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Multiple Approaches to Real Time Route Information

FINAL REPORT

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Submitted by

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16. Abstract

The objective of this project is to design high-level Advanced Traveler Information System (ATIS) architecture geared towards utilizing the existing transportation infrastructure and resources available in New Jersey. This investigation utilized the National ITS System Architecture (NSA) to develop a statewide standard for collecting, processing, and disseminating traffic and transportation information. The information required to create these high-level system architecture diagrams was obtained from a series of surveys and interviews of the major public and private transportation agencies in New Jersey, such as the New Jersey Department of Transportation (NJDOT), TRANSCOM (Transportation Department Coordinating Committee), and the New Jersey Turnpike Authority. The results were incorporated into an agency resource database, which provided a concise, detailed description of each agency assets. Analysis of this database revealed the existing capabilities of each agency, which was used to generate the high-level system architecture. Next, Traveler Information Service Scenarios were generated based on the developed Architecture to determine the effectiveness of the architecture in realistic situations, the role that NJDOT should play in these cases, and future needs of NJDOT in terms of collection, processing, and dissemination. Finally, based on the analysis results, NJDOT was given recommendations on its role in ATIS in New Jersey, both from a financial and operational perspective.

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EXECUTIVE SUMMARY

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INTRODUCTION

Today, the landscape of the United States is sown with combinations of steel, asphalt, and concrete, which compose the national transportation system. Highways and railways serve as the medium for travelers to access all regions of this country, from the barren Badlands of South Dakota to well-developed areas such as New York City. However, traveling on these roads is not always as peaceful or serene as the destinations they reach. Over time, drivers have been plagued by congestion, accidents, and other transportation related incidents that increase travel times, stress levels, overall travel costs, and may sometimes even cost lives. Commuters who work in New York often find themselves leaving several hours early in order to ensure on time arrival. A recent study conducted by the USDOT Bureau of Statistics showed that the average daily person-hours of delay in 1994 for the New York Metropolitan area was 2,162,000 hours, compared to 1,310,000 hours in 1982. This statistic simply states that the delay experienced by citizens of this region is exorbitant. Also, the economic impact of this statistic is outrageous as well. In the same study, it was found that the congestion cost per capita exceeded $500, in the same region. Congestion costs per capita reflects the amount of money lost by each individual per year due to congestion, either by delay, damage to the roadway, or other factors.(1)

Traveling on U.S. roads not only means monetary setbacks, but also the possibility of being involved in accidents, fatal or otherwise. Other studies conducted by the U.S. Transportation Bureau of Statistics have shown a slow, steady increase in national transportation fatalities since 1992, as exhibited in the following graph. These fatalities can be attributed to accidents caused by poor weather conditions, driver error, DWI or numerous other catalysts.

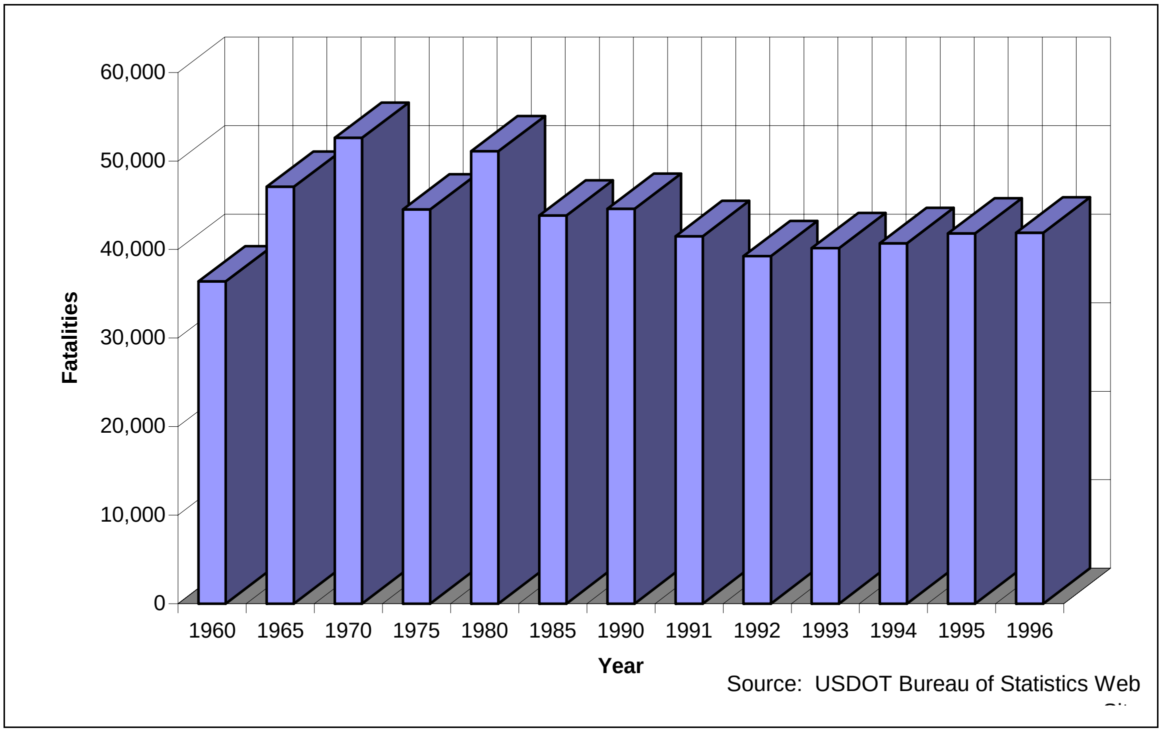

Figure 1. Total National Highway Transportation Fatalities in the United States [1]

Table 1, developed by the NJDOT and published on its web site, documents the number of reported accidents in New Jersey. Again, a steady increase in reported accidents can be seen since 1992. It is important to note that a large difference exists between the actual number of accidents in New Jersey and the reported number of accidents due to the fact that all motorists are not willing to involve local or state police authorities, and would rather settle the dispute between the parties involved in the accident. Another point to remember is that the NJDOT only counts accidents that total more than $500 in damages on record. The total worth of these accidents easily exceeds several million dollars, and the total number of person-hours of delay specifically due to these accidents is also in the million-hour range. A sharp increase in accidents is evident between 1996 and 1997, which can be attributed to the increasing population of New Jersey, particular in northern and central New Jersey. Interpolation of the data shows that the estimated 280,000 accidents for 1998 are actually quite conservative; rather, the total number of accidents may well number over 290,000.

