation management associations, county planning staffs, and information service providers. The Coordinating Council is a policy level group that is responsible for approving ITS budgets and the direction of ITS planning.

This document presents a broad overview of ITS in the Delaware Valley and a synopsis of the accomplishments attributed to the ***Institutional Coordination of ITS in the Delaware Valley*** project. It describes what ITS is, why ITS is needed, and what benefits can be derived from ITS. Local ITS components already deployed by the region's stakeholders are then presented. It also describes the planning process developed by DVRPC, local ITS challenges, recommended ITS polices, and an ITS deployment plan. Lessons learned from a prototype incident management effort in the I-76/I-476 crossroads area are also reviewed. Lastly, the report outlines, in a simplistic manner, the local Regional ITS Architecture.

Additional information can be found in detailed technical reports issued by DVRPC to document the major tasks accomplished by the project. These include:

- ✓ *Define Agency Interface with the Freeway Network*, January 1999
- ✓ *Coordination White Paper*, November 2000
- ✓ *Prototype Freeway Corridor Incident Management Report: I-76/I- 476 Crossroads*, December 2000
- ✓ *Regional ITS Architecture*, March 2001

WHAT IS ITS?

You are traveling on an unfamiliar highway and you hear on the radio that a major accident has closed the highway ahead; what do you do? It is five o'clock, time to leave the office, and you wonder what is the best route to get to the day- care center before it closes. Or, you are on a train running slightly late and worry whether the bus you transfer to will wait for you. As one of the largest metropolitan areas in the country, travelers in the Delaware Valley are constantly faced with these situations. In the past, availability of travel information was haphazard and not always up to date, reflecting a lack of real-time information and making it impossible to answer these questions. With deployment of Intelligent Transportation Systems, agencies can now monitor transportation facilities with increasing accuracy and provide more timely information to the traveling public as well as respond to accidents in a more efficient manner.

You're in a car and hear on the radio that a major accident has closed the highway; what do you do?

It is five o'clock, time to leave the office; what is the best route to get to the day-care center before it closes?

ITS represents an array of new technologies to monitor travel conditions and to impart information. In a manner similar to the way that advanced electronics such as computers, cellular phones, and the Internet has fundamentally changed the office, the application of many of the same technologies is changing the way transportation systems are managed. For example, within the Philadelphia area, personnel in Pennsylvania Department of Transportation's (PennDOT) traffic control center, using TV cameras on I-95 in Center City, can observe traffic congestion and instantaneously notify motorists of delays through overhead variable message signs. If congestion results from an accident, police and medical personnel are notified. Nearly all the toll agencies in the region have implemented E-ZPass, an electronic toll collection system that allows motorists to pay their tolls without stopping at toll booths. This reduces traffic congestion and air pollution at the toll plaza. Global positioning systems (GPS) on SEPTA buses are used to identify the bus location and to announce the upcoming stop. In the future, these systems will allow SEPTA's operations center to track their buses and determine schedule adherence, take remedial actions if necessary, and notify passengers waiting at bus stops of any delays.

Variable Message Sign on I-95 by Philadelphia International Airport.

A major byproduct of ITS is the ability to provide better management of the transportation system through the sharing of information among public agencies and with the public. Real-time video feeds of an accident can be utilized by police, fire, and emergency management personnel to gauge the proper response. If traffic is detoured from the highway onto local streets, arrangements can be made with local police departments to automatically modify traffic signal timings to handle the surge of traffic. Transit agencies will have the ability to reroute buses to avoid gridlock conditions, or, if necessary, to operate additional buses or trains as motorists switch to other modes of transportation. Through variable message signs, highway advisory radio, and dissemination of information to the media, the public will have a more comprehensive and timely picture of travel conditions and travel options.

Highway Advisory Radio on US 1 near Princeton, NJ

ITS affects not just highways and transit but all modes of transportation. For example, on-board sensors can indicate to truck inspectors which commercial vehicle to pull over for safety inspections. With more advanced equipment, trucking companies can track their fleets for on-time adherence and maintenance scheduling. Ultimately, through advanced highway systems and specially equipped vehicles, drivers may receive automatic assistance in operating their vehicles through speed control and collision avoidance systems.

The private sector is a major partner in deploying ITS services, especially when it comes to disseminating information to the public. Many of the emerging ITS technologies, such as in-vehicle navigation devices, are being developed by the private sector to fill unmet needs. These devices plot vehicle position, give directions, and notify police of a potential accident. Information Service Providers act as middlemen, packaging real-time travel information and customizing it for personalized use. Traffic condition information on specific roads will be available via cellular phone, Internet, or handheld devices; reservations for hotels, restaurants, or parking garages could also be made through these services.

WHY ITS?

There are a myriad of reasons why ITS is needed. Some are local in nature, such as the need to mitigate traffic impacts of freeway closures or other lesser incidents, which seem to occur all too frequently. Others are national trends that are technological in nature and impact the Philadelphia area. This section explores a few of the more significant reasons why ITS's time has come.

The frequency of large scale traffic disruptions in the Philadelphia area is increasing.

Traffic Accidents Remember the I-95 tire fire or the tanker explosion in Chester City? Does it seem like only last week there was another overturned tractor-trailer on the Schuylkill Expressway? These are extreme examples of traffic incidents that occur on a daily basis on our highway system. Nationally, approximately 60 percent of the congestion in the largest metropolitan areas is attributable to nonrecurring congestion, otherwise known as traffic incidents. In Philadelphia, with an aging highway infrastructure, intense traffic congestion and a large number of trucks traveling the highway system, incidents appear to be happening more frequently with a devastating impact on traffic.


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The Philadelphia Inquirer

JULY 18, 2000

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Win gives Flyers home-ice advantage

A Six-Hour Schuylkill Stoppage

Freeway Becomes Parking Lot Following Tractor-Trailer Crash

A massive backup caused by a jackknifed tractor-trailer turned the Schuylkill Expressway into a 12-mile-long parking lot for six hours. Immobilized drivers sunbathed on car roofs, tossed Frisbees and ate pizza provided by an adventurous deliveryman.

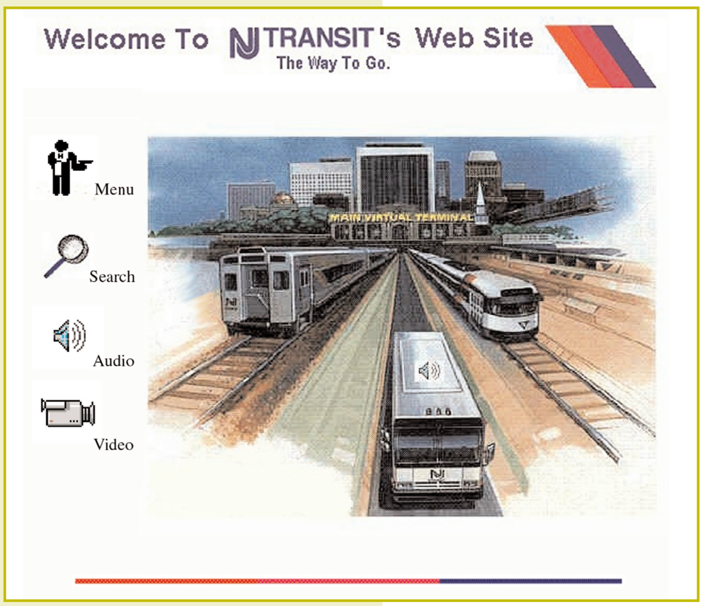
Demand Pumps Up Gas Prices

Long-range traffic trends show traffic demand increasing faster than highway capacity.

Traffic Congestion Studies across the country repeatedly show that the nation's metropolitan highway networks are becoming more congested. Long-range trends predict that congestion levels will accelerate. At the same time, there has not been a commensurate increase in highway capacity due to high costs, environmental regulations, and the public's unwillingness to have new highways constructed in their neighborhoods. In the Philadelphia area, the rate of increase in vehicle miles traveled far exceeds the rate of population growth. ITS offers a mechanism to partially offset the increasing disparity between traffic demand and highway capacity by allowing the existing highways to be used more efficiently.

Congress has made a determination to mainstream ITS, making it easier to obtain funding for ITS capital and operating costs.

Mainstreaming ITS With long-range forecasts of increasing traffic congestion and the need to keep the country economically competitive in today's global economy, Congress and the US DOT made a determination to mainstream ITS. Federal ITS funding, for capital and operating costs, has been made more flexible. There is greater emphasis in the planning and engineering phases of a project to incorporate ITS into traditional highway and transit improvement projects. US DOT has sponsored a number of demonstration projects and model deployment initiatives to test ITS concepts and to serve as a learning laboratory for other regions. Lastly, to insure interoperability among ITS systems and to standardize ITS equipment in an effort to minimize costs, US DOT has promoted a National ITS Architecture and companion ITS Standards.



Communication Technology Wireless phones, pagers, the Internet, and digital television are increasingly providing information to people. In turn, the public is demanding more information in order to make educated choices. Transportation information is increasingly seen as a highly marketable commodity. Many companies are rushing in to fill this gap. Some, like SmartRoute or Mobility Technologies, offer dynamic real-time travel information. Others, like OnStar, provide a direct communication link between the vehicle and a live operator who can dispatch roadside assistance, locate the closest hotel or gas station, or even provide directions. While there is still no standard business model for traveler information, the need for real-time transportation "content" is becoming critical for the private sector.

ITS BENEFITS

For years, public agencies have recognized the benefits of deploying ITS to make their transportation system facilities operate more efficiently. Now agencies are discovering that the benefits are even greater if they coordinate with each other to deploy and operate such technologies as an integrated system. To satisfy the question of how much greater, US DOT has conducted extensive evaluations of the various ITS demonstration projects and model deployment programs that they have sponsored. While the quantitative data from these case studies is fairly sparse, a clear picture of ITS benefits is emerging.

By the year 2005, incident-related congestion is expected to cost the American public over $75 billion in lost productivity.

Incident Management By the Year 2005, incident-related congestion is expected to cost the American public over $75 billion in lost productivity, and result in over 8.4 billion gallons of wasted fuel. By implementing incident management programs, a 10 to 45 percent reduction in congestion caused by incident delay (due to accidents, disabled vehicles, etc.) is possible. With technology such as embedded sensors in roads, closed circuit television cameras mounted along highways, and variable message signs, traffic control centers can detect slowdowns caused by accidents and initiate a response within seconds of an incident occurring. The response includes verification that an incident occurred, determination of the appropriate emergency resources required, and, if necessary, providing incident information to motorists. In this region, these types of programs have already been implemented on I-95, I-476, and NJ 42. Emergency Service Patrols travel some expressways in Pennsylvania and New Jersey, offering assistance to disabled vehicles and motorists involved in accidents, thus facilitating quicker responses to incidents. The following are specific examples of benefits gained by successful incident management programs in other metropolitan areas:

NJDOT Emergency Service Patrol vehicle

- In Atlanta, during the 1996 Olympic Games, the average time between verifying that an incident has occurred and dispatching emergency equipment was reduced 50 percent, from 9.5 minutes to 4.7 minutes.
- Since it became operational in 1995, San Antonio's TransGuide System has reduced incident response time by 20 percent.

- The COMPASS program in Toronto, Canada reduced the average duration of an incident from 86 minutes to 30 minutes.

Freeway management systems have reduced vehicular crashes by 24 to 50 percent.

Freeway Management Systems Elements of a freeway management system, such as monitoring, surveillance, and control of freeway operations, have resulted in travel time improvements ranging from 10 to 22 percent, in addition to crash reductions of 24 to 50 percent, when compared to conditions before the programs were implemented. The major ITS functions that make up freeway management systems are monitoring and control of freeway operations through closed circuit television cameras, and management strategies such as implementing ramp metering and devising traffic diversion plans to parallel arterials. An integral part of a freeway management system includes displaying or providing applicable information to the motorist through variable message signs, highway advisory radio, or in-vehicle navigation equipment. Some successful examples of freeway management systems include:

- The INFORM program on Long Island, New York manages traffic on three parallel limited access highways and has increased PM peak period traffic speeds by 13 percent.
- A long-range study of the ramp metering and freeway management system in the Seattle, Washington area over a six-year period shows that accident rates have fallen 38 percent compared to the base period.

Case Study: Incident Management in Brooklyn, New York

Before the Gowanus Expressway/Prospect Expressway rehabilitation project incident management program was introduced, it took an average of 1.5 hours to clear a typical incident. The program includes an automated incident detection system with processors to analyze data from television cameras to determine speed and volume of the vehicles. An alarm sounds if an incident is detected, alerting the traffic control center operators. Since implementation of the system, the time it takes to aid a motorist whose vehicle has broken down has been reduced to 19 minutes. If an accident occurs, the average time from inception to clearing is now 31 minutes on average.

Reductions in travel time from traffic signal improvements are estimated to range from 8 to 25 percent.

Arterial Management Systems Arterial management systems are used to manage traffic flow and control arterial roadways. Arterial management includes roadway surveillance by means of embedded loop detectors and television cameras, and advanced signal control capabilities that allow implementation of more sophisticated traffic signal timing plans responsive to traffic conditions. Another aspect of an arterial management system is providing travelers with information with regard to arterial street travel conditions, often encouraging them to use less congested parallel routes. The Institute of Transportation Engineers estimates that reduction in travel time from just traffic signal timing improvements ranges from 8 to 25 percent. In addition, improvements in arterial traffic flow and delay reductions have a generally positive environmental impact by reducing vehicular emissions and fuel consumption. Some specific examples of the benefits accrued from arterial management programs include:

- Los Angeles' Automated Traffic Surveillance and Control Program has increase travel speeds by 16 percent, reduced vehicle stops by 41 percent, and reduced vehicular emissions by 14 percent.
- Optimization of approximately 700 signalized intersections in Fairfax, Prince William, and Loudoun Counties in Virginia produced an estimated annual savings to motorists of nearly $20 million.