Table 1. Number of Accidents Reported to the NJDOT [2]

Year	Number of Accidents Received by NJDOT from Police Agencies
1988	319,073
1989	302,762
1990	272,277
1991	245,098
1992	245,870
1993	246,434
1994	259,689
1995	252,713
1996	260,290
1997	275,323
1998	EST. 280,000

Statistics such as these cause concerns about the safety of the state's transportation system. Table 1 presents statistics that cover only highway accidents involving cars, buses, and trucks. Accident rates for trains and boats are not quite as large, due to the fact that these vehicles are not as abundant, but are significant enough to cause worry as well. To deal with these issues, federal government agencies, specifically the USDOT and the Federal Highway Administration (FHWA), have developed the Intelligent Transportation System (ITS) program. The National ITS System Architecture (NSA), the backbone of the ITS program, is designed to alleviate the transportation dilemmas facing the U.S. Within the NSA lies the Advanced Traveler Information System (ATIS) subsystem, which is a system designed to alleviate traffic congestion, and help reduce the number of accidents and fatalities on domestic roads and highways. [3]

The data presented here illustrate the present transportation problems in New Jersey and the surrounding regions. The data can be grouped into several operational fields, such as freeway management and incident management. Congestion, and the resulting delay and confusion created, is a consequence of traffic demand exceeding the capacity of the transportation system at specific points. An efficient freeway management system, such as an ATIS, can reduce the amount of congestion using several means, such as freeway metering and alternate route guidance. Additionally, an ATIS can inform travelers of hazardous conditions, and thereby reduce crash risk and the number of accidents. An ATIS can also be used as an incident management system. Accidents cannot be completely prevented, but the resulting delay caused by accidents can be reduced drastically with an efficient incident management program. Finally, the NJDOT, and various other transportation agencies such as the New Jersey Turnpike Authority (NJTPK), and the New Jersey Parkway Authority have already gathered large quantities of traffic data from equipment in the field. Unfortunately, this data is used primarily for statistical analysis, rather than being implemented into a well-defined plan. However, this data is not stored in a central location and not disseminated in an efficient manner. For example, the NJTPK already gathers real-time data concerning travel times along particular segments of the turnpike, but yet, this data is not released to the public.(2) A statewide Advanced Traveler Information System can address these issues effectively.

Table 2. Current ATIS Services

TYPE OF INFORMATION	SOURCE OF INFORMATION	DISSEMINATION MEDIUM
TRAVEL CONDITIONS		
Weather Conditions and Advisories	Observations, Weather Stations, Roadway Sensors	Traffic Maps & Text on Internet, HAR, VMS, Radio, Television
Travel Times	Roadway Sensors	Traffic Maps, Text, & Real-Time Video on Internet
Congestion	Roadway Sensors, Observations	Traffic Maps, Text, & Real-Time Video on Internet, HAR, VMS, Radio, Television
ROAD WORK		
Location of Construction Sites	State DOT Work Schedule	Traffic Maps & Text on Internet, HAR
Lane Closings/Detours	State DOT Work Schedule	Traffic Maps & Text on Internet, HAR, VMS, Radio, Television
INCIDENT INFORMATION		
Incident Location	Roadway Sensors, CCTV, Observation	Traffic Maps & Text on Internet, HAR, Radio, Television
Delay Caused by Incident	Roadway Administrator (i.e. DOT, Authority)	Traffic Maps & Text on Internet, HAR, VMS, Radio, Television
Alternate Routes	Roadway Administrator (i.e. DOT, Authority)	Traffic Maps & Text on Internet, HAR, VMS, Radio, Television
TRANSIT INFORMATION		
Schedules	Transit Authority	Route Maps & Text on Internet, Radio, Television
Delay	Transit Authority	Route Maps & Text on Internet, Radio, Television

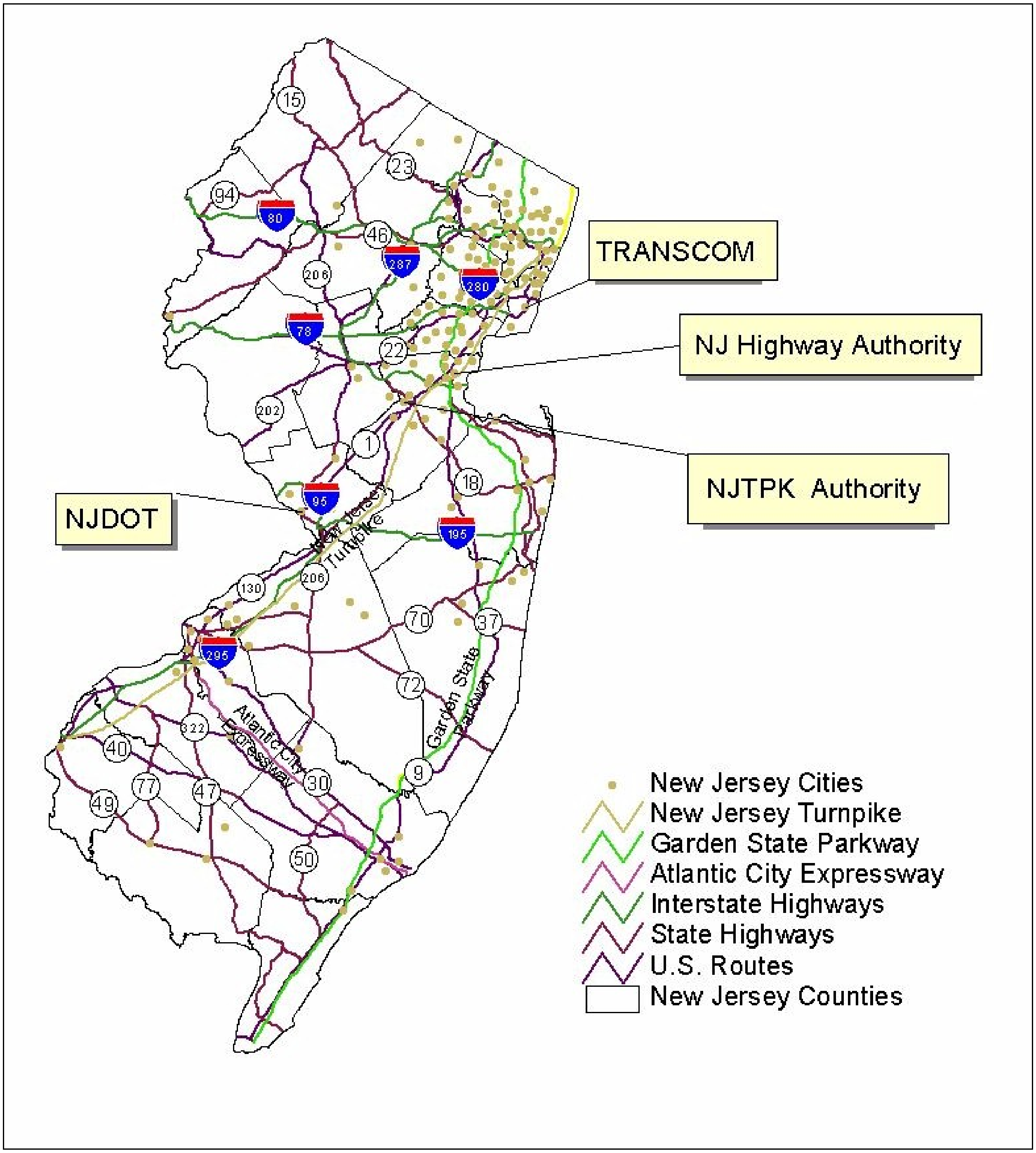

Figure 2. State of New Jersey Transportation System

ADVANCED TRAVELER INFORMATION SYSTEMS

This section is intended to satisfy the requirements of Task #1, as described in the proposal for "**MULTIPLE APPROACHES TO REAL TIME ROUTE INFORMATION**". In this task, we review the existing literature regarding Advanced Traveler Information Systems (ATIS), existing implementations of ATIS systems, and a discussion of existing traveler information providers in New Jersey.