Case Study: Arterial Management in Durban, United Kingdom

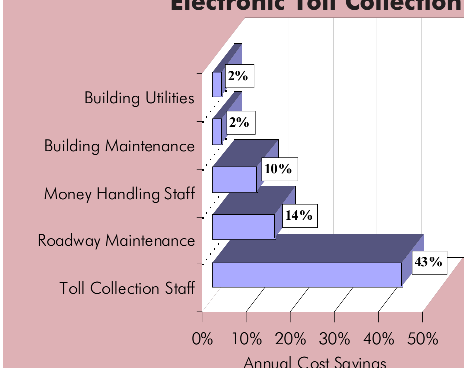
SCOOT is a real-time traffic responsive control system, wherby signal timings are continuously updated, depending on the traffic demand. SCOOT has been installed in several cities in the UK, and studies show a road user cost savings of approximately 12 percent. In Durban, annual vehicle operating cost savings were greater than 3 percent and annual time cost savings were greater than 7 percent.

Electronic Toll Collection Electronic Toll Collection has been shown to reduce emissions, decrease delay, improve traffic flow, and save on the operating costs at toll plazas. It is estimated that the number of people required to operate toll collection booths can be reduced by 43 percent, the cost of money handling personnel by 10 percent, and roadway maintenance by 14 percent. Electronic toll collection increases toll plaza capacity by 200 to 300 percent compared to attended lanes. Electronic toll collection is implemented as E-ZPass in this region. Some sample electronic toll collection success stories include:

- On the Tappan Zee Bridge, New York toll plaza, a manual toll lane can accommodate 400-450 vehicles per hour while an electronic lane peaks at 1,000 vehicles per hour.
- During its first year, the Delaware River Port Authority (DRPA) opened 73,062 E-ZPass accounts and distributed 125,929 E-ZPass transponders. Today more than half the vehicles crossing DRPA's bridges during the morning commute period use E-ZPass. On an average weekday, almost 40 percent of DRPA's total traffic uses E-ZPass.

Electronic toll collection increases toll plaza capacity by 200 to 300 percent compared to attended lanes.

Estimated Agency Benefits of Electronic Toll Collection



It is estimated that current and planned transit management system deployments will yield benefits totaling between $3.8 and $7.4 billion nationally.

Transit Management Systems Transit management systems have demonstrated that they are capable of reducing travel time by improving operation of the vehicles and by overseeing general operations of the transportation network. Transit management systems improve schedule adherence, resulting in reduced passenger wait times and improved transfer coordination. Also, the application of transit management systems reduces the overall cost of operations and improves staff productivity and utilization of facilities and equipment. Analysis of benefits accruing to the transit industry from transit management system technologies, such as automatic vehicle location systems, automated passenger information, and surveillance cameras, predicts that current and planned deployments will yield benefits totaling between $3.8 billion and $7.4 billion.

Some successful transit management programs include the following:

- In Milwaukee, on-time performance has improved from 90 percent to 94 percent after implementing an automatic vehicle location system.
- There has been a 23 percent increase in on-time performance of buses with automatic vehicle location in Baltimore.
- New Jersey Transit's interactive voice response system reduced information request telephone wait time from 85 to 27 seconds and monthly calls increased by 40,000.

Case Study: Transit Management with Automatic Vehicle Location in Kansas City, Missouri

In Kansas City, with automatic vehicle location implementation, response times to bus operator calls for assistance have been reduced to 3-4 minutes, on-time performance improved from 80 to 90 percent, and reductions were experienced in scheduled running times, thus generating an estimated maintenance and operator cost savings of $400,000 annually.

Commercial Vehicle Operations systems are estimated to reduce fatalities by 14 to 32 percent.

Commercial Vehicle Operations On-board safety systems, along with electronic clearance and automated roadside safety inspections, are estimated to reduce fatalities by 14 to 32 percent. Cost savings associated with hazardous materials incident response programs are estimated to be $1.7 million annually per state, or $85 million nationwide. Electronic clearance systems have been shown to reduce motor carrier labor costs resulting in a benefit/cost ratio of 7:1. These systems are meant to support a safe and seamless intrastate and interstate transportation system. ITS programs for commercial vehicles include electronic clearance, automated roadside safety inspection, on-board safety monitoring, computer-aided dispatching, and the implementation of automated administration systems. The following are examples of successful Commercial Vehicle Operations programs:

- By implementing automated oversize and overweight permitting and routing systems, Minnesota DOT reports that it has been able to reduce its workforce from more than 20 people across 16 districts and five people in a central office to nine individuals managing the entire state.

- A two-year study by the American Trucking Association Foundation found that the commercial vehicle administrative processes reduced carriers' costs by an estimated 9 to 18 percent when electronic data interchange is used.

- By using automated vehicle monitoring and telecommunications systems, commercial vehicle carrier Best Line of Minneapolis, Minnesota estimates a $10,000 per month savings since 300 drivers previously lost about 15 minutes each day waiting to talk with dispatchers.

Estimates of delay savings due to motorist travel information reach as high as 1900 vehicle-hours for a peak period incident and 300,000 vehicle-hours in incident related delay annually.

Traveler Information Systems Traveler information systems provide commuters and other travelers with timely and accurate information about travel choices. Estimates of delay savings attributable to motorist travel information reach as high as 1900 vehicle-hours for a peak period incident and 300,000 vehicle-hours in incident-related delay annually. The travel information can be received at home, at work, or en route via radio, television, telephone, kiosks, personal computers and the Internet, pagers, in-vehicle navigation devices, variable message signs, or highway advisory radio. The types of information disseminated may include data on traffic volumes, traffic speeds, road and weather conditions, road construction updates, special events likely to affect travel, transit vehicle status, and early detection of incidents. The following are examples of successful traveler information systems:

SmartRoute Systems, an Information Service Provider, provides real-time travel information via telephone, the Internet, and TV.

- Surveys performed in the Seattle and Boston areas indicate that when provided with better traveler information, 50 percent of travelers change routes of travel and 45 percent change time of travel.

- A pilot project in the Netherlands found a 40 percent increase in route diversions based on traffic information by the 300 vehicles equipped with radio receivers.

- ARTIMIS (Advanced Regional Traffic Interactive Management and Information System) is a regional traffic management system serving the Northern Kentucky and Cincinnati, Ohio metropolitan areas. After implementation, more than 99 percent of those surveyed said they benefited by avoiding traffic problems, saving time, reducing frustration, and arriving at their destinations on time.

- The Los Angeles SmartTraveler project has deployed a small number of information kiosks in locations such as office lobbies and shopping plazas. The number of daily accesses range from 20 to 100 in a 20-hour day, with the lowest volume in offices and the greatest in busy pedestrian areas. The most frequent request was for a freeway map, with 83 percent of users requesting this information. Over half of the requests were for bus and train information.

LOCAL ITS COMPONENTS

Most transportation agencies in the Philadelphia region are deploying advanced transportation management systems using ITS. This chapter will describe the basic ITS components that are being implemented. The first part of this chapter provides an overview of operations centers, which are the focal points of coordination at each agency. The second part describes the field equipment that is used to monitor the transportation system and disseminate traveler advisories to the public.

Traffic operation centers are the focal point of congestion and incident management.

Traffic Operations Centers Traffic operations centers have essentially two major responsibilities: manage the highway system for congestion and incidents, and coordinate operations both internally and with other traffic operations centers, transit management centers, and police and fire departments. While responsibilities will vary by agency, an operations center may include capabilities to manage computerized traffic signal systems, variable message signs, and highway advisory radios; monitor closed circuit television cameras; manage emergency service patrols; and coordinate incident management response teams. While equipment in each operations center varies, the typical control center contains computer workstations, radio scanners, television monitors, audiotext recording booths (for highway advisory radio messages), and fax machines (for sending information to other agencies). In the Philadelphia region, some of the agencies that employ traffic operations centers include PennDOT, NJDOT, Philadelphia Streets Department, Pennsylvania Turnpike Commission and the New Jersey Turnpike Authority. PennDOT's Traffic Control Center, located in King of Prussia, is the primary coordination point of District 6-0's operations. NJDOT's Traffic Operations Center, located in Cherry Hill, oversees the southern half of the state.

Monitoring highway activity at PennDOT District 6-0 Traffic Control Center

Operations console for PennDOT District 6-0 Traffic Control Center.

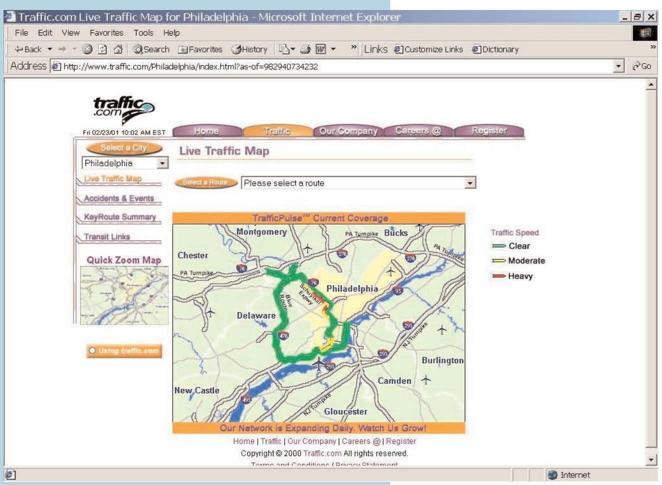
Transit Operations Centers SEPTA, PATCO and New Jersey Transit have operations centers to manage their transit activities. SEPTA's operations center primarily functions as a command/control point for Regional Rail Operations, City Bus and Rail Operations, Suburban Bus and Trolley Operations, and SEPTA Transit Police. Operations center staff at SEPTA have the ability to monitor the transit system and reroute trains and buses as required. When an incident occurs, the center notifies a line or street supervisor (for rail or buses, respectively) to investigate and manage the situation. PATCO Center Tower controls and coordinates all aspects of the PATCO line, including rail operations, maintenance,

Transit operation centers in this region have the ablility to manage their entire systems from a central location.

Bus coordination at SEPTA's Control Center

Rail console at SEPTA'S Control Center

surveillance and monitoring activities, and traveler advisory assistance to the public. New Jersey Transit operations is divided into two divisions: the northern division and the southern division, which is headquartered at the Newton Garage in Camden and is responsible for dispatching buses in the Philadelphia area. Transit operations centers typically consist of computer workstations and large display boards that allow personnel to monitor train locations, switches, and power supply status. Communication equipment at both rail and bus consoles permit operations center personnel to directly speak with train operators, bus drivers, maintenance crews, and other personnel. Other capabilities include broadcasting messages over public address systems, transmitting messages to the public via variable message boards, monitoring stations through closed circuit television cameras, and receiving messages from emergency call boxes in station areas.



Website page of Traffic.com's Philadelphia Traffic Map

Information Service Provider One of the basic concepts of ITS is to disseminate travel information to the public in a timely manner. This could be achieved either en-route through variable message signs or transit display boards, or pre-trip through the Internet, e-mail or audio messaging. Many public agencies rely upon private sector information service providers to supplement and enhance the availability of travel information with customized services such as live television and radio broadcasts in conjunction with the local media. In the Philadelphia region, NJDOT and PennDOT have a public-private partnership with SmartRoute Systems, Inc. to disseminate their traveler information. Staff from the SmartRoute Operations Center can monitor live video feeds on oversized monitors from NJDOT, PennDOT, and their own cameras. Other information service providers in the region include Metro Traffic, Express Traffic, and Mobility Technologies.

Information Service Providers in the region are centralized sources for travel information.

SmartRoute Operation Center

Commercial vehicle inspection station on I-95

Commercial Vehicle Operations Commercial vehicle operations entail a wide range of services, including commercial driver licensing, vehicle registration, vehicle inspection, enforcement of weight limitations, and collection of motor vehicle taxes. ITS will eventually automate many of these services with one-stop shopping. For example, electronic devices placed in commercial vehicles will be used for identification purposes and to assess appropriate motor vehicle taxes. In the future, weigh stations will utilize automatic weight measuring equipment (fixed sensors embedded in the pavement) instead of pulling over commercial vehicles for manual inspections. Calculating weight of commercial vehicles at highway speeds will save truckers time and money.

Electronic Toll Collection Benefits of electronic toll collection include less congestion at toll plazas, improved air quality, and increased convenience for travelers. E-ZPass was developed by a consortium of toll agencies located in the northeast United States. When a vehicle passes through an E-ZPass designated toll lane, an electronic tag (in the form of a small box mounted on a vehicle windshield) is detected by an antenna and the appropriate toll is deducted from the customer's prepaid E-ZPass account. E-ZPass will eventually be employed on all toll bridges and toll roads in the region.

Sign notifying trucks to stop at weigh station

Current manual inspection and registration methods for commercial vehicles will eventually become automated.

E-Z Pass toll lane at the Walt Whitman Bridge

Electronic toll services such as E-ZPass provide increased convenience for travelers in this region.

Emergency service patrols in Pennsylvania and New Jersey are a valuable tool for incident management.

NJDOT Emergency Service Patrol Vehicle

Emergency Service Patrols Emergency service patrols are a public service sponsored by the Pennsylvania and New Jersey Departments of Transportation and many local toll agencies to help disabled vehicles on the major expressways in the region. Some emergency service patrols operate only during peak travel times and others patrol throughout the day. Their services help to prevent secondary accidents by keeping traffic moving, pushing disabled vehicles off the road, obtaining additional resources if necessary, and giving warnings to other motorists through flashing lights or variable message signs. Emergency service patrol vehicles typically supply gas and fix tires; they are equipped with maintenance tools, gas, floodlights, radios, and traffic control devices.

PennDOT Emergency Service Patrol Vehicle

Highway Advisory Radio travel advisory sign on US 1 in Mercer County, New Jersey

Highway Advisory Radio Highway advisory radio provides motorists with up-to-the-minute reports on road and traffic conditions, travel restrictions, and general safety information. Highway advisory radio is a low-wattage radio transmitter that broadcasts pre recorded messages over a fairly small area. Flashing warning signs notify motorists to tune in to a designated AM radio station that is broadcasting messages sent from the traffic control center. While most highway agencies offer limited highway advisory radio coverage, the Pennsylvania Turnpike and New Jersey Turnpike have implemented highway advisory radio systems that cover the entire length of their respective roadways.

Highway advisory radio services enhance traveler information systems through radio broadcasts.