Background

Initial studies concerning Traveler Information Systems (TIS) show they offer significant benefits to all travelers. As depicted in Table 3, a TIS reduces crash risk, travel times, fatalities, delays, emissions, and increases customer satisfaction (USDOT, 1998a)(3). This study was conducted using simulation software on major highways in the States, in both urban and rural areas. These reductions will enhance the national transportation system by making the system safer, quicker, and reliable. Also, it will provide monetary relief by reducing the annual congestion cost per capita in individual regions.

Table 3. Summary of Traveler Information System (TIS) Benefits (3)

Crash Risk	Decreased driver stress, Predicted reduction: 4% to 10%
Fatalities	Decreased with fast EMS response using GPS fix and route guidance
Travel Time	Decreased by 4% to 20%, more in severe congestion
Throughput	Simulations show 10% increase resulting from real-time traffic information receivers in 30% of vehicles
Delay	Savings up to 1,900 v-h peak hour, up to 300,000 v-h annually
Emissions Estimates	Decreased HC emissions by 16% - 25%
Customer Satisfaction	Less Stress Perceived; Wireless comm. To emergency center yields perception of heightened security from 70% to 95%

A Traveler Information System serves many functions. Effective TIS can provide multi-modal trip planning, route guidance, and advisory functions for travelers and drivers of all types (car, train, bus, etc.). Trip planning assistance is provided pre-trip or en-route. Pre-trip planning provides travelers with roadway information, including road condition, traffic information and travel times, as well as transit information which can be used to select route, mode, and departure time. This support can be accessed from home, the workplace, park and ride facilities, transit stations, and many other locations. En route-traveler information provides travelers with roadway and transit information while traveling, including traffic information, roadway conditions, transit information, route guidance information, and other supplementary information including travel conditions, special events, and parking (USDOT 1998a)[3].

Several TIS systems are currently operational in the United States. The Georgia NAVIGATOR, the traveler information system for the city of Atlanta, was designed to reduce congestion caused by the 1996 Olympic Games. The system proved to be very beneficial, as evidenced by the positive coverage it received from the press and the members of the athletic community (GDOT, 1998)[4]. TIS systems are currently in place in regions such as Houston, San Antonio, Minnesota, Boston, and Los Angeles. These systems not only have helped reduce congestion, but have increased customer satisfaction. Prior to the installation of a TIS, these areas experienced similar problems to those in New Jersey. Accident rates in these states were high, as were the person-hours of delay. After these systems were installed, statistics for these two categories dropped, and the overall transportation system performed much more efficiently.

Traveler Information Providers

The driving force behind a successful ATIS is information. In order for travelers to trust any ATIS system, it must disseminate accurate, reliable, and timely information. The most important question from the traveler is simply, “Where does the information come from?” Currently, there are several locations from which traveler information is collected, stored, analyzed, or disseminated. These sites can be divided into four categories: state agencies/organizations, regional organizations, transportation management associations (TMAs), and private agencies. Each of these agencies can play a role in the deployment of an ATIS system in New Jersey.

Table 4. New Jersey Traveler Information Providers

State Agencies and Organizations	Regional Organizations	Transportation Management Associations	Private Agencies
New Jersey Highway Authority	TRANSCOM	Cross County Connection	Metro Traffic
New Jersey State Police	South Jersey Transportation Planning Organization	Hudson TMA	Etak, Inc.
N.J. Turnpike Authority	New Jersey Transportation Planning Authority	Keep Middlesex Moving	Smart Route Systems, Inc.
NJDOT	I-95 Corridor Coalition	Meadowlink	MetroCommute
NJ TRANSIT		Morris County Rides	Shadow Traffic
New York State Thruway Authority		Transit Plus of Essex & Union	ARCINC, Inc. (TravTips)
Port Authority of New York and New Jersey		Hunterdon Area Rural Transit	
South Jersey Transportation Authority		Ridewise of Raritan Valley	

The state and government agencies/organizations listed in the chart represent the major players in the policy and development area of the state's transportation system. In order to install an ATIS, each of these organization should be involved, since they can provide funding, information, and guidance. The regional organizations can also be held in similar regard. TRANSCOM is the region's primary transportation consortium that includes the New York State Department of Transportation, the Connecticut Department of Transportation, Metropolitan Transportation Authority, MTA Bridges & Tunnels, New Jersey Department of Transportation, New Jersey Highway Authority, New Jersey Transit Corporation, New Jersey Turnpike Authority, New York City Department of Transportation, New York State Police, New York State Thruway Authority, Port Authority of New York and New Jersey, Port Authority Trans-Hudson Corporation, and

Palisades Interstate Park Commission. Located in Jersey City, New Jersey, TRANSCOM is administratively and legally a unit of its host agency, the Port Authority of New York and New Jersey, though it is governed, funded and staffed by all of its member agencies. TRANSCOM's Operations Information Center (OIC) is open 24 hours a day, seven days a week. It shares incident, construction and special event information simultaneously and selectively among over one hundred highway, transit, police agencies, and media traffic services, by phone, fax and alphanumeric pager. It also maintains a shared database of its member agencies' construction projects. It is quite evident that TRANSCOM, and other regional organizations, can provide large amounts of information viable for ATIS. Transportation management associations are responsible for improving local transportation systems. For example, the Cross County Connection (CCM) works to improve transportation in South Jersey encompassing Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, and Salem counties. CCM promotes car/vanpooling, public transportation, biking and walking as well as telecommuting and alternative work schedules. Instead of addressing the individual traveler, CCM approaches employers and asks them to promote alternative transportation solutions to their employees. Finally, and possibly foremost, are the private agencies. These agencies already have TIS services available to travelers via the internet for the New Jersey and the surrounding regions. At the moment, users can access this information, without a service charge, and find incidents, construction delays, or congestion along any travel route. Figure 3 illustrates the coverage area for four of these services, Etak, Inc., TravTips, Smart Route Systems, Inc., and MetroCommute. The small pictures below the large map show the coverage as seen on the respective company’s internet site. As seen in the diagram, Smart Route only provides traveler information for the Philadelphia area. However, this company plans on introducing a site for the New York/New Jersey region in the near future. The two other companies on the list, Metro Traffic and Shadow Traffic, do not have web sites, but still provide traveler information via telephone, email, or by providing the mass media (radio, television) with the appropriate information.

All of these organizations can be sources of information for an ATIS system in New Jersey, or can simply benefit from the existence of an ATIS system. During the development of an ATIS in New Jersey, these companies should be contacted.