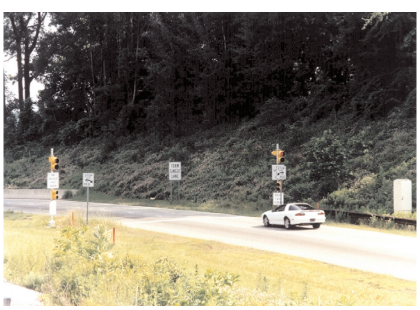
Variable message boards at SEPTA's Market East Station

Variable Message Sign Like highway advisory radio, variable message signs along a highway provide real-time en-route travel advisories to motorists. However, instead of receiving information through the radio, variable message signs relay information through message boards placed alongside the roadway or centered over travel lanes. In transit stations, variable message signs can take the form of message boards located in waiting areas and on platforms to provide information about rail or bus arrivals, departures, or other special information that may be useful to the traveler. Variable message signs are typically controlled through traffic or transit operations centers.

Variable message signs enhance traveler information systems through message boards at transit stations or along highways.

Ramp Metering Ramp metering regulates the rate of traffic entering a freeway by way of a traffic control signal located on a highway on-ramp. The signals can be pre-timed and programmed to operate during peak hours, or set to be responsive to current conditions by adjusting the flow of traffic onto the highway. PennDOT deploys ramp metering techniques on I-476 in Delaware County.

Ramp metering maintains highway speeds by regulating the rate of traffic entering the roadway.


Ramp metering at the entrance to I-476

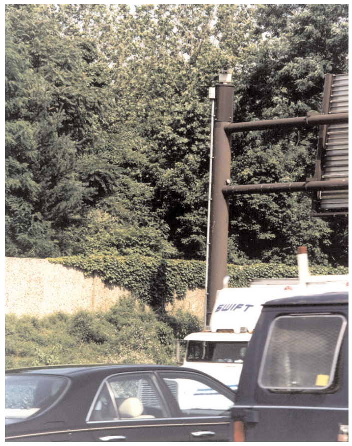
Ramp metering warning sign


Variable message sign on northbound I-95 near Philadelphia International Airport

Closed circuit television technology is useful to both transit and traffic management centers like PennDOT.

Closed circuit television monitors at SEPTA's Transit Operations Center

Emergency call boxes are strategically placed so that travelers can immediately report emergency situations.

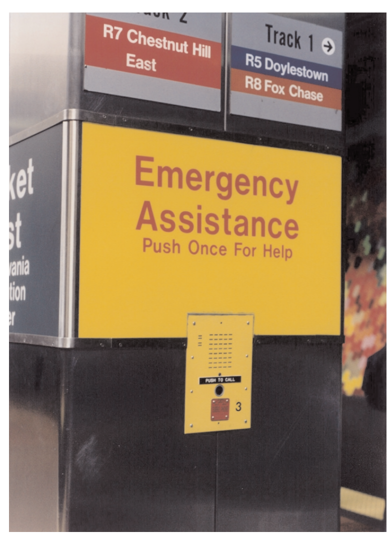


A PennDOT closed circuit television camera along I-476

Closed Circuit Television Closed circuit television technology is used in a variety of ways in the region. Closed circuit televisions may be placed in transit stations or along transit routes and are used by transit operations centers, such as SEPTA, to monitor current rail and bus activity, as well as monitoring transit users at stations. Traffic operations centers and information service providers, such as PennDOT and SmartRoute, respectively, use this technology for monitoring current traffic conditions via installation of closed circuit televisions along roadways and at key intersections and interchanges. Closed circuit televisions are not only used for detection, but also to confirm reports of incidents and to determine the level of response.

Emergency Call Boxes Emergency call boxes are valuable tools for passengers and motorists to notify authorities about an emergency situation. At transit stations, they are usually placed in waiting areas or on the platforms; they are directly connected to transit operations centers. On highways, they are typically placed alongside the roadway at half-mile intervals and are usually connected with 911 services.

Self-efficient, solar powered emergency call box on I-295



Emergency call box at SEPTA's Market East Station

REGIONAL ITS PLANNING PROCESS

To foster regional ITS planning and interagency coordination, DVRPC has taken an active role in organizing and hosting the Delaware Valley's ITS Coordinating Council and ITS Technical Task Force. The former is composed of high-level ITS policy makers, while the latter constitutes a committee of technical-level staff. The ITS Technical Task Force originally met as an ad hoc group, but has since evolved into monthly meetings of highway, transit, emergency responders, planners, and other organizations interested in ITS in the Delaware Valley. It has become the focal point of ITS information sharing and coordination among the region's operating agencies. DVRPC, in cooperation with the Technical Task Force, developed the Regional ITS Architecture, inventoried ITS deployments in the region, conducted training and outreach programs, and developed a concept for regional information sharing and operational coordination. In July 2000, the DVRPC Board formally incorporated the ITS Coordinating Council and the ITS Technical Task Force into DVRPC as a standing committee and subcommittee, respectively.

ITS Technical Task Force is a technical- level group, meeting monthly, composed of highway, transit, emergency responders, planners, and other organizations interested in ITS.

Regional ITS Committees The Delaware Valley ITS Coordinating Council consists of policy-level representatives from 30 regional stakeholders and is co-chaired by DVRPC, PennDOT, and NJDOT. The Council holds meetings twice a year to establish policy and direction for the ITS Technical Task Force and to adopt an annual work program and budget for PRIMIS and other regional initiatives. Member organizations of the ITS Coordinating Council are listed in Table 1. (See page 31)

Composed of technical staff representatives from over 35 regional stakeholders, the Delaware Valley ITS Technical Task Force is the focal point of regional ITS coordination. Chaired by an elected member of the committee, and meeting approximately once a month, the Task Force is a forum for agencies to share information on ITS deployments, develop a consensus on regional ITS issues, respond to federal and private sector initiatives, and to develop an annual work program and budget for PRIMIS and other regional initiatives. It has the ability to establish subcommittees to tackle specific issues as they arise. As a technical-level group, it directs DVRPC's ITS planning activities that in turn supports the Task Force. Previous major accomplishments include the development of the PRIMIS concept and the Regional ITS Architecture. A list of the organizations who participate in the ITS Technical Task Force is also contained in Table 1.

ITS Coordinating Council meeting

ITS goals and objectives will result in measures to quantify the region's sucess in implementing ITS.

ITS Goals and Objectives DVRPC, through the ITS Technical Task Force, developed a set of ITS goals and objectives for the region. The following goals are meant to guide ITS deployment in the Delaware Valley:

Goal 1: Foster institutional coordination to facilitate information exchange and improve efficiency of operations.

Goal 2: Promote interoperability among operations centers through compliance with National ITS Architecture and Consistency Requirements.

Goal 3: Promote safety and more effective incident management.

Goal 4: Improve the dissemination of traveler information.

Goal 5: Promote sufficient funding to construct, operate, and maintain ITS Programs.

Goal 6: Use ITS as a tool for economic development and managed growth.

User Services determines what ITS should accomplish from the user's perspective.

User Services User Services, the first step in ITS architecture development, describe what ITS should accomplish from the user's perspective. Should ITS implement traffic control projects, traveler information programs, or commercial vehicle operations? The National ITS Architecture identifies 31 User Services that can be deployed in varying combinations to meet the diverse needs of a variety of different customers. User Services act as a menu of ITS options that a specific region may choose to implement.

Early in the planning process, the ITS Technical Task Force was charged with identifying the appropriate User Services for the Delaware Valley. A broad array of users were considered, including the traveling public as well as different types of system operators. The process resulted in the following 14 User Services being ranked as a high priority:

Traffic Control Capability to manage traffic on streets and highways; includes surveillance capability, control support, traffic optimization programs; provides traffic information to other ITS elements.

Incident Management Identifies incidents, formulates response actions, supports coordination among responders.

Highway-Rail Intersection Augments standard highway traffic signal devices with more intelligent intersection controllers; provides closure information to motorists via roadside message devices.

Pre-Trip Information Assists travelers to make mode choice and route decisions prior to departure; provides travel information.

En-Route Driver Information Provides motorists with travel information once their trip has begun.

Public Transportation Management Automates operational and administrative functions, including vehicle tracking, route planning, and scheduling.

En-Route Transit Information Provides travelers with real-time transit vehicle information allowing travel alternatives to be chosen once traveler is en-route.

Public Travel Security Creates a safe environment in all physical areas related to public transit; includes security sensors to alert operators and security management to coordinate a response.

Electronic Payment Services Allows travelers to pay tolls, transit fares, and parking charges electronically; provides service support and electronic payment integration among all modes.

Commercial Vehicle Electronic Clearance Automates ports of entry and weigh station functions for interstate and intrastate commercial vehicles and carriers.

Automated Roadside Safety Inspection Automates roadside safety inspection tasks; includes on-board sensors to check vehicle systems.

User Service (US) Screening Criteria:

Is US responsive to actual regional needs?

Does US have widespread or more limited application?

Does US support or enhance existing projects or planned programs?

Does maturity of technology and/or local expertise permit rapid deployment?

Does US have political and institutional support?

Is US appropriate to the DVRPC region or should it be implemented at a higher level?

Advanced Vehicle Safety User Services (Long-Term Priorities)

Longitudinal Collision Avoidance — Determines actions to safely drive a lead vehicle, also notifies drivers of a potential hazardous situation when backing up.

Intersection Collision — Notifies driver of the presence of a hazardous situation and the need for immediate action.

Safety Readiness — Insures driver and vehicle are in safe operating condition.

Pre-Crash Restraint Deployment — Detects an impending collision with moving or stationary object and initiates deployment of restraint devices .

Archived Data Functions, consisting of the ability to store historical data, was considered a medium priority.

Route Guidance, which provides directions to travelers based upon real-time travel conditions, was considered a medium priority.

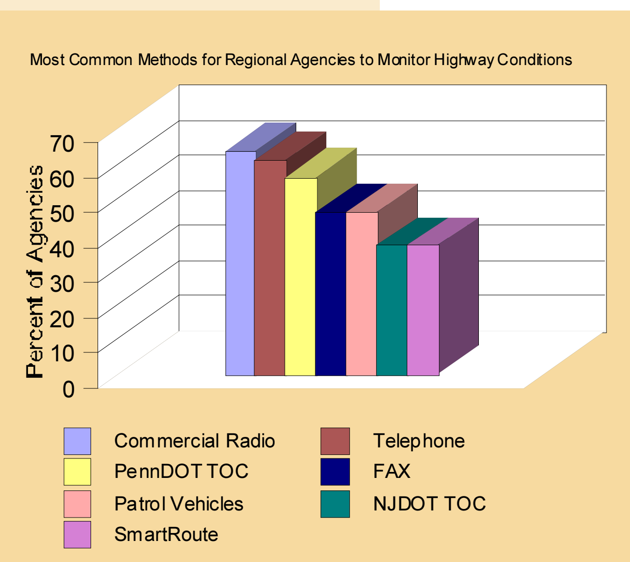
There is a disparity between how regional agencies and municipalities monitor traffic conditions.

Hazardous Material Incident Response Provides real-time information on hazardous material cargo and its condition to enforcement and emergency personnel.

Emergency Notification and Personal Security Provides for faster notification that an incident has occurred through an automated collision notification system or a manually initiated device.

Emergency Vehicle Management Provides for a more efficient response to a distress call through improved tracking of emergency vehicles, route guidance capability to avoid backups, and signal priority systems for emergency vehicles.

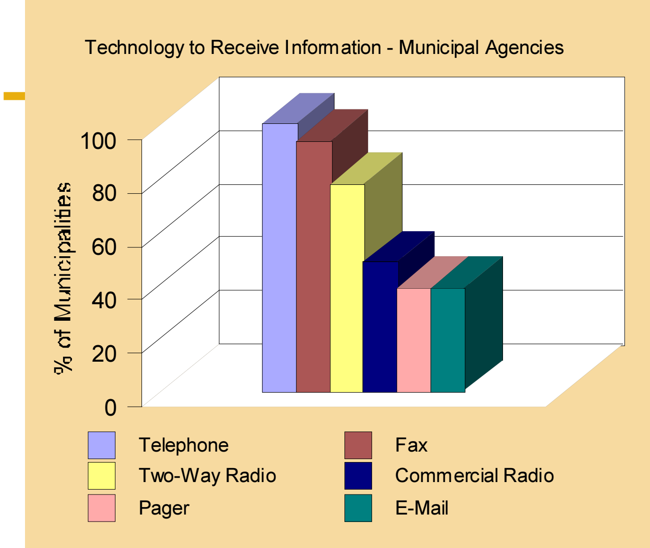
Information Sharing Survey In 1999, DVRPC conducted two surveys that were designed to identify current and potential ITS stakeholders, document the existing flow of information among stakeholders, and identify missing links and new opportunities for communication among these stakeholders. The surveys assessed the level of interest of the stakeholders in becoming active participants in developing procedures and agreements for the sharing of traffic and travel information. One survey focused on regional agencies, most of whom later became members of the ITS Technical Task Force. The second survey was targeted to municipalities situated along the expressway system in Pennsylvania. Results from this survey were used to select a corridor for a prototype incident management effort.



Survey highlights and findings include:

- Commercial radio and telephone calls were the primary methods of monitoring travel conditions for both municipalities and regional organizations.

- There was a significant disparity between the municipal responses and those of the regional organizations concerning the sending and receiving of information about congestion, incidents, special events, and construction activities. Almost half of the regional organizations sent/received this type of



information to/from PennDOT's traffic operations center. However, only 10 percent of the responding municipalities sent this type of information to PennDOT's Traffic Control Center, while 25 percent of the responding municipalities received this type of information from PennDOT's traffic operations center. The municipalities indicated that they were more likely to send and receive this information to/from the Pennsylvania State Police.

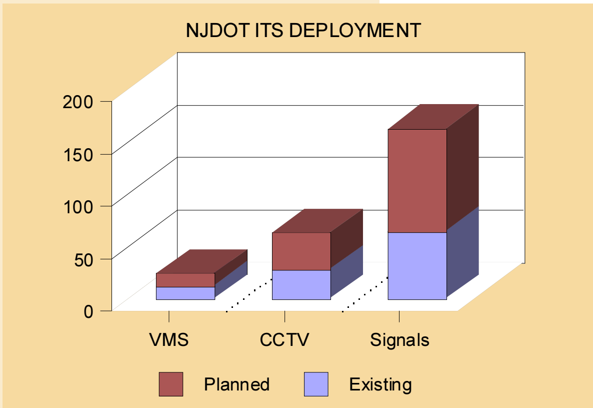
- Typically, there is very little sharing of transportation or travel related information among municipalities.

- In terms of telecommunication technology, all regional agencies have the ability to receive information via telephone, and most have fax capabilities. Two-way radio is the next most common mode of communication. However, two-way radio is not an effective mode of communication between different organizations because each organization operates on a different radio frequency. More than half of the regional organizations employ pagers and e-mail, while less than half the municipalities use these technologies.

- There was a very high level of interest among the regional agencies to participate in some form of information-sharing program. Among the municipalities, interest in such a cooperative effort varied; in some corridors there was a total lack of interest, in other corridors it varied by municipality.

There is very little sharing of transportation or travel related information among municipalities.

ITS Deployment Inventory With each agency in the region implementing their own ITS programs, it was very difficult for any one agency to observe the larger picture of ITS deployment in the region. Consequently, an ITS inventory of existing and proposed deployments was developed to help provide this overview to all the ITS stakeholders. It was accomplished by periodically polling 16 agencies as to their current ITS deployment activities. A summary of some of the activities as of March 2001 are as follows:



NJDOT In the Delaware Valley region of South Jersey, NJDOT currently monitors 28 surveillance cameras and operates 13 variable message signs and three highway advisory radio units on I-295, US 1, NJ 42, and NJ 73. Their system also includes 65 signalized intersections under computerized traffic control. The number of cameras, variable message signs, and computerized intersections will approximately double when work is completed by installing additional equipment on I-295, NJ 70, NJ 73, US 30, and US 130.

PennDOT In Pennsylvania, PennDOT recently relocated and expanded its traffic control center serving the Philadelphia area. It currently oversees the operations of 51 surveillance cameras and 12 variable message signs located mostly on I-95, I-476, and I-676. An additional 147 cameras and 47 variable message signs are planned for I-76, I-476, US 202, US 422, and PA 309.

SEPTA'S Transit Operation Center

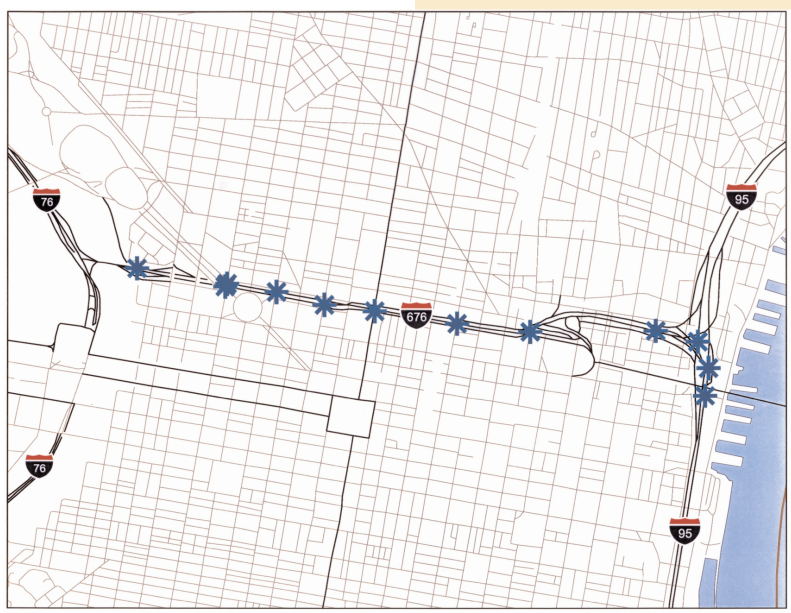
SEPTA A number of projects that SEPTA is implementing fall under the umbrella of ITS. First is the consolidation of all of their operations centers into one unified operations center, including light rail, subway-elevated lines, bus, regional rail, and SEPTA Transit Police. SEPTA is also working with the Philadelphia Streets Department to install signal preemption on the Route 10 Trolley to speed its travel along Lancaster and Lansdowne Avenues. They also plan to test automatic vehicle location devices on 50-100 buses to demonstrate the ability to track transit vehicles. Another project includes a pilot program that installed CCTV cameras on seven subway stations and four regional rail stations. Lastly, new information displays were installed at 25 regional rail stations and seven transit stations.

Delaware River Port Authority DRPA is planning to construct a new centralized operations center that will assume some of the responsibilities that currently reside at operation centers located at each of their bridges. They have recently installed surveillance cameras on their bridges to expeditiously identify accidents and other potential problems.

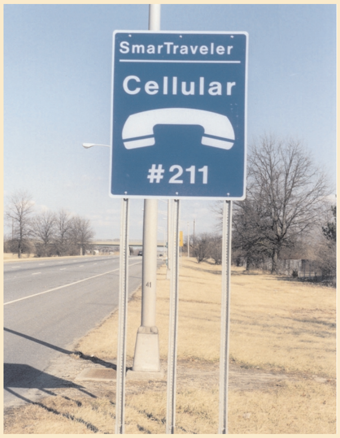
Emergency Service Patrols Both NJDOT and PennDOT operate special emergency response vehicles on some of their highways. In New Jersey, portions of NJ 42, NJ 55, I-76, I-676, and I-295 are patrolled. In Philadelphia, these vehicles operate on I-76, I-95, and I-676. They are equipped to perform minor repairs, fix flat tires, supply gas, and are able to remove disabled vehicles from the highway. They are also supplied with warning equipment to safely guard vehicles involved in an accident until the police arrive and complete their investigation. All toll authorities in the region have special police units assigned to them to actively patrol their facilities. In most cases, they are special units of the state police.

The Philadelphia Streets Department has 231 intersections interconnected with a closed loop traffic signal system; another 313 intersections are planned or under construction.

Closed Loop Traffic Signal Systems Many municipalities in the region are constructing closed loop traffic control systems to improve signal coordination and make them more responsive to traffic conditions. The two most extensive systems are operated by NJDOT and the City of Philadelphia. The former's system currently covers 65 intersections over 43 miles of US 1 in Mercer County and NJ 73 in Burlington and Camden Counties. An additional 97 intersections on 67 miles of US 30, NJ 38, NJ 70, and NJ 73 are under construction. The Philadelphia Streets Department has 231 intersections under closed loop control with another 313 planned or under construction. Some of the more significant routes covered by the system include: US 1 (Roosevelt Boulevard), Allegheny Avenue, 52nd Street, South Broad Street, and the northeast, southeast, and southwest quadrants of Center City.



Location of PennDOT TV cameras on I-95 and I-676 in Center City.



SmartRoute traveler information

Traveler Information Programs All transit organizations andTransportation Management Associations (TMAs) employ traveler information programs. SEPTA, New Jersey Transit, PATCO, and Amtrak all offer interactive telephone information, extensive web sites, and information displays at their major stations. In the region, seven Transportation Management Associations, public-private partnerships that foster improved transportation services, offer websites with construction advisories. In addition, the Greater Valley Forge TMA and Greater Mercer TMA offer customized construction notifications that are e-mailed to subscribers based upon specified routes specified by the traveler. All toll authorities have extensive websites offering information on interchanges, tolls, construction activities, services on the toll road, and, in some cases, status information on road conditions. The New Jersey Turnpike and Pennsylvania Turnpike also provide road condition information via the telephone. SmartRoute and Traffic.com, private sector information service providers, disseminate real-time roadway information to the public via telephone and the Internet. Typical information includes travel times and incident and construction activity for major expressways in the region.

ITS training and public outreach programs have been identified as high-priority objectives.

ITS Training and Public Outreach Programs Successful ITS planning involves continual educational outreach. DVRPC, in cooperation with the ITS Technical Task Force, supports this mission on behalf of those involved in ITS operations in the region by sponsoring conferences and training courses.
These include:

Over 140 participants attended a one-day Incident Management Conference sponsored by the National Incident Management Coalition and DVRPC.

National Incident Management Coalition (NIMC) Conference (May 2000) — This one-day conference, with over 140 participants, was held to apprise transportation policy decision makers, police, fire, and EMS officials about the various ITS and incident management initiatives being conducted by the departments of transportation and the state police in Delaware, New Jersey, and Pennsylvania.

National Transit Institute's "Planning the Integration of Transit and Traffic ITS Applications"(January 2000) — This two-day course focused on transit applications of ITS, reviewing best practices of transit-oriented ITS in the United States and abroad.

National Highway Institute's ITS Software Acquisition Course (September 2000) — A two-day course, targeted to project engineers and ITS implementors, which described the "do's" and "don'ts" of acquiring ITS software based upon experiences in other regions.

AZTECH Model Deployment Showcase (October 2000) — The Federal Highway Administration sponsored a model deployment effort in Phoenix, Arizona to demonstrate how different agencies can cooperatively share information and manage that region's transportation system. Local planners from the Philadelphia area were sent to Phoenix to participate in tours of the operations centers and to attend seminars on how institutional coordination can work.

Local and state Transportation Representatives on a bus tour in Phoenix, Arizona

National Highway Institute's ITS Incident Management Course (November 2000) — This training course was targeted to highway, police, and fire personnel. It focused on procedures to respond and manage incidents; there were several role-playing workshops for participants to learn from each other. As a result of very positive feedback, additional sessions of this course will be offered in the near future.

Fiber Optic Training Course (November 2000) — This course focused on the potential to utilize commercial fiber optic networks for communication and information exchange within the region and served as a primer on the operating concepts of fiber optics as a communication tool.

The ITS Service Plan for this year includes the following:

- Tours of regional operations and control centers
- Production of an ITS public relations video
- Online ITS training courses
- Courses on ITS partnerships, incident management, and communications protocol and standards

Each year, the Federal Highway Administration and Federal Transit Administration fund ITS Service Plans to help metropolitan areas support the successful deployment of ITS technologies. Some of the training courses described above were funded through a previous Service Plan for the Philadelphia area. The recently approved Service Plan for this year calls for the following activities: tours of operation and control centers for the region's ITS stakeholders; production of a public relations video describing what ITS is and showing successful examples in the region; online ITS training courses for regional stakeholders; and National Highway Institute courses on ITS Public/Private Partnerships, ITS Incident Management, and on National Transportation Communication for ITS Protocol (NTCIP) and ITS Standards.

Regional ITS Architecture One of the most significant accomplishments of the ITS planning process was development of the Regional ITS Architecture for the Delaware Valley. The architecture represents a common framework for each entity that implements ITS projects. A more detailed explanation of the ITS architecture is contained in the next chapter. Proposed changes to the Metropolitan and Statewide Transportation Planning Regulations issued by US DOT call for an extensive outreach program to a wide range of stakeholders when developing regional architectures. The process employed by the ITS Technical Task Force and DVRPC in jointly developing the architecture surpasses these standards.

Table 1: Delaware Valley ITS Stakeholders

	TTF	CC		TTF	CC
AAA — Mid Atlantic Region	✓		New Jersey DOT Traffic Operations South	✓	✓
AMTRAK	✓	✓	New Jersey State Police	✓	✓
Burlington County	✓	✓	New Jersey Turnpike Authority	✓	✓
Burlington County Bridge Commission	✓		New Jersey Transit	✓	✓
Community Transit	✓	✓	PATCO	✓	✓
Chester County TMA	✓		Pennsylvania DOT Central Office	✓	✓
Delaware County	✓	✓	Pennsylvania DOT — District 6-0	✓	✓
Delaware River Joint Toll Bridge Commission	✓	✓	Penn State University Applied Research Laboratory	✓	
DelDOT		✓	Pennsylvania State Police	✓	✓
Delaware River Port Authority	✓	✓	Pennsylvania Turnpike Commission	✓	✓
Delaware Valley Regional Planning Commission	✓	✓	Philadelphia — Mayor's Office of Transportation	✓	✓
Drexel Univ. — Intelligent Infrastructure Institute	✓		Philadelphia Fire Department	✓	✓
FHWA — New Jersey	✓	✓	Philadelphia Parking Authority		✓
FHWA — Pennsylvania	✓	✓	Philadelphia Police Department	✓	✓
Gloucester County	✓	✓	Philadelphia Streets Department	✓	✓
Greater Valley Forge TMA	✓		SmartRoute Systems	✓	✓
Greater Mercer TMA	✓		SEPTA	✓	✓
Montgomery County	✓	✓	South Jersey Transportation Authority	✓	✓
New Jersey DOT	✓	✓	TRANSCOM	✓	✓

REGIONAL ITS ARCHITECTURE

Nationally, billions of dollars are being invested in ITS. Given this enormous investment, there are concerns about the ability of local ITS systems to communicate with each other and share information. To address this problem, US DOT created the National ITS Architecture to provide a common framework for planning, defining, and integrating intelligent transportation systems. The architecture is not a system design nor is it a design concept. It defines the framework around which multiple design approaches (e.g., regional architectures) can be developed, each one specifically tailored to meet the individual needs of the user, while maintaining the benefits of a common architecture. A simple example of what the architecture is trying to accomplish can be visualized by considering how stereo systems work. Stereo systems consist of different components: receivers, speakers, CD players, DVD players, etc. Components can be produced by different manufacturers with each offering distinctive features. However, by having standard inputs, outputs, and connecting cables, a person can mix components and manufacturers without worrying if they are compatible.

The ITS architecture provides a common framework for planning, defining, and integrating intelligent transportation systems.

Specifically, the National ITS Architecture defines:

- The functions that must be performed to implement a given User Service, such as gather traffic information or request information about a specific transit route.
- The physical entities or subsystems where these functions reside, such as whether they are roadside devices or emergency vehicles.
- The interfaces and information flows between the physical subsystems.

In addition, the National ITS Architecture identifies and specifies requirements for standards needed to support national and regional interoperability.

US DOT's ITS conformity regulations require development of a regional ITS architecture to serve as the basis of regional integration.

To fulfill the congressional mandate of ITS conformity, US DOT has recently issued ITS regulations and will shortly issue additional rules to foster integration of ITS into the transportation planning and project development processes. As currently envisioned, revisions to the metropolitan planning regulations will insure that ITS is one of the factors considered in the transportation planning process. Separate ITS regulations require:

- Development of a regional ITS architecture for each metropolitan area.
- Specifications for ITS projects to incorporate national and/or regional architectural requirements and national ITS standards.
- Establishment of a mechanism for projects to be monitored for compliance with the above requirements.