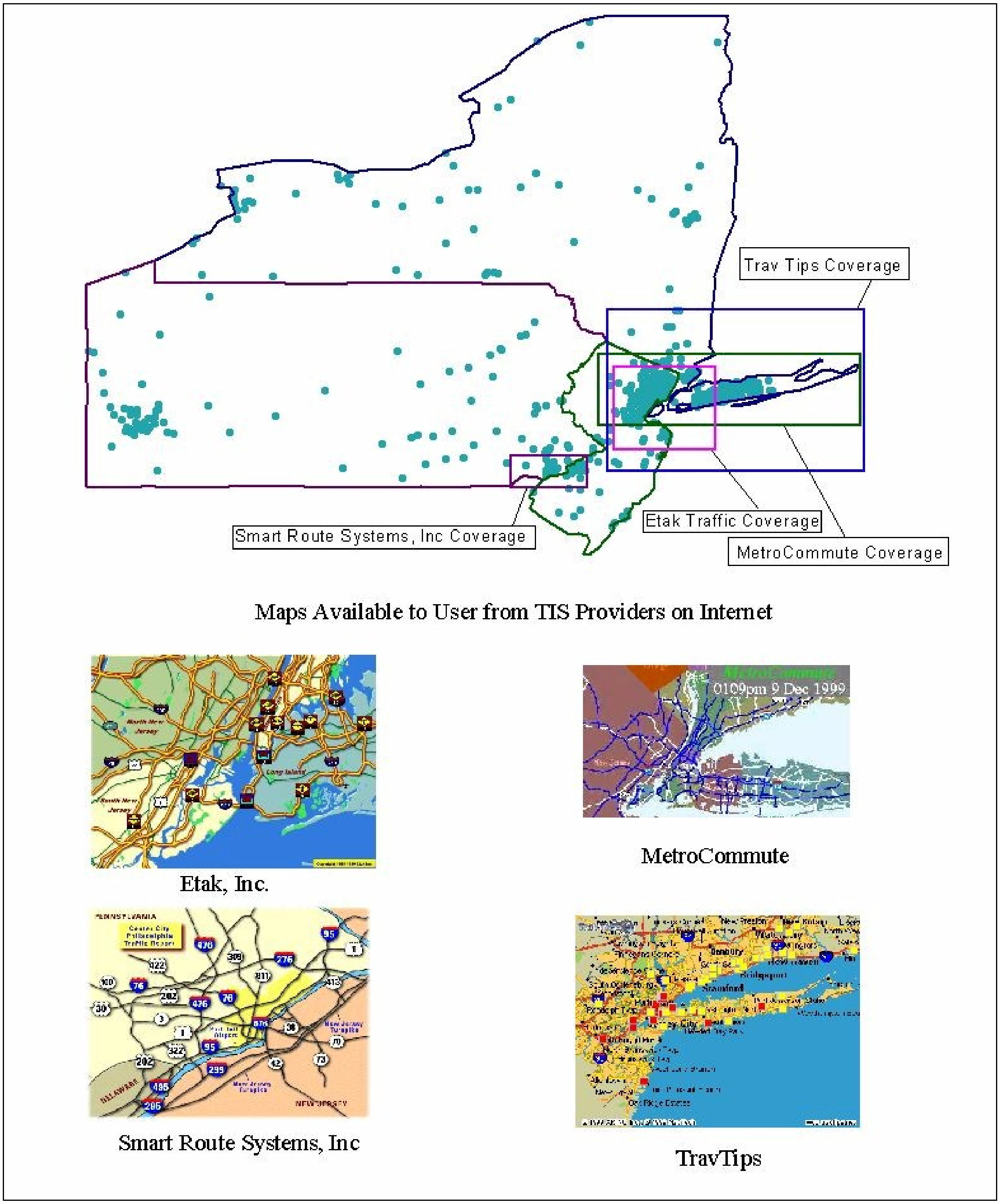

Figure 3. Coverage Area for TIS Providers Via Internet

(Source: www.smartroute.com, www.travtips.com, www.metrocommute.com, www.etak.com)

The I-95 Corridor Coalition

The I-95 Corridor plays a significant role in New Jersey's transportation system. I-95 connects five of the twenty most congested cities in the United States. The corridor's eight major metropolitan areas account for 524 million daily vehicle miles of travel. Since the corridor cuts through the heart of New Jersey, much of the traffic it produces affects New Jersey residents. Hence, when considering ATIS implementation within this state, the present status of the I-95 corridor must be examined.

The I-95 Corridor Coalition has conducted numerous studies pertaining to ATIS implementation. Results of several of these studies are pertinent, specifically surveillance requirement/technology, user needs and marketability, and traveler information services.

The first study identifies the primary goals of the corridor-wide surveillance system, and the technology needed to fulfill these goals (www.i95coalition.com). As discussed previously, an integral requirement for a successful ATIS system is timely and accurate traveler information. Only careful surveillance of a transportation network can provide this type of information. The corridor's surveillance system goals, obtained from a survey of the corridor's member agencies, are summarized in Table 5.

Table 5. I-95 Corridor Coalition Surveillance System Goals [5]

Source: www.i95coalition.com

Enhance traffic management	Improve multi-modal and inter-modal transportation operations
Enhance real-time traffic control operations	Enhance traffic management during snow storms and other emergencies
Support Traveler Information Services	Enhance the transportation systems planning database
Facilitate Travel Demand Management Strategy	Support traffic law and regulation enforcement

The preceding goals can significantly enhance traveler information services, both for the entire corridor, and for New Jersey in particular. Successful information dissemination of data gathered from the first four goals could create a successful TIS itself. However, implementation of these strategies is dependent upon present day technology. Currently, the corridor applies the traffic surveillance technologies shown in Table 6.

Table 6. I-95 Corridor Surveillance Technologies [5]

Source: www.i95coalition.com

Inductive Loop Detectors	Magnetic Detectors and Magnetometers
Sensing Cables, Pressure Plates, and Bending Plates	Infrared/Photoelectric Detectors
Acoustic Detectors	Microwave Radar Detectors
Vehicle Probes	Video Vehicle Detection Systems
Closed-Circuit Television (CCTV)	Aerial Surveillance

It is important to note that this list only shows traffic surveillance technologies. The predominant types of electronic surveillance technologies in use today are inductive loop detectors and CCTVs. The use of CCTV is expected to increase in the future, while that of inductive loops is expected to decrease due to high maintenance costs and the emergence of radar detectors. Finally, though not shown, human surveillance is used extensively by Coalition member agencies. Detailed information concerning geographic coverage of human surveillance is not available, though this type of surveillance is expected to play an important role in the future.

Assessing the technological capabilities of the I-95 Corridor Coalition is only the first step in determining its ATIS possibilities. In the second report, the user needs and marketability of ATIS services to travelers of the I-95 corridor must be determined. From telephone surveys conducted by the coalition, the following demographic statistics have been obtained:

- 31% of the adult population (12.5 million) use I-95.

- 72% of the adult population (29.1 million) are high tech product users (i.e. at least one of: fax, cellular phone, has PC, uses PC, has on-line PC service).
- 64% of the adult population (25.9 million) are users of at least two travel information sources during or before trips.
- 50% of the adult population (20.2 million) are users of personal computers.
- 20% of the adult population (8.1 million) are subscribers to an on-line computer service.
- 63% of the adult population is willing to pay for travel information services.

Further analysis revealed the specific needs of user groups, including local auto travelers, long distance auto travelers, and transit travelers. For local trips, traffic conditions were considered most important during pre-trip planning, whereas information on construction activities and alternate routes was most important for en-route planning. Similar results were found for long distance travel needs. Pre-trip planning for these travelers included finding information on traffic, construction, and weather, and information deemed necessary while en-route included alternate routes, construction and weather. For transit users, schedule information and arrival times/delays were of equal importance.

Reviewing these statistics revealed the enormous potential of ATIS within the I-95 corridor. The large percentage of adults who have access to information sources such as the internet, cellular phones, faxes, and pagers represents a large population of viable traveler information customers. Also, since the majority of adults are willing to pay for traveler information, an ATIS can potentially be financially self-serving.

The range of potential market sizes for various ATIS services was also determined from the results of the survey. Drivers were asked to determine the amount of money they would pay for ATIS services. Two choices were given: to pay $3 to $5 for information from each of the sources listed, and $1000 to $2000 for installation of an in-vehicle TV display (Choice A), or to pay $1 to $5 for information from each source, and $500 to $2000 for installation of an in-vehicle TV display (Choice B). The results are as follows:

Table 7. Potential Market Size for Long Distance Recreational Traveler Information Services [(6)]

Information Service	*Percent Willing to Pay Choice A*	*Percent Willing to Pay Choice B*	*Range of Potential Market (in millions)*
Interactive Television	40%	63%	11 to 17.3
Cellular Phone Service	27%	59%	7.4 to 16.2
Computer On-Line Service	33%	55%	9.1 to 15.1
Travelers Alert Map	35%	72%	9.6 to 19.8
In-Vehicle TV Display	8%	19%	2.2 to 5.2
Survey Sample Size: 27.5 Million			

Source: I-95 Corridor Coalition: Project #6: user needs and marketability

Similar results (using the same Choice A or B criteria) were found for other information services, including emergency response systems (i.e. 1-800 Emergency Roadside Assistance), Air Travelers Information Systems (Kiosks or Booths), and on-line services for all modes of transportation (mass transit, air, auto).

To provide the traveler information services previously discussed, a comprehensive ITS system architecture must be designed. In 1994, the Coalition initiated the Traveler Information Services (TIS) Project to develop the implementation plan for the Corridor-wide Traveler Information System (CTIS). The CTIS was designed to achieve the following five specific user-service goals:

1. Enhance urban and interurban corridor road travel for various roadway users.
2. Enhance modal and intermodal travel for various urban and inter-city mass transit users.

3. Enhance the safety of travelers.

4. Increase the availability of traveler information.

5. Increase tourism.

The I-95 CTIS will evolve over a period of years, going through three identifiable stages, each with its unique level of technology, funding relationships between the public and private sector, and level of traveler behavior modification. The three phases will be implemented over a period of ten years: Phase I (zero to two years), Phase II (two to five years), and Phase III (five to ten years).

Phase I is focused upon deploying basic information to the broadest possible audience at little or no charge. It is capable of rapid communication of incident, traffic, and transit needs to all public agencies playing a critical role in incident management. Users can expect such information elements as real-time traffic conditions and incident information, construction activity, special event data, weather conditions, and transit information such as schedules and delays.

Phase II depends considerably upon the public sector's aggressive promotion of Phase I and its acceptance by end-users. In terms of technological apparatus, Phase II introduces interactive multimedia traveler information services via telephone, TV, online services, and PDAs. In the information realm, users of CTIS can access more advanced traveler information such as predictions and estimations of traffic conditions, traffic demand patterns and trends, detailed dynamic trip planning and routing information and guidance, and dynamic multi-modal planning. Also, Phase II expects financial input from the end-users who need detailed traveler information, such as commercial fleets and other private sector agencies.

In Phase III, emphasis shifts to widespread deployment of in-vehicle navigation devices that can display real-time, multi-modal information. These in-vehicle devices serve several purposes. First, and obviously, they are intended to provide travelers with their information needs. Second, these devices can also serve as mobile probes, recording real-time traffic conditions and anonymously reporting them back to CTIS. However, legal issues must be addressed in order to use these devices as vehicle probes.

Table 8. I-95 Corridor Coalition Deployment Strategy

Source: www.i95corridor.com

	Time Period			
Service	*Baseline*	*Year 2+*	*Year 5+*	*Year 10+*
On-line Computer Service		X		
In-Vehicle Device				X
HAR	X			
Public Kiosks			X	
VMS	X			
Cable TV		X		
Network TV		X		
Telephone	X			
Pagers		X		
Hand Held Devices			X	

As can be seen, the I-95 Corridor Coalition has spent a significant amount of time investing research in the Advanced Traveler Information Systems field. Analysis of their results shows that the enormous potential of the ATIS market to help alleviate traffic congestion, and also has a financial institution for the public and private sector.

The Georgia Navigator

Analysis of the Georgia NAVIGATOR provides evidence of the economic benefits of an ATIS system. The NAVIGATOR system was designed with seven purposes in mind:

freeway management, incident management, multimodal traveler information, transit management, electronic toll collection, electronic fare payment, and traffic signal control. In 1998, the Georgia Department of Transportation conducted a study to analyze the monetary benefits of the NAVIGATOR's freeway and incident management capabilities. The study area was 70.5 miles of freeway on Interstates 75 and 85 in the Atlanta area. The results of the study can be seen in the following figures. Figures 4 & 5 respectively represent the duration of an incident before and after NAVIGATOR. Examination of Figure 4 evidences a large time periods in several locations, specifically between when an incident happens and when it is reported, the time that it takes for response to arrive, and the actual time necessary to clear an incident. Comparing Figure 4 with Figure 5 reveals a dramatic decrease in the aforementioned times, and also in the total incident duration. Simple calculations using these figures leads to a 23-minute reduction in incident duration, which in turn, results in a cost savings of $44.6 million due to reduced delay time (GDOT 1998)[4]. Savings was calculated using three variables, cumulative traffic flow, capacity reduction due to an accident, incident duration, and cost per vehicle per hour ($13.96). Delay was computed using the first three variables. This delay in vehicle hours was then multiplied by a cost factor of $13.96 per vehicle per hour to obtain the cost savings value of $44.6 million. Specific details concerning these calculations can be found in the report published by the GDOT [4]. All factions of society experience the calculated cost savings. Due to the reduction in congestion, the congestion cost per capita is reduced, saving employers and employees' time and money. Also, the government saves money because it does not have to spend money repairing freeway sections that are damaged (congestion causes freeway damage such as rutting and pavement deterioration) due to congestion.