The Delaware Valley Regional ITS Architecture was developed by DVRPC with input from the ITS Technical Task Force.

DVRPC has developed the Regional ITS Architecture for the Delaware Valley through a coordinated process with a wide array of stakeholders. This effort was guided by the ITS Technical Task Force and conducted in accordance with guidance set forth by US DOT in the National ITS Architecture. The Regional ITS Architecture for the Delaware Valley addresses:

- The integration of ITS systems and components.
- The roles and responsibilities of a wide range of ITS stakeholders.
- The tailoring of ITS deployment and operations to local needs.
- The sharing of information between stakeholders.
- The future expansion of ITS programs.

Delaware Valley ITS Regional Architecture Elements

User Services

Subsystems

Terminators

Inventory of Existing and Planned ITS Deployments

Agency Roles and Responsibilities

National ITS Standards

Market Packages

Implementation Strategy

The Regional ITS Architecture also identifies key national ITS standards applicable to the local architecture.

Major elements of the Delaware Valley ITS Regional Architecture are summarized below:

User Services User Services outline what ITS should do from the user's perspective. The concept of User Services begins the system or project definition process by establishing the high-level services that will be provided to address identified problems and needs. The 31 User Services identified in the National ITS Architecture were screened for their applicability to the Delaware Valley. The high-priority User Services for the region were described in the Regional Planning Process section of this document. A more comprehensive listing of the User Services, and their applicability to the region, is contained in Table 2.

Table 2: High and Medium Priority User Services

User Service/ITS Function	Priority: High	Priority: Medium
Travel and Traffic Management		
Pre-trip Travel Information	X	
En-route Driver Information	X	
Traffic Control	X	
Incident Management	X	
Highway-Rail Intersection	X	
Route Guidance		X
Ride Matching and Reservation		X
Traveler Services Information		X
Public Transportation Management		
Public Transportation Management	X	
En-Route Transit Information	X	
Public Travel Security	X	
Electronic Payment Services		
Electronic Payment Services	X	
Commercial Vehicle Operations	X	
Commercial Vehicle Electronic Clearance	X	
Automated Roadside Safety INspection	X	
Hazardous Material INcident Response	X	
Emergency Management		
Emergency Notification and Personal Security	X	
Emergency Vehicle Management	X	
Information Management		
Archived Data Function		X

User Services outline what ITS should do from the user's perspective. It begins the systems definition by establishing high-level services that will be provided to address identified problems and needs. Rankings denote the ability of a specific User Service to meet regional needs as judged by the ITS Technical Task Force. Low -priority user services are not shown.

Subsystems represent real world physical entities like traffic operations centers, toll collection systems, or transit vehicles.

One of the objectives of the ITS Regional Architecture is to show relationships between local organizations and the existing and proposed information flows between them.

Philadelphia Traffic Officer and Philadelphia Streets Department Maintenance Crew are examples of terminators.

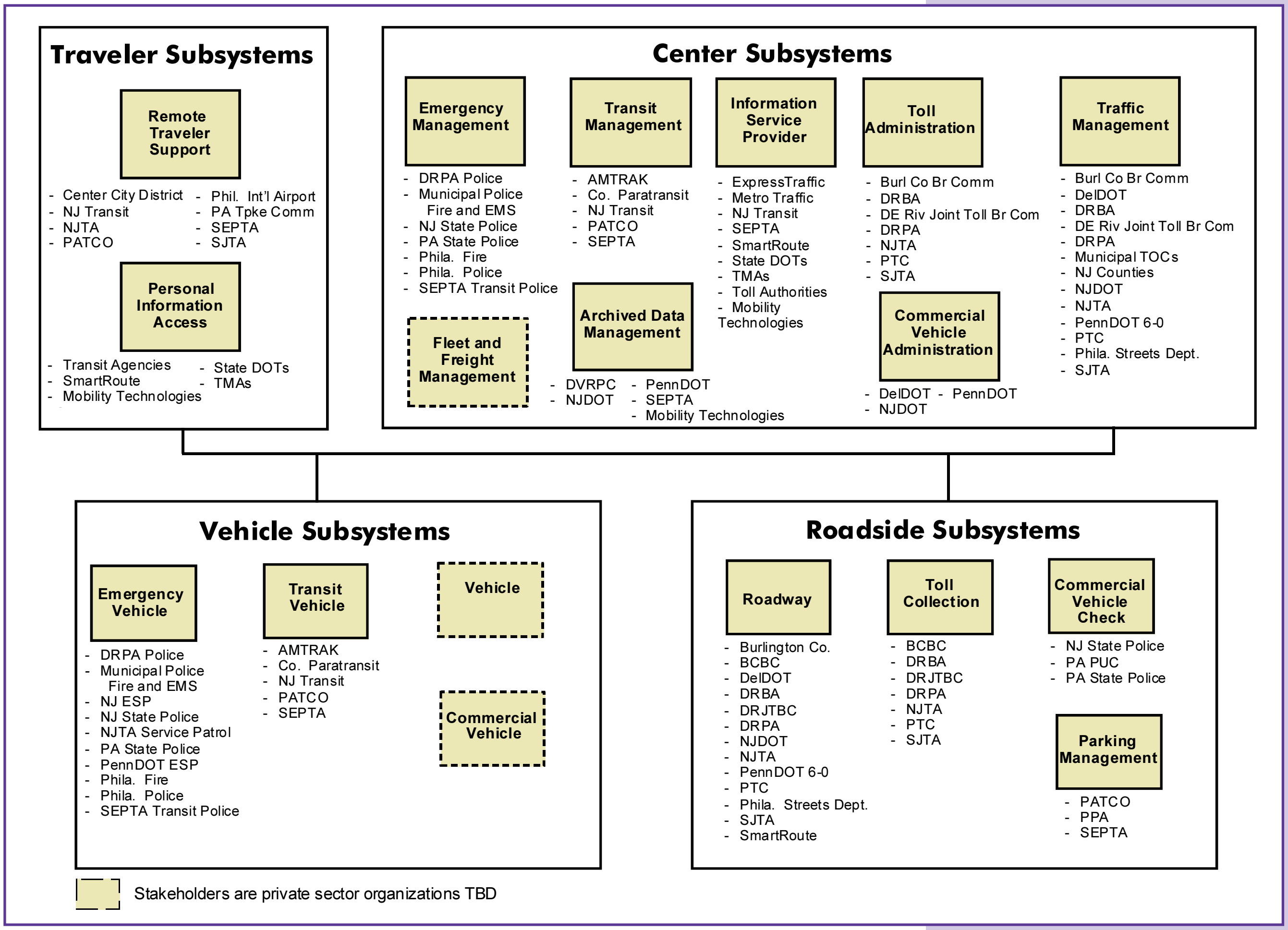
Public agencies will maximize the benefits of their ITS programs by using the Regional ITS Architecture to identify which organizations need their information on transportation conditions.

Subsystems There are 19 subsystems in the National ITS Architecture that are grouped into four classes: Centers, Roadside, Vehicles, and Travelers. Real world examples of center subsystems are traffic management centers, transit management centers, and emergency management centers. Roadside subsystems include roadway devices (variable message signs, roadway detectors, traffic signals), toll collection devices, and commercial vehicle check equipment (weigh stations, driver credential inspection equipment). Vehicle subsystems encompass basic vehicles, emergency vehicles, transit vehicles, and commercial vehicles. Travelers are divided into two categories: those that receive information from remote field apparatus such as kiosks or dynamic display boards in train stations, and those that receive information at home or in the office from personal devices such as the telephone or Internet. This concept is graphically displayed in Figure 1, which shows those subsystems applicable to the Delaware Valley and key stakeholders associated with them.

Terminators Terminators represent the people, systems, and general environment that interface with the ITS architecture. Essentially, terminators define the boundary of the Regional ITS Architecture. Examples of terminators include traffic maintenance personnel, transit fleet managers, transit drivers, public affairs staff, toll operators, county 911 operations, commercial vehicle operations inspectors, and special event operators (e.g., the Pennsylvania Convention Center). The National ITS Architecture contains 73 terminators; the regional architecture screened all 73 for their applicability to the region and identified the local stakeholders represented by them.

Agency Roles and Responsibilities The preceding elements of the Regional ITS Architecture concentrated on defining various architectural elements — subsystems and terminators. For each of these elements, the Regional ITS Architecture includes a section which identifies local organizations responsible for these functions. In another section of the Regional ITS Architecture, however, the reverse approach was taken. For 10 key agencies, high-level architectural requirements were presented showing institutional arrangements and existing and proposed information flows between subsystems (i.e., agencies). This is generically displayed in Figure 2 and Table 3. The diagram, using standard architecture conventions and nomenclature, shows a simplified version of a traffic management subsystem with information flows into and out of it from other

Figure 1: ITS Subsystems Overview with Key Stakeholders



This diagram depicts the ITS subsystems and corresponding key stakeholders applicable to the Delaware Valley. The center subsystems include those stakeholders in the region who operate traffic management centers (e.g. PennDOT's Traffic Operations Center), transit management centers (e.g. SEPTA's integrated operations center), or emergency management centers (e.g. local and state police). Roadside subsystem stakeholders may be involved with managing toll collection systems, like DRPA; regulating commercial vehicle checks, like the state police; or implementing roadway technologies such as variable message signs or traffic loop detectors, like the Philadelphia Streets Department. Traveler subsystem stakeholders provide two modes of information dissemination. One supplies information to personal communication systems for the home or office, such as SmartRoute managing access of up-to-date travel and traffic information via phone, pager, or the Internet. The other function of traveler subsystem stakeholders is to provide information in a public setting, such as Amtrak message boards. Vehicle subsystems consist of transit and emergency vehicles, such as the Emergency Service Patrols supplied by NJDOT or PennDOT, which are equipped to send and receive incident information.

Figure 2: Sample Traffic Management Subsystem

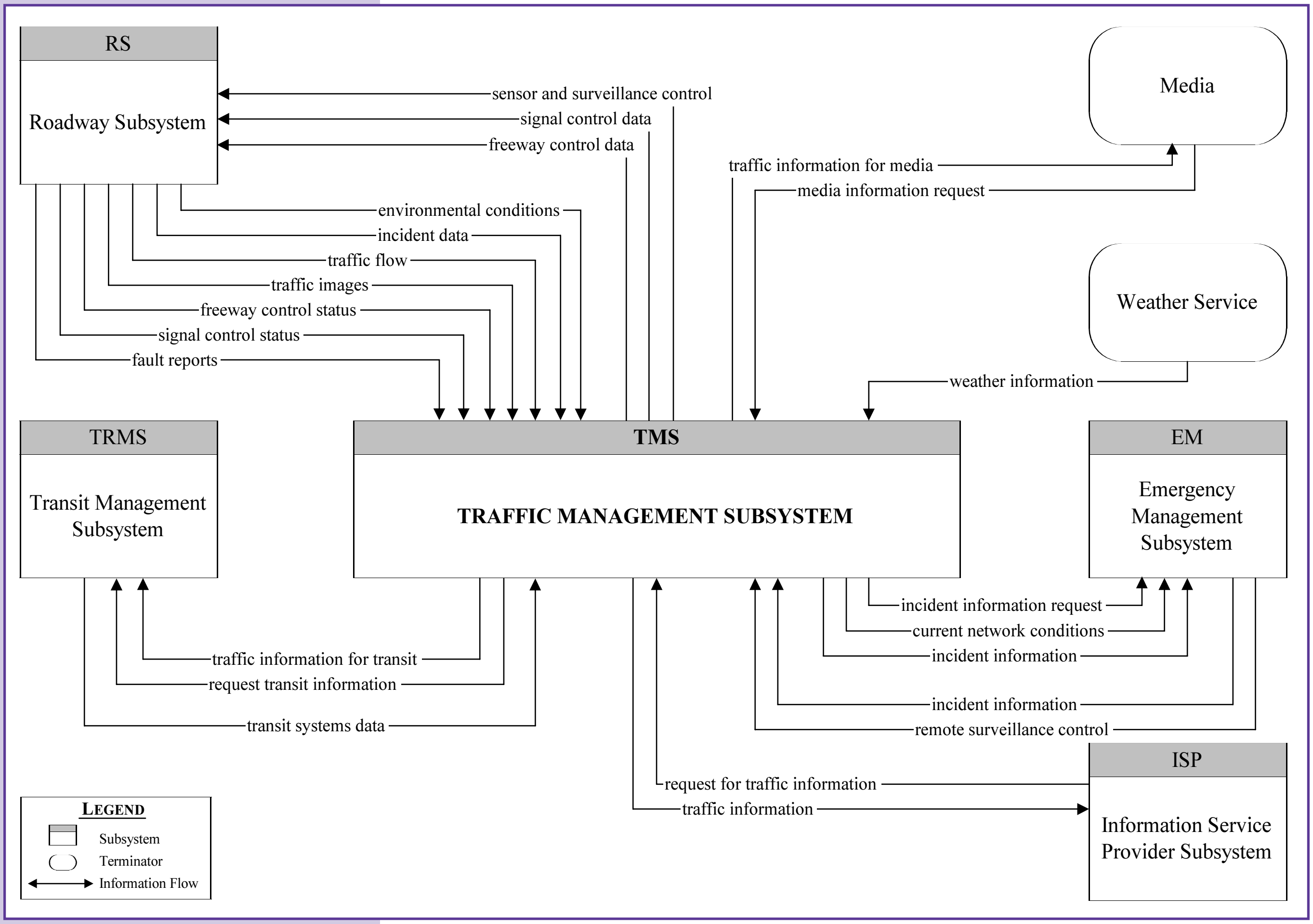


Figure 2 depicts representative information flows between Traffic Management Subsystems and the subsystems and terminators they interact with. For example, between Traffic Management Subsystems such as PennDOT or NJDOT and Transit Management Subsystems such as SEPTA, PATCO or NJ Transit, types of information that may be exchanged are transit and traffic status reports. Traffic information is given to Information Service Providers such as SmartRoute or Metro Traffic as per their requests. Incident conditions are a vital exchange between Traffic Management Subsystems and Emergency Subsystems such as state and local police departments. The Weather Service terminator, such as the National Weather Service, continually provides updated weather reports, and the Media terminator receives traffic information if it is requested. Lastly, the Roadway Subsystem sends the Traffic Management Subsystem information such as video footage (traffic images), signal control status, incident data, and, if necessary, will receive control instructions such as messages to display on variable message signs.