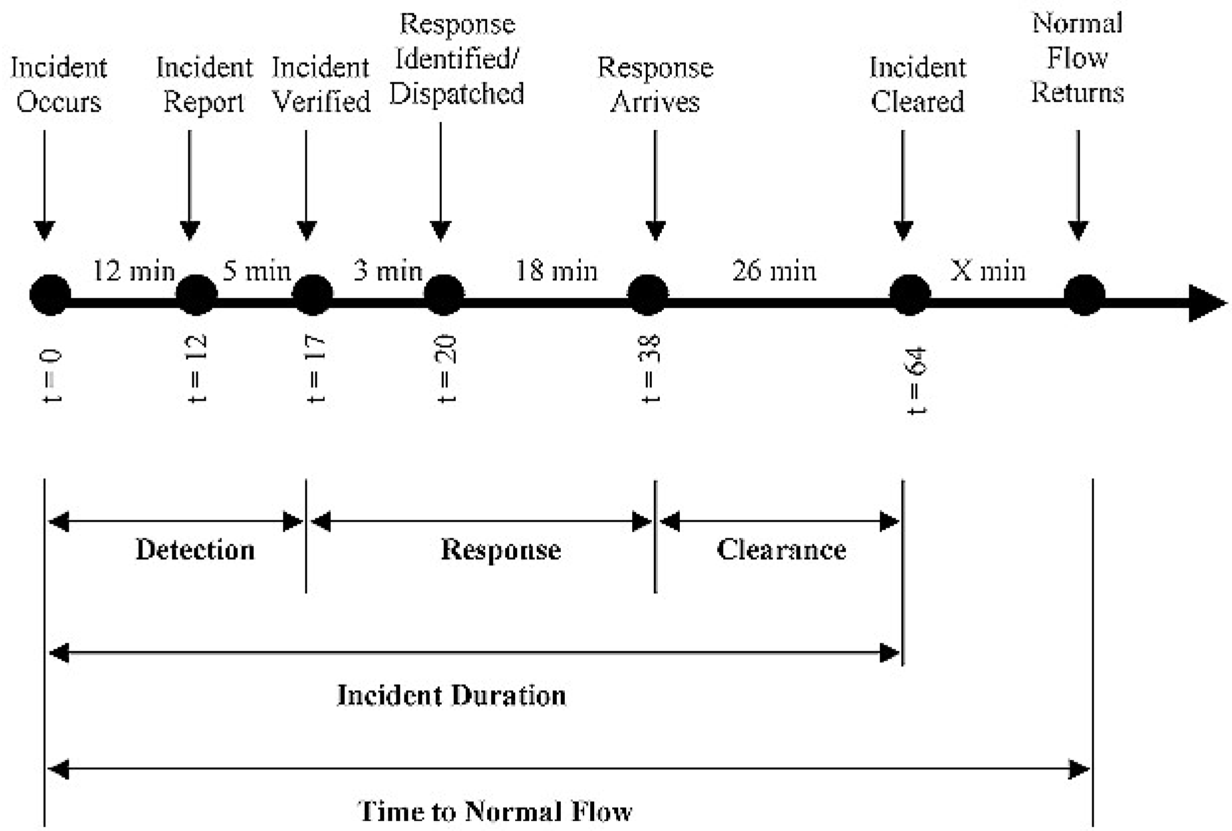

Figure 4. Timeline of an Incident *Before* NAVIGATOR [4]

Source: Calculating benefits for NAVIGATOR, Georgia's Intelligent Transportation Systems

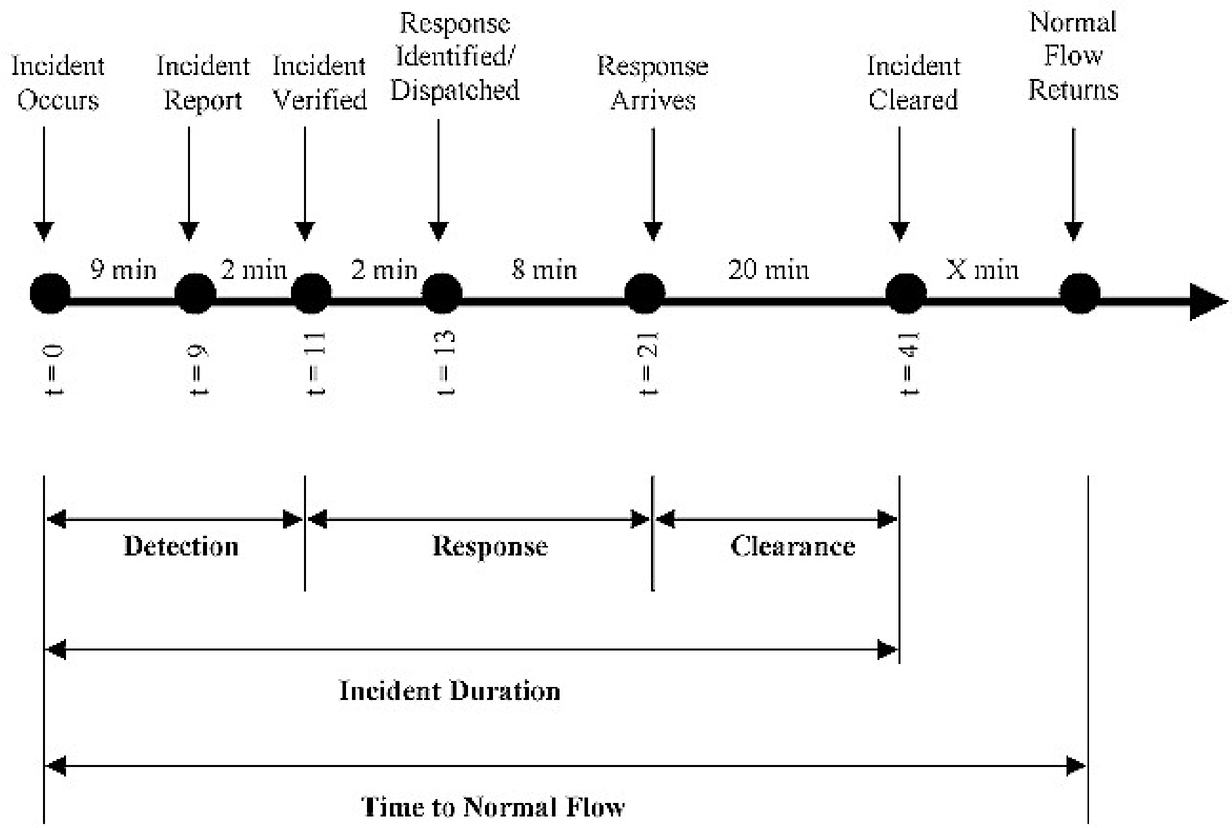

Figure 5. Timeline of an Incident *After* NAVIGATOR [4]

Source: Calculating benefits for NAVIGATOR, Georgia's Intelligent Transportation Systems

A Traveler Information System, similar to those designed in other regions of the country, would be beneficial to New Jersey, specifically northern and central New Jersey. These areas experience severe congestion due to their tremendous population density, business districts, and also because these areas house the arterials that commuters use to travel to and from New York City. In order to develop a successful and effective TIS, the National ITS System Architecture must be used. Using the NSA also has several advantages, foremost being that the NSA will be the standard used across the country. In order to insure homogeneous ITS deployment (meaning all local and regional ITS systems can interact in the hardware and software realm), the NSA should be followed. The following is a concise description of the National ITS System Architecture and how the NSA can be used to develop a Traveler Information System. Understanding the role of the NSA in the development of the TIS can save time, money, and effort and will also enable the system to be compatible with other regional TIS systems.