Table 3: Sample Traffic Management Subsystem Stakeholders

	Key Agencies
EM Emergency Management Subsystems	Delaware River and Bay Authority Police Delaware River Port Authority Police — All Bridges Local Volunteer/Professional Fire/EMS Departments Municipal Police Departments NJ State Police NJ Transit Police PA State Police Philadelphia Fire Department Philadelphia Police Department SEPTA Transit Police
RS Roadway Subsystems	Burlington County Bridge Commission DelDOT Delaware River Joint Toll Bridge Commission Delaware River Port Authority Municipal Traffic Operations Centers NJ Turnpike Authority PennDOT Philadelphia Streets Department PA Turnpike Commission South Jersey Transportation Authority
ISP Information Service Provider	Metro Traffic SmartRoute
TMS Traffic Management Subsystems	Burlington County Bridge Commission DelDOT Traffic Management Center DE River and Bay Authority Centralized Op. Center Delaware River Joint Toll Bridge Commission Delaware River Port Authority NJDOT Traffic Operations South NJ Turnpike Authority Traffic Operations Center PennDOT District 6-0 Traffic Control Center PA Turnpike Commission Communications Center Philadelphia Streets Department South Jersey Transportation Authority
TRMS Transit Management Subsystems	Amtrak NJ Transit Southern Division PATCO Center Tower SEPTA Operations Center
Media Terminators	Newspapers, Radio, TV Stations
Weather Service Terminators	National Weather Service

The Regional ITS Architecture is a "living document" that will be periodically updated to reflect changes in organizational relationships and information flows.

subsystems and terminators. The accompanying table lists organizations represented by the subsystems and terminators. The name of the data flow and its direction is indicated on the diagram. For example, the diagram shows Traffic Images (i.e., video footage) being transmitted from the Roadway System (i.e., surveillance cameras) to the Traffic Management System (i.e., a traffic operations center). In the Regional ITS Architecture, this is customized for each organization. Information flow definitions and other documentation are contained in the National ITS Architecture and the National ITS Standards.

Market Packages Market packages identify elements of the physical architecture (i.e., subsystems, terminators, and information flows) that are required to implement a particular user service. If User Services represent ITS goals, market packages indicate what ITS tools are required to implement the goals. They provide an accessible, deployment-oriented perspective to the regional architecture. Table 4 identifies those market packages that are considered high and medium regional priorities by the ITS Technical Task Force.

Table 4: High and Medium Priority Market Packages

Traffic Management
Network Surveillance (H)
Probe Surveillance (H)
Surface Street Control (H)
Freeway Control (H)
Traffic Information Dissemination (H)
Regional Traffic Control (H)
Incident Management System (H)
Traffic Forecast and Demand Management (M)
Electronic Toll Collection (H)
Virtual Traffic Management Center and Smart Probe Data (M)
Standard Railroad Grade Crossing (H)
Railroad Operations Coordination (M)
Road Weather Information System (H)

Emergency Management
Emergency Response (H)
Emergency Routing (H)
Mayday Support (H)

Traveler Information
Broadcast Traveler Information (H)
Interactive Traveler Information (H)
Autonomous Route Guidance (M)
Dynamic Route Guidance (H)
Information Service Provider Based Route Guidance (M)
Integrated Transportation Management & Route Guidance (M)
Yellow Pages and Reservation (M)
Dynamic Ridesharing (M)
In-Vehicle Signing (M)

Public Transportation
Transit Vehicle Tracking ((H)
Transit Fixed-Route Operations (H)
Demand Response Transit Operations (M)
Transit Passenger and Fare Management (H)
Transit Security (H)
Transit Maintenance (H)
Multi-modal Coordination (M)
Transit Traveler Information (H)

Commercial Vehicle Operations
Fleet Administration (M)
Freight Administration (H)
Electronic Clearance (H)
Commercial Vehicle Administrative Processes (H)
Weigh-In-Motion (H)
Roadside Commercial Vehicle Operations Safety (H)
On-board Commercial Vehicle Operations Safety (M)
Commercial Vehicle Operations Fleet Maintenance (M)
HAZMAT Management (H)

Archived Data Management
ITS Data Mart (M)
ITS Data Warehouse (M)
ITS Virtual Data Warehouse (M)

(H) High Priority
(M) Medium Priority

INCIDENT MANAGEMENT

Highway congestion is an everyday occurrence in all urban areas in the United States. Bottlenecks caused by design features (such as the Conshohocken Curve on the Schuylkill Expressway) and the inability of the roads to handle traffic demand create congestion. This type of congestion is referred to as "recurring" since it occurs regularly. Random events such as accidents, disabled vehicles, spilled loads from tractor-trailers, or other extraordinary events that reduce the capacity of a freeway are considered "non-recurring" congestion.

According to the Texas Transportation Institute, incident related delays account for almost 60 percent of total delay in the 50 largest US metropolitan areas.

Incident management provides solutions to non-recurring congestion problems through planned activities designed to reduce the impacts of incidents on traffic flow. Incident management is the process of managing multi-agency, multi-jurisdictional responses to highway traffic disruptions. Current practice recognizes incident management as a seven-step process: detection, verification, response, site management, traffic management, clearance, and recovery.

Seven Step Incident Management Process

Detection: Identification that an incident has occurred via phone calls, highway call boxes, closed circuit television cameras, service patrols, etc.

Verification: Determination of the precise location and nature of the incident.

Response: Rapid deployment of appropriate personnel and resources to the scene.

Site Management: Coordination of on-scene resources to ensure the safety of incident victims, other motorists, and response personnel.

Traffic Management: Management of resources to reduce the impact on traffic flow including directing traffic by police officers, use of cones or barriers, variable message signs, etc.

Clearance: Removal of any disabled vehicles, wreckage, debris, or spilled material from the roadway.

Recovery: Restoration of the roadway capacity to its pre-incident condition.

Prototype Incident Management Corridor

Recognizing the importance of incident management on congestion reduction and its interrelationship with ITS, a prototype incident management corridor study was conducted. As a prototype, its purpose was to ascertain whether incident management programs should be implemented in other corridors, determining the best practices in implementing such a program, and identifing the types of projects such a program would generate.

The I-76/I-476 crossroads area was selected as the prototype corridor because this area experiences some of the highest traffic volumes in the region, and it has a history of a significant number of major incidents. Because of its location at the interchange of two of the region's busiest expressways, this corridor has the potential to generate considerable impact on the regional transportation system when an incident does occur.

A crucial step in developing the prototype incident management program was to identify relevant stakeholders, since incident management involves a wide variety of organizations at different levels of government across a broad range of responsibilities. A Task Force was

Municipalities that make up the Prototype Incident Management Corridor:

- Conshohocken Borough
- Lower Merion Twp
- Plymouth Twp
- Radnor Twp
- Upper Merion Twp
- West Conshohocken Borough

formed consisting of police, fire, and emergency medical services groups from the six municipalities in the corridor; as well as the Pennsylvania State Police, PennDOT, Pennsylvania Turnpike, county 911 services, and other appropriate regional agencies.

Issues And Solutions One of the main objectives of the Task Force was to bring the disparate organizations together to discuss any problems or issues they may have concerning incident management in the corridor. This provided an opportunity to build relationships in a more casual atmosphere than normally encountered when responding to an incident. Among the topics raised were noise wall access, ramp designations, emergency detour routes, lack of a common radio frequency for communications, renumbering of Pennsylvania Turnpike interchanges, post-incident response evaluations, resource equipment list, multi-municipality signal coordination, and the use of specialized equipment. Below are two examples of issues identified by the Task Force and workable solutions that were developed to address them:

Issues raised by the Incident Management Task Force:

- Duplicate milepost numbers on I-476
- Renumbering of Pennsylvania Turnpike interchanges to coincide with mileposts
- Unsigned emergency detour routes
- Lack of a common radio frequency for communications
- Need to conduct post incident response evaluations
- Development of resource equipment list
- Shared use of specialized equipment

Noise Wall Access Noise walls provide benefits to residents and businesses adjacent to a highway by buffering the noise generated by passing vehicles. However, they also limit access for emergency personnel, forcing them to reach the scene of an incident by means of congested highways instead of from adjacent surface streets or parking lots. When I-476 was constructed, small openings were periodically placed in the noise walls for fire hoses to pass through. However, they are too small for personnel or any equipment. When PennDOT informed the Task Force of plans to construct additional noise walls within the corridor area, Task Force members indicated the need for "person doors" to allow personnel and equipment to enter the roadway. Since the noise walls were in the early stage of design, PennDOT was able to work cooperatively with Upper Merion Township to include four of these emergency access doors within the design. PennDOT has also indicated a willingness to continue to work with local townships to identify future locations for access doors.

I-76/I-476 Interchange Ramp Designations Due to the complexity of the I-76/I-476 interchange (there are 13 distinct on or off ramps), different emergency responders will be dispatched depending upon the location of the problem and the responder's ability to reach that specific ramp quickly. An emergency responder can very easily be dispatched to the wrong location if a motorist can not clearly describe to a 911 operator on which ramp the incident has occurred. On more than one occasion, emergency responders have searched different on or off ramps looking for the problem. In response to these concerns, PennDOT has installed on each ramp signs the approximate size and shape of milepost markers. They function as unique identifiers for each ramp of the I-76/I-476 interchange. The ramps have been assigned a number corresponding to the exit number ("6") and a letter designating the specific ramp. It is PennDOT's intent to use this interchange as a pilot project to determine if ramp designations should be installed at other interchanges of similar complexity.

Ramp designation marker at I-76/I-476 Interchange

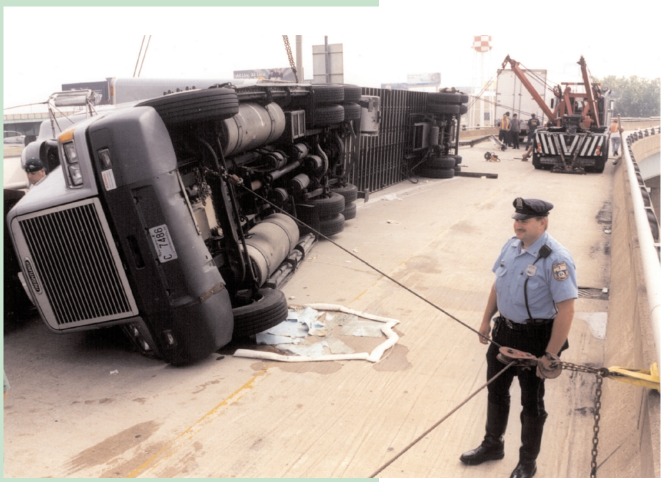
Lessons Learned The following is a list of some of the important lessons identified through this two-year effort:

Expand the Incident Management Program to Other Corridors All of the participants of the Task Force, at both the local and regional levels, indicated that this has been a very worthwhile endeavor. Foremost, it gave Task Force members an opportunity to get together and discuss mutual problems and strategies. The dynamics of this group have evolved, resulting in a certain comfort level among the members. The participants appear to be able to speak openly and frankly about issues that affect them and appreciate the helpful responses to questions that they receive from other organizations. For this reason alone, regardless of its other accomplishments, it is beneficial to expand this program to other high incident corridors.

Potential Incident Management Corridors:

- I-76 in Philadelphia
- I-95 in Philadelphia
- I-95 in Delaware County
- I-476 in Delaware County
- I-76/I-295/NJ 42 in New Jersey

Get the Right Players to the Table A key to the effectiveness of this forum was to make sure that the appropriate organizations are represented in the group so that meaningful and comprehensive discussions can be held on all topics. A concerted effort is also needed to identify those stakeholders who may not be participating, (e.g. PennDOT Maintenance, towing agencies) and encourage them to attend, not only because they are necessary to this group, but also because they will realize benefits through participation.



Tractor-trailer accident at I-95 off-ramp near Waltt Whitman Bridge

- **Get Something Done** It was important to offer Task Force members an opportunity to identify their needs in responding to incidents. As with any group, a key to keeping high levels of participation is to demonstrate that something could be accomplished to address their needs and make their jobs easier.

- **Incident Management Training** Task Force participants recognized the need for additional training that would look at the bigger picture of incident management. The federal government and many professional organizations offer programs that should be offered to Task Force participants.

- **Conduct Mock Incidents** Tabletop mock incident exercises should be used to simulate different scenarios, replicating the activities of various organizations in response to an incident without the usual chaos of an actual incident. This mechanism gives participating agencies an opportunity to explain the procedures they follow, allows for mutual critiques of these procedures, and provides an opportunity for improved coordination. In other areas of the country, these simulations have proven helpful in developing response plans and coordination processes.

- **Conduct Post-Incident Response Evaluations** Unlike a mock exercise that focuses on activities prior to an actual incident, post-incident evaluations focus on events that occurred during an actual incident. This process analyzes the activities of emergency responders and suggests improvements in agency response techniques and equipment. It should be conducted within 2-3 weeks of an incident by an impartial mediator.

LOCAL ITS CHALLENGES AND POLICIES

There are many challenges that need to be confronted to effectively deploy ITS. Some are regional in nature that cut across operating agencies and transportation modes; others are unique to specific organizations. Regions all across the country are facing similar challenges and the federal government is funding demonstration projects to develop prototype solutions. However, ITS implementation and operation ultimately must reflect local needs and institutional arrangements. Through the ITS Technical Task Force, DVRPC and other agencies have recognized these new challenges and have begun working to develop appropriate solutions. This chapter presents some of these local challenges and regional policies to address them.

ITS requires a radical departure from the way many public agencies have traditionally functioned. This has created challenges both internal to those agencies as well as to the region as a whole.

ITS Challenges

ITS requires a radical departure from the way many agencies have traditionally functioned. Instead of building roads, highway agencies now must also manage them. New relationships must be forged within organizations between the operations staff and the more tradition-bound bureaucracy, and among organizations who never had a need to speak to each other in the past. The following are some of the primary challenges facing local ITS implementors and operators. These challenges set the ground rules for which policy solutions need to be developed.