NATIONAL ITS SYSTEM ARCHITECTURE

This section is intended to satisfy the requirements of Task #2, as described in the proposal for "**MULTIPLE APPROACHES TO REAL TIME ROUTE INFORMATION**". In this task, we explore the National ITS System Architecture (NSA) and its components, the benefits of using the NSA to develop an ATIS system architecture, and survey existing regional system architectures.

Background

The National System Architecture (NSA) program was developed by the FHWA to support ITS implementations over a 20-year time period in urban, interurban, and rural environments across the country. The NSA program was completed in early 1996, with the help of several large companies, including Rockwell, Loral (formerly IBM), NASA's Jet Propulsion Laboratory and MITRE Corporation. As defined by the FHWA, a system architecture "is a framework that describes how system components interact and work together to achieve total system goals and objectives" (USDOT 1998b)[(10)]. Accordingly, general names were given to system components in order to accommodate local design choices and changes in technology or government arrangements over time. This configuration provides flexibility at local levels, while allowing the general structure of the National ITS Architecture to remain stable. A more thorough understanding of the NSA can be accomplished by understanding the following concepts: User Services and User Services Requirements, Logical Architecture, Physical Architecture, Equipment Packages, and Market Packages.

The NSA development effort centered around 31 user services defined by the USDOT and ITS America. These user services were grouped into seven categories for convenience: Travel and Traffic Management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle Safety Systems, and Information Management. The concept of user services allows the process of system or project definition to begin by addressing identified problems and developing high-level services to accommodate these problems.

User Services Requirements represent the number of functions necessary to accomplish each user service. For example, the pre-trip travel information user service is actually defined by over 40 user service requirements, as exhibited in Figure 6.

1.1 Pre-trip Travel Information (User Service)

User Service Requirements:

1.1.0 ITS shall provide a Pre-Trip Travel Information (PTTI) capability. To assist travelers in making mode choices, travel time estimates, and route decisions prior to trip departure. It consists of four major functions, which are, (1) Available Services Information, (2) Current Situation Information, (3) Trip Planning Service, and (4) User Access. Information is integrated from various transportation modes and presented to the user for decision-making.
PSpecs: 1.2.5.5, 4.4.1.8, 6.1.1, 6.1.2, 6.3.1, 6.3.2, 6.3.3, 6.5.1, 6.8.3.1, 6.8.3.2, 6.8.3.3

1.1.1 PTTI shall provide travelers with information on those travel services available for their use.
PSpecs: 1.2.5.5, 6.1.1, 6.3.2, 6.8.3.2

1.1.1.1 PTTI shall provide users with available services information that is timely.
PSpecs: 1.2.5.5, 6.1.1, 6.3.2, 6.8.3.2

1.1.1.1.1 PTTI shall provide users the latest available information on transit routes.
PSpecs: 6.1.1, 6.3.2, 6.8.3.2

1.1.1.1.2 PTTI shall provide users the latest available information on transit schedules.
PSpecs: 6.1.1, 6.3.2, 6.8.3.2

1.1.1.1.3 PTTI shall provide users with real time schedule adherence information.
PSpecs: 6.1.1, 6.3.2, 6.8.3.2

1.1.1.1.4 PTTI shall provide users the latest available information on transit transfer options.
PSpecs: 6.1.1, 6.3.2, 6.8.3.2

1.1.1.1.5 PTTI shall provide users the latest available information on transit fares.
PSpecs: 6.1.1, 6.3.2, 6.8.3.2

Figure 6. Portion of Pre-Trip Travel Information User Service Requirements [7]

In other words, at least 40 different functions must be implemented in order to fully deploy pre-trip travel information user service. By defining user services and user service requirements, developers of the NSA had tangible goals to achieve. Finally, the established number of user services is not fixed. Rather, the existing user services were intended to help develop the NSA with the condition that new user services would be defined as problems presented themselves over time.

The NSA logical architecture defines a set of functions and information flows that fulfills the established user service requirements. Data flow diagrams (DFDs) graphically represent processes and data flows that form a particular transportation management function, such as manage traffic. DFD's are hierarchical in nature. Each DFD can decompose into several more detailed layers. In the National ITS Architecture documentation, the manage traffic process interacts with seven other processes.

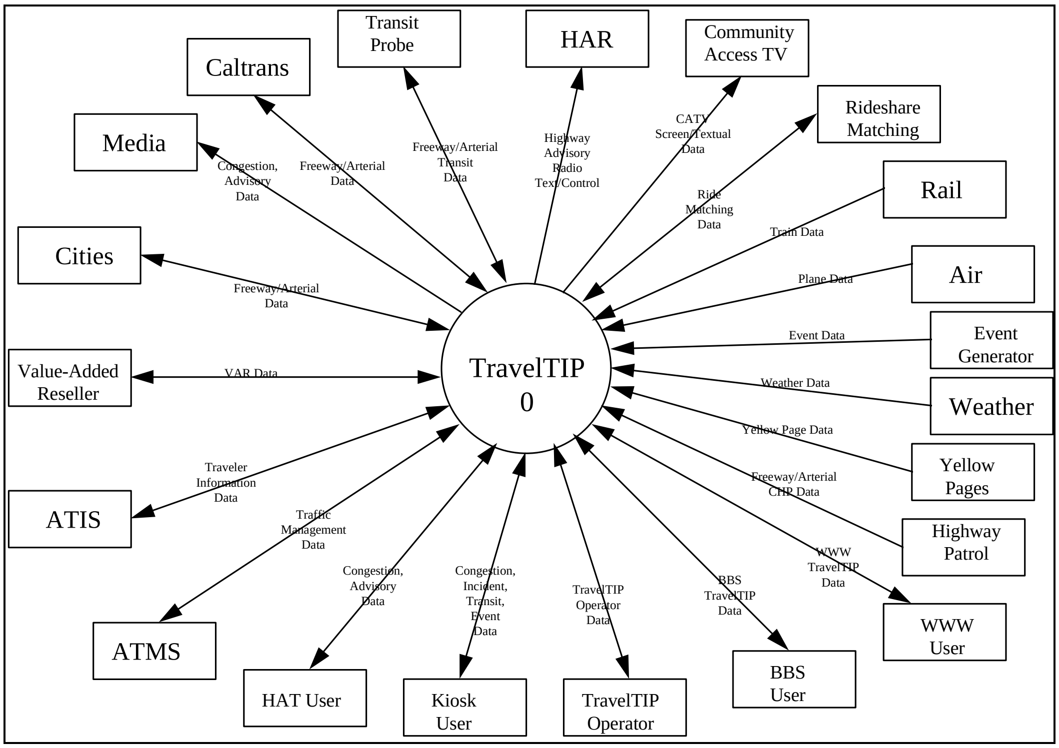

Figure 7. TravelTIP Logical Architecture [8]