Diverse Stakeholder Interests The Greater Philadelphia area is a tri-state region with three state highway departments, eight major toll authorities, five major transit agencies, county and municipal public works departments, state and local police departments, and countless local fire and emergency medical service companies. Most of these organizations are parochial, concerned about their own facilities and not about how their operations impact transportation facilities outside their own jurisdiction. Some agencies, like police departments, consider ITS marginal to their core operations. Even among the major agencies, who share a regional perspective, their operational objectives vary widely. Under these conditions it is very difficult to formulate common goals and develop day-to-day working relationships.

From a coordination perspective, the Greater Philadelphia area is one of the most complex regions in the country:

- Three states
- Eight major toll agencies
- Five major transit agencies
- County and municipal public works departments
- State and municipal police departments

Many agencies have difficulty hiring and retaining ITS staff because the technical skills and responsibilities needed to operate and maintain ITS systems do not fall under the traditional job categories used by most public sector organizations.

Technical Abilities ITS requires basic technical skills to staff operation centers and more advanced skills to operate computer systems or to operate and maintain field equipment like sensors or variable message signs. Many public agencies have lagged in investing in information technology and therefore are not equipped to begin implementing ITS systems or the advanced communication technology required to share information. The technical skills and responsibilities needed to operate and maintain ITS systems do not fall under the traditional job descriptions used by most of the public sector organizations. Agencies have had difficulty in gaining approval for new job titles that reflect the new technical skills. Even when public agencies surmount this problem, they are finding it difficult to compete against the private sector in hiring and retaining trained technical staff. The private sector often offers substantially higher salaries and greater opportunities for advancement.

Insufficient Funding for ITS Operations Since ITS represents both an array of new technologies and a new approach to managing the transportation system, agencies have consistently struggled to find adequate funding to operate and maintain ITS systems. Federal grants have largely subsidized the deployment of ITS equipment and construction of operation centers. After the equipment is installed, operating agencies must bear the on-going operating costs. These costs not only include money for traditional "operation and maintenance" to keep the equipment up and running but also nontraditional expenses for communication lines to bring data from the field to the operations center, personnel to staff operation centers, emergency service patrols and incident management personnel. Due to the high tech nature of ITS, the costs associated with many aspects of equipment maintenance are considerable. The current challenge for many of these organizations, as well as the region, is to establish dedicated ITS funding similar to the line item funding for maintenance activities such as fixing potholes or repairing traffic signals.

"After Hours" Operations After hours operations refers to staffing operation centers and other support units during overnight and weekend periods. Most operation centers in the region function on a 24 hour, 7 day a week schedule. However, the region's two largest transportation departments do not operate their control centers and maintenance units around-the-clock. PennDOT is slowly migrating to 24 hour operations and NJDOT extends hours of operation during summer weekends and other times when they feel it is justified. During off hours when the operation centers and maintenance yards are closed, there are procedures in place to contact staff and activate services in response to emergency conditions. Unfortunately, traffic congestion and accidents occur 24 hours a day. Without around-the-clock operation centers, police departments are lacking a valuable resource that they rely upon in identifying and responding to incidents. If maintenance crews are needed to clear debris or repair damage during off hours, there could be a significant time lag in notifying personnel, having them drive to a maintenance yard to gather their equipment, and then dispatching them to the accident scene. Efficient operations depend upon speedy responses and reliability. Without after hours operations, an agency is considered an unreliable partner.

Traffic congestion and accidents occur 24 hours a day; however, many traffic operation centers are closed at night and on weekends. Without around-the-clock operation centers, police departments are losing a valuable resource that they rely upon in identifying and responding to incidents.

Integrating ITS into Project Development Many of the ITS projects that have been implemented in the region are a result of special grants targeted to implement specific ITS projects. As the federal government cuts back these special grants, the region must define the role for ITS in the mix of transportation projects competing for federal and state transportation monies. The DVRPC Board has gone on record to support inclusion of ITS components in larger projects. However, there is a trade-off between incorporating ITS components into projects, thus raising their overall project cost, versus funding a larger number of projects. Recent emphasis in the region has been on maintaining the transportation infrastructure; namely, resurfacing roads or maintaining bridges in lieu of adding new capacity to the highway system. Since ITS is effective in reducing traffic congestion without the problems associated with constructing additional highway capacity, and therefore supports regional goals, should ITS receive higher funding priority?

The DVRPC Board has gone on record to support inclusion of ITS components in larger transportation projects.

Pennsylvania is unique in that all traffic signals are owned and operated by individual municipalities. Consequently, municipalities do not coordinate the timing of their traffic signals with those of adjacent municipalities.

Transit agencies and toll authorities are accustomed to operations. They have chains of commands that clearly specify roles and responsibilities during normal operations and incident conditions, whereas highway agencies have traditionally only designed and built highways.

Inter Municipal Traffic Signal Coordination Traffic signal coordination is designed to optimize travel flow on arterials by coordinating signal timings of adjacent signals. Pennsylvania is unique in that all traffic signals are owned and operated by individual municipalities. Municipalities have not taken the initiative to coordinate the timing of their traffic signals with those of adjacent municipalities. This arrangement prevents any type of vehicle progression along arterial highways that cross municipal boundaries. However, with ITS stressing real-time traffic management, this business model is no longer acceptable. For example, if traffic is diverted from an expressway to a parallel arterial because of an incident, it is critical to have the ability to change signal timings to reflect the surge in traffic and still retain signal coordination. A new approach to operating and maintaining advanced traffic signal systems across municipal lines must be developed.

The Evolving Operations Paradigm With the tools offered by ITS, managing the region's transportation system can finally become a reality. ITS facilitates real-time monitoring of the transportation network and allocates resources to resolve problems that may arise. Certain organizations such as transit agencies or toll authorities are accustomed to operations. They have established chains of command that clearly specify roles and responsibilities during normal operations and incident conditions. Their operations centers primarily function as a command/control point, monitoring conditions and notifying line personnel who are responsible for rectifying problems. However, other organizations, specifically the highway departments, have not adequately established chains of command for operations nor have they established a centralized command post for all their services. As design and-build organizations, their corporate cultures have never had to address these organizational issues before.

Implementing Federal ITS Mandates Many of the challenges previously discussed – involving a wide variety of stakeholders, emphasising operations and management, obtaining more flexible funding, "main streaming" ITS – have manifested as a result of trying to comply with federal transportation legislation enacted over the last few years. They have also become the focus of a national debate on how to update this legislation. Past federal transportation legislation has also promulgated the concept of a National ITS Architecture and national ITS standards. The region has been very successful in developing a Regional ITS Architecture to comply with this policy and is now confronting the issue of ITS standards. When Congress adopts new transportation legislation, the region must begin developing procedures and policies to comply with the forthcoming federal mandates.

ITS Policy

Solutions to ITS challenges need to evolve over time.

Not all local ITS challenges have been addressed to date. Many issues are amenable to solutions; others need to evolve over time as new technology or institutional relationships help the region to develop a consensus. Below are some of the more significant policy recommendations developed by DVRPC and the ITS Technical Task Force.

Implement 24 X 7 Operations for Traffic Control Centers

Incidents occur on the region's transportation network at all times of the day and night. When early detection and an immediate response from a critical agency is not available, the impacts from the incident can escalate quickly and become considerably more serious in a matter of minutes. For incidents involving injuries, the first several minutes become critical to survival and recovery. When one of the key participants in this process is not available because their operations center is shut down, an extra burden is placed on the other affected operators and management of the incident suffers. The region's ITS stakeholders have repeatedly stated that if an organization has a operations center, it is imperative that it be immediately available on a 24 hour, 7 day a week basis to assist in regional incident management efforts. Therefore, traffic operation centers must operate on a 24 hour basis.

Traffic operation centers must operate on a 24 hour basis.

Travel Information Dissemination Is a Private Sector Responsibility New communication technologies and businesses offer a plethora of choices to disseminate travel information to the public. The Internet, cellular phones, wireless Internet, cable operators, in-vehicle telematics, and a host of similar technologies can offer customized personalized services

NJDOT, Cross County Connection TMA, L-3 Communications and Rutgers University have formed a partnership in a demo project to install roadway sensors that will collect congestion information and disseminate it to travelers via pagers. This photo shows sensors being installed at the intersection of I-295 and NJ 73 in Mount Laurel.

targeted to individual consumers. These services are typically operated by the private sector, which has made enormous investments in these technologies. Public agencies cannot and should not be expected to compete against them in terms of investing in consumer technology. In fact, most transportation operation centers operate with minimum staffing levels and there is little opportunity for them to disseminate information to the public. When an incident occurs, their primary responsibility is incident management and issuing general advisories. The public sector has a major role in providing travel information content to the private sector, which in turn can customize it for wider distribution over their communication channels. Development of public-private partnerships is the business model that appears to work best for this situation in the region.

Dedicate Funding for ITS Operations As the benefits of ITS technologies begin to be realized throughout the implementing agencies as well as by funding agencies, elected officials and the general public, the demand for their deployment will rise. However, those requesting these ITS projects along with those funding and deploying these projects must realize the inherent difference between ITS projects and the traditional road/bridge building projects. Once deployed, ITS technologies must be continually operated and there are on-going operating costs. Federal regulations permit the use of federal funds to pay for ITS operations and maintenance programs. Past Transportation Improvement Programs, as well as the current one, have included funding for ITS operations such as emergency service patrols and operation centers; thereby establishing a local precedent.

The federal government recognizes that in order to insure continuous operation of ITS systems, and for these systems to achieve their intended functions, costs associated with operations and maintenance are eligible for federal funding. Specifically, labor costs, administrative costs, utility costs (e.g., telecommunications), system maintenance, and replacement of defective components are all eligible for federal funding. Before the region determines how much of the operations and maintenance costs should be paid for by the operating agencies and how much should be funded by federal or state monies, the ITS Technical Task Force must make a long-range estimate of ITS costs and the potential shortfall in funding. After this determination has been made, the ITS Task Force should initiate discussions with the Regional Transportation Committee to recommend an appropriate level of operations funding. A line item for ITS in the region's Transportation Improvement Program is a possible mechanism to insure continuing and adequate funding.

The federal government insures continuous operation of ITS systems by allowing associated costs to be eligible for federal funding.

Integrate ITS into Transportation Improvement Program Projects The region's primary transportation infrastructure needs are identified in the DVRPC Long Range Plan. As specific projects evolve from those needs, they are ultimately programmed for funding on the Transportation Improvement Program. Integrating ITS into the project development process involves formally embodying ITS into the Long Range Plan, and then incorporating the appropriate ITS components into Transportation Improvement Program projects as they proceed into the preliminary engineering and design processes. Reviewing plans and project need statements for ITS opportunities will not only help with the deployment of ITS in the region, but also enhance the benefits of individual projects. The current practice of implementing ITS components on a piecemeal basis undermines the effectiveness of ITS programs. While this policy may increase current project costs and may require longer completion times, in the long run it will be less costly to install ITS equipment as part of a project than to retro-fit installation years later. The region's Transportation Improvement Program and Long Range Plan should be evaluated periodically along with the regional ITS deployment plan to identify projects that should include ITS components.

ITS should be incorporated into the region's Long Range Transportation Plan.

Individual projects on the Transportation Improvement Program should be reviewed for ITS opportunities.

PRIMIS

The number one regional ITS priority is to establish a mechanism for operation center-to-operation center information sharing and coordination. In response to this need, the ITS Technical Task Force developed the concept of PRIMIS. PRIMIS represents a framework for the region's ITS stakeholders to share and disseminate information on travel conditions and coordinate responses to incidents and other unusual conditions. Because the ITS Technical Task Force determined it would be premature to

Philadelphia
Regional
Integrated
Multi-Modal
Information
Sharing

implement a high-tech information sharing system when many agencies are still struggling to develop and implement ITS programs, and the ultimate cost for such a system could easily exceed $20 million, it was agreed that PRIMIS should be phased over an 8-10 year period.

Phase I of PRIMIS is a low-tech, non-capital intensive approach at improving relationships among ITS shareholders. It will create an information exchange network targeted to agencies in the greater Philadelphia area.

PRIMIS I (years 0-2): The first phase of PRIMIS is envisioned as low-tech, non-capital intensive approach to building relationships among stakeholders, which is necessary for effective coordination. It represents an improvement from existing conditions by placing greater emphasis on interagency contacts and building technical expertise. Ultimately, the stakeholders will begin developing a concept of operations for Phase II and commence design and acquisition. With $400,000 per year funding from the region's Transportation Improvement Program, this phase of PRIMIS is currently underway.

Phase II of PRIMIS focuses on incident notification and emergency response coordination.

PRIMIS II (years 3-7): This phase of PRIMIS represents a modest high-tech approach to information sharing and operational coordination. As a no frills system, costing approximately $3 million, it focuses almost exclusively on incident notification and emergency response coordination. It involves 29 agencies that deal with traffic and transit operations, emergency management, and traveler information, with ten of the agencies having the highest implementation priority. It is anticipated the communication component of PRIMIS II will rely upon the I-95 Corridor Coalition's Information Exchange Network. The I-95 Corridor Coalition, a group of 25 state departments of transportation and toll organizations between Virginia and Maine, has a wide area network to share travel and incident information among the cooperating agencies. It is envisioned PRIMIS II will extend the coverage for the Delaware Valley portion of the corridor by creating a more detailed local highway and transit network. Incident data will be entered into the information exchange network via workstations located at agency operation centers. PRIMIS II will place workstations at agencies, such as New Jersey Transit and SEPTA, that are not currently part of the I-95 Corridor Coalition Information Exchange Network.

PRIMIS III (years 5+): This phase of PRIMIS represents an enhancement of PRIMIS II by incorporating an interactive database and graphical user interface to view congestion levels, incident information, and live video feeds from cooperating agencies. In terms of the magnitude of information and how it is stored and displayed, this is a costly investment. Translation software at each agency's workstation will merge individual databases into the regional database. By "warehousing" the database, users will be able to access information on every highway segment or transit route stored in the system. With a graphical user interface, travel speeds will be depicted by different colors on a map; symbols will indicate accident locations, maintenance activities, or warning messages posted on variable message signs. PRIMIS III clearly offers a superior system for information sharing and coordination. Development of the regional database and translation software, coupled with the need to provide high-speed broad band video, pushes the implementation cost in excess of $20 million. The annual operating and maintenance cost to continually upgrade and operate the system is approximately $7 million per year.

Phase III of PRIMIS is envisioned to incorporate an interactive database with a graphical user interface to view congestion levels, incident information, and live video feeds.

Programed and Planned ITS Deployments

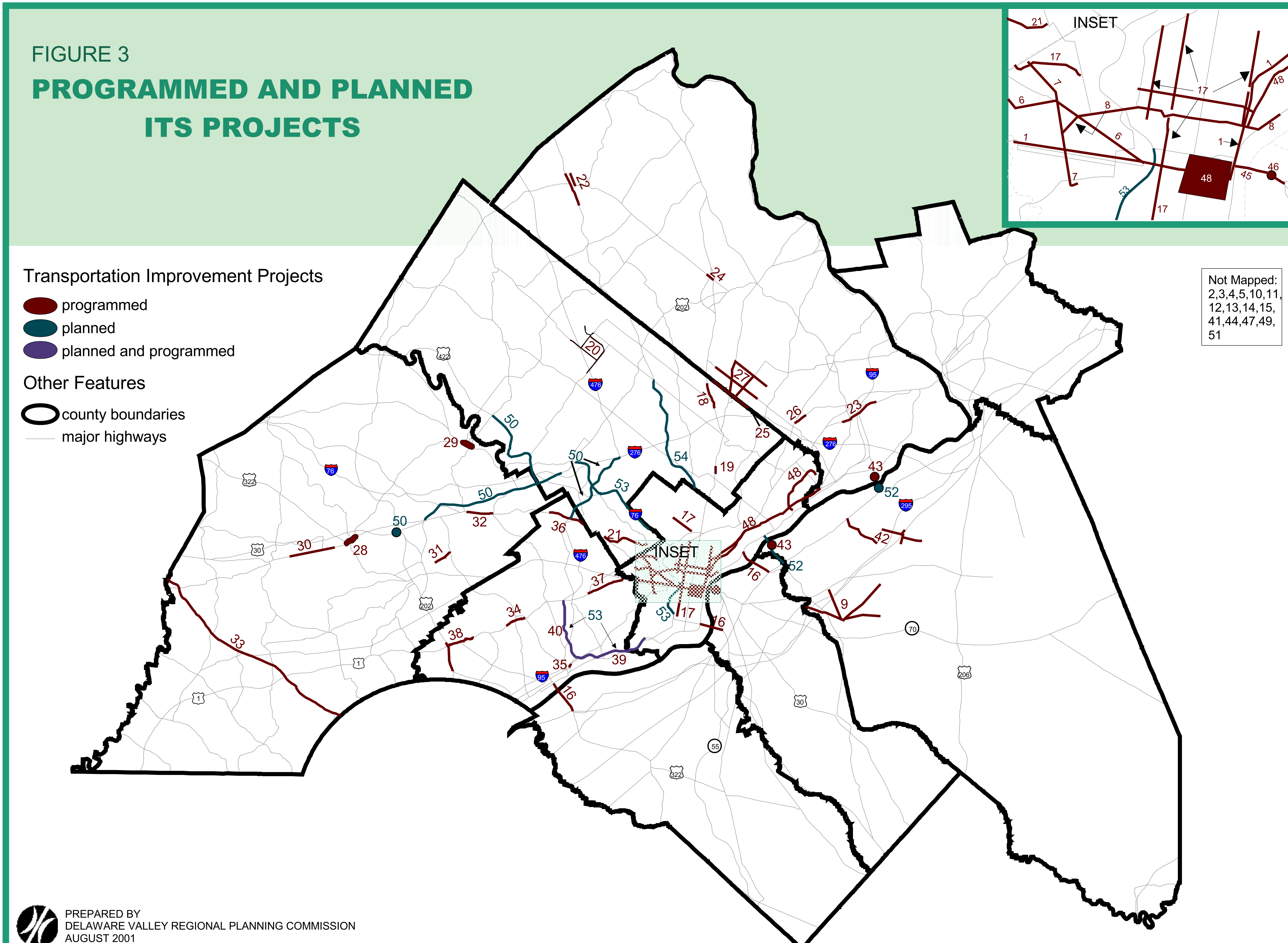
Many agencies have plans for ITS deployments. This section will highlight some of the more significant projects that are either listed in the region's Transportation Improvement Program or identified by the agencies as their next priorities.

Many agencies have identified, planned, and programmed ITS deployment projects to be implemented in the next few years.

The following table lists those projects in the region that are either programmed or planned. Programmed projects are ones that either have been listed on the regional Transportation Improvement Program or an agency's capital improvement program. Planned projects are those that are not yet on the Transportation Improvement Program but have been identified by a sponsoring agency as its next priority. A highway may have both programmed and planned projects. With the exception of those projects that are not location specific, all projects listed on Table 5 are displayed in Figure 3 with corresponding identification number. Sponsoring agencies are listed in the table along with the project's name if it has been identified in the Transportation Improvement Program or by the sponsoring agency. The Transportation Improvement Program number, if applicable, is also listed. The last column in the table lists the major projects ITS elements.

FIGURE 3

PROGRAMMED AND PLANNED ITS PROJECTS



PREPARED BY
DELAWARE VALLEY REGIONAL PLANNING COMMISSION
AUGUST 2001

Table 5: PROGRAMMED & PLANNED ITS PROJECTS

ID#	TIP #	Sponsor	Project Name	Location	Type of Improvement
PROGRAMMED ITS PROJECTS					
1	S055	SEPTA	Market-Frankford Automatic Train Control	Philadelphia City and Upper Darby Twp, Market-Frankford Subway-Elevated Line	Automatic Train Control Signal System
2	S081	SEPTA	Surface Communications System With Automatic Vehicle Locator	Systemwide	Computer Aided Radio Dispatch System, Automatic Vehicle Locator System
3	S087	SEPTA	Fare Collection System Upgrade	Systemwide	Automatic Fare Collection System
4	S101	SEPTA	Intelligent Systemwide Communications Improvements	Systemwide	Centralized Communications Control Center
5	T691	NJ Transit	IS/Technology	Systemwide	Passenger Communication and Fare Collection Systems
6	9794	SEPTA	Route 10 Light Rail Transit First	SEPTA Light Rail Route 10	Transit Vehicle Signal Progression and Preemption, Roadway Detectors
7	9795	SEPTA	Route 52 Transit First	SEPTA Bus Route 52	Transit Vehicle Signal Coordination and Priority
8	9796	SEPTA	Girard Avenue Light Rail	SEPTA Route 15	Transit Vehicle Signal Coordination and Preemption, Roadway Detectors
9	D9911	Burlington Co	Burlington Co Computerized Signal Control, Phase IV	Church Rd (CR 616), Church St (CR 607), Mt Laurel Rd (CR 674)	Closed Loop Traffic Signal System
10	X181	NJDOT	Emergency Service Patrol	NJ State Highways	Incident Management Program
11	X120	NJDOT	Emergency Response Operations	Statewide	Emergency Response Operations
12	X235	NJDOT	Statewide Operations Center	NJ State Highways	Incident Response and Traffic Management
13	X66	NJDOT	Traffic Monitoring Systems	Statewide	Weigh-in-Motion, Speed Detection
14	X230	NJDOT	Statewide Incident Management Program	Statewide	NJDOT Incident Response Team, State Police Traffic Incident Management Unit
15	X159	NJDOT	Truck Weigh Stations	Statewide	Weigh-in-Motion
16	0572	DRPA	Smart Bridges	DRPA Bridges	ITS Applications Integration
17	9797	Philadelphia	Arterial Interconnect 99 #2	22nd St, 29th St, C.B. Moore Ave, Mascher St, Wayne Ave, Wynnefield Ave	Closed Loop Traffic Signal System
18	8811	Montgomery Co	PA 611 Closed Loop Signal System	Horsham Twp: PA 611 from Blair Mill Rd to Maple Ave	Closed Loop Traffic Signal System
19	8812	Montgomery Co	PA 611 Closed Loop Signal System	Jenkintown Boro: PA 611 from Washington Ln to Rydal Rd/Clovery Ave	Closed Loop Traffic Signal System
20	8772	Towamencin Twp	Towamencin Signal System Interconnection	PA 63, PA 463, PA 363, Sumneytown Pike, Allentown Rd	Closed Loop Traffic Signal System
21	8773	Lower Merion Twp		Montgomery Ave from US 1 (City Ave) to Grays Ln	Closed Loop Traffic Signal System
22	5760	Bucks Co	Quakertown Joint Closed Loop	Quakertown Boro, Richland Twp: Rt 309, California Rd, Main St	Closed Loop Traffic Signal System
23	5726	Bucks Co		Middletown Twp: US 1, Business from Hulmeville Rd to Oxford Valley Rd	Closed Loop Traffic Signal System
24	5762	Bucks Co		Doylestown, Buckingham, Plumstead Twp, Doylestown Boro: Route 313 from Sawmill Rd to E. Court St	Closed Loop Traffic Signal System
25	5764	Bucks Co		Warminster, Horsham, Hatboro, Upper Moreland: County Line Rd from Delmont Ave to Davisville Rd	Closed Loop Traffic Signal System
26	5765	Bucks Co		Lower Southampton Twp: Bridgetown Pike from Buck Rd to Old Bristol Rd	Closed Loop Traffic Signal System
27	5766	Bucks Co		Warminster Twp: Street Rd, Bristol Rd, York Rd, Jacksonville Rd	Closed Loop Traffic Signal System
28	6911	Chester Co		Downingtown Boro: US 30, PA 113, US 322	Closed Loop Traffic Signal System
29	6912	Chester Co		Phoenixville Boro: PA 23, PA 29, PA 113	Closed Loop Traffic Signal System
30	6942	Chester Co		Caln Twp: Rt 30 Business	Closed Loop Traffic Signal System
31	6943	Chester Co		East Goshen Twp: Paoli Pike from Airport Rd to North Chester Rd (PA 352)	Closed Loop Traffic Signal System
32	6945	Chester Co	Route 30 Closed Loop Traffic Technology	Willistown Twp, Tredyffrin Twp: US 30 from Woodview Dr and PA 252	Closed Loop Traffic Signal System
33	6963	PennDOT	PA 41 ITS Enforcement Initiative	Chester and Lancaster Counties: PA41 from Delaware State Line to US 30	Roadway Detectors and Monitoring
34	7882	Delaware Co		Middletown Twp: US1, Baltimore Pike from Valley Rd to Granite Run Mall	Closed Loop Traffic Signal System
35	7885	Delaware Co		Chester City: US 13 from Morton Ave/12th St to 9th St/Clover Ln	Closed Loop Traffic Signal System
36	7889	Delaware Co		Radnor Twp: US 30, Lancaster Ave from Wayne Ave to Lowry's Ln	Closed Loop Traffic Signal System
37	7909	Delaware Co		Upper Darby Twp: State Rd from Rt 3, Chester Pike to US 1, Twp Line Rd	Closed Loop Traffic Signal System
38	7914	Delaware Co	Concord Twp Closed Loop System	Concord Twp: Rt 1 from US 202 to Cheyney Rd (SR 4015), Rt 202 from State Farm Dr to Naaman's Creek Rd (SR 0491)	Closed Loop Traffic Signal System
39	7900	Delaware Co	I-95 ITS	Tinicum Twp, Ridley Twp, Ridley Park Boro: I-95	Variable Message Signs, Closed Circuit TV Cameras, Vehicle Detectors
40	7901	Delaware Co	I-476 ITS	Marple, Springfield, Nether Providence, Ridley Twps: I-476	Variable Message Signs, Closed Circuit TV Cameras, Vehicle Detectors
41	8746	PennDOT	Pottstown Area Signal System Upgrade	Pottstown Boro, N Coventry Twp	Closed Loop Traffic Signal System
42	9801	Burlington Co	Burlington Co Computerized Signal Control, Phase III	Willingboro Twp: CR 626; Westampton Twp: CR 630, CR 637	Closed Loop Traffic Signal System
43	B	BCBC		Burlington-Bristol Bridge and Tacony-Palmyra Bridge Toll Plazas	E-ZPass
44	A	DRBA		Delaware Memorial Bridge	CCTV Cameras, Closed Loop Traffic Signal System, E-ZPass, Emergency Call Boxes
45	B	DRPA		Ben Franklin Bridge	CCTV Cameras
46	B	DRPA	Traffic Operations Center	Camden, NJ	Develop Centralized Control Center to Monitor Traffic Flow and Perform Incident Detection and Response Functions on All DRPA Bridges
47	B	NJTA	Travel Information Website		Develop Website to Display Real Time Traffic Conditions
48	various	Philadelphia		Academy Rd, Center City NE/SE Quadrants, Frankford Ave	Closed Loop Traffic Signal Systems
49	0594	Del Valley Region	ITS Institutional Coordination (PRIMIS)	Regionwide	Regional Interagency Coordination
50	8382	PennDOT	US 202 Section 400 Project	US 202, I-76, I-476, PA 422, US 30	CCTV Cameras, Variable Message Signs, Vehicle Detection System
PLANNED ITS PROJECTS					
51	Not Applicable	NJDOT	Freeway Traffic Management System	I-295, NJ55, I-76, NJ 42	Variable Message Signs, CCTV
52		BCBC	Traffic Management System	Burlington-Bristol and Tacony-Palmyra Bridges	CCTV Cameras, Variable Message Signs
53		PennDOT	Freeway Traffic Management System	I-76, I-95, I-476	Variable Message Signs, Closed Circuit TV Cameras, Vehicle Detectors
54		PennDOT	PA 309 Reconstruction Project	PA 309	CCTV Cameras, Variable Message Signs, Vehicle Detection System

A: Projects not included on the TIP and outside of the region, B: Projects not included on the TIP and funded by responsible agency

PUBLICATION ABSTRACT

Title of Report:	**Overview of Institutional Coordination of Intelligent Transportation Systems (ITS) in the Delaware Valley**
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Abstract:

This report presents an overview of a multi-year effort to coordinate and plan ITS deployment in the Delaware Valley. It shows why ITS is needed, gives examples of existing ITS programs, and describes some of the benefits that ITS could provide to this region. Major elements of the ITS coordinating effort are described, including development of the Regional ITS Architecture, incident management programs, and local ITS challenges and policies.

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