However, the manage traffic process itself can be broken down into five sub-processes, and then each of these sub-processes can be further broken down. The NSA logical architecture is a tool that assists in organizing numerous entities (processes) and identifying relationships between each process. At the lowest level of detail in the hierarchy are the process specifications (P-specs). Though it does identify relationships between process and data flows, it does not specify the format of the data flows nor does it define where or by whom functions are performed in the system. Figure 7 is an example of a DFD for the logical architecture of TravelTIP, an ATIS system developed for Orange County, California. As depicted in the diagram, the TravelTIP program can be broken down into 21 different processes. Each of these processes is further analyzed in subsequent DFDs. The arrows represent information flows to and from TravelTIP. The physical architecture provides users or implementers with a physical representation of how the system provides the required functionality. In the NSA, the physical architecture, depicted in Figure 8, takes the process (P-specs) identified in the logical architecture and assigns them to physical groups, called subsystems. In addition, data flows designated in the logical architecture are grouped

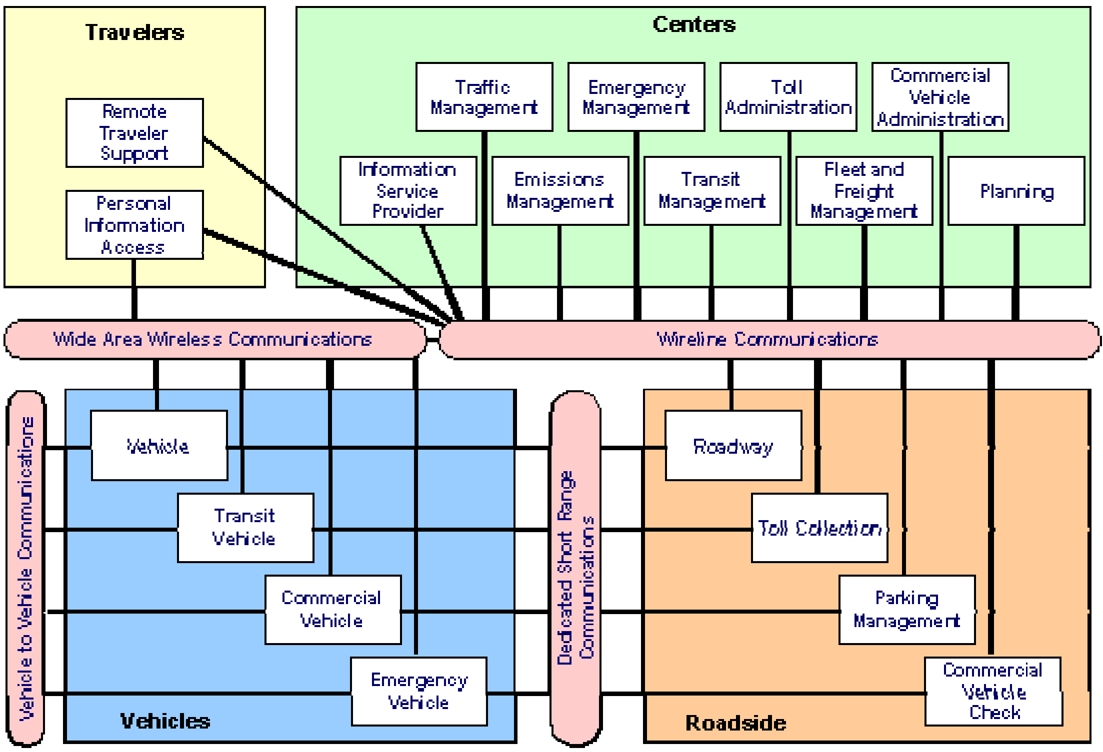

Figure 8. National ITS Architecture Subsystems and Communications [9]

together into physical architecture flows. In the NSA, two layers describe the physical architecture: the transportation layer and the communications layer. The transportation layer of the NSA shows the relationship between transportation-management-related elements. This layer contains 19 subsystems, which are grouped into four classes, or subsystems: vehicles, roadside, centers, and remote access.

The communications layer of the physical architecture provides communication services that connect the subsystems. There are 4 types of communication services: wide area wireless communications, wireline communications, vehicle-to-vehicle communications, and dedicated short-range communications.   Figure 8 also shows the relationships between the subsystems and the communications layer. By using this diagram, ATIS functions can be easily visualized.

Equipment packages are packages of hardware and software necessary to fulfill the requirements of P-specs of a particular subsystem. The grouping of P-specs took into account user services and the functionality within them. Equipment packages, which comprise a market package (discussed next), were used as an estimating tool for deployment costs. The NSA has defined approximately 110 equipment packages in total. For example, the traffic management subsystem comprises 17 equipment packages, such as “TMC Based Signal Control” and “TMC Based Freeway Control”.

Market packages are defined by sets of equipment packages from different subsystems required to work together to deliver a specific transportation service. In other words, they “identify the pieces of the National ITS Architecture required to implement a service.” The NSA defines 61 market packages, which can be divided into seven groups:

- ATMS: Advanced Traffic Management Systems
- APTS: Advanced Public Transportation Systems
- ATIS: Advanced Traffic Information Systems
- AVSS: Advanced Vehicle Safety Systems
- CVO: Commercial Vehicle Operations
- EM: Emergency Management
- ITS: ITS Planning

Basic Information Broadcast (Equipment Package)

This Equipment Package provides the capabilities to collect, process, store, bill, and disseminate traveler information including traveler, transit, ridematching, traffic, and parking information. The traveler information shall include maintaining a database of local area services available to travelers with up-to-the-minute information and providing an interactive connectivity between, sponsors, and providers of services. The transit information shall include the latest available information on transit routes and schedules, transit transfer options, transit fares, and real-time schedule adherence. The traffic information shall include latest available information on traffic and highway conditions, and current situation information in real-time including incidents, road construction, recommended routes, current speeds on specific routes, current parking conditions in key areas, schedules for any current or soon to start events, and current weather situations. This Equipment Package shall also provide users with real-time travel related information while they are traveling, and disseminate to assist the travelers in making decisions about transfers and modification of trips. These capabilities shall be provided using equipment such as a fixed facility with a communications system such as a data Subcarrier device.

Figure 9. Description of Basic Information Broadcast Equipment Package (7)

Most market packages are made up of Equipment Packages in two or more subsystems. These packages are designed to address specific transportation problems, and the solutions using developed equipment packages. The development of market packages provides several advantages. First, though a given market package may provide only part of the user service, it is a building block in that it allows more advanced packages to use its services. Second, market packages can specifically address regional and local needs. Third, supporting benefits and cost analyses were conducted for each market package. These reports can be used as further resources in deployment of ITS systems. Next, market packages are not tied to any specific technologies or institutional requirements. As transportation needs evolve, existing market packages can be modified, and new ones can be created. Finally, market packages serve as a door into the physical architecture of the NSA. They can be used as an "alternative starting point for defining project functional requirements and system specifications".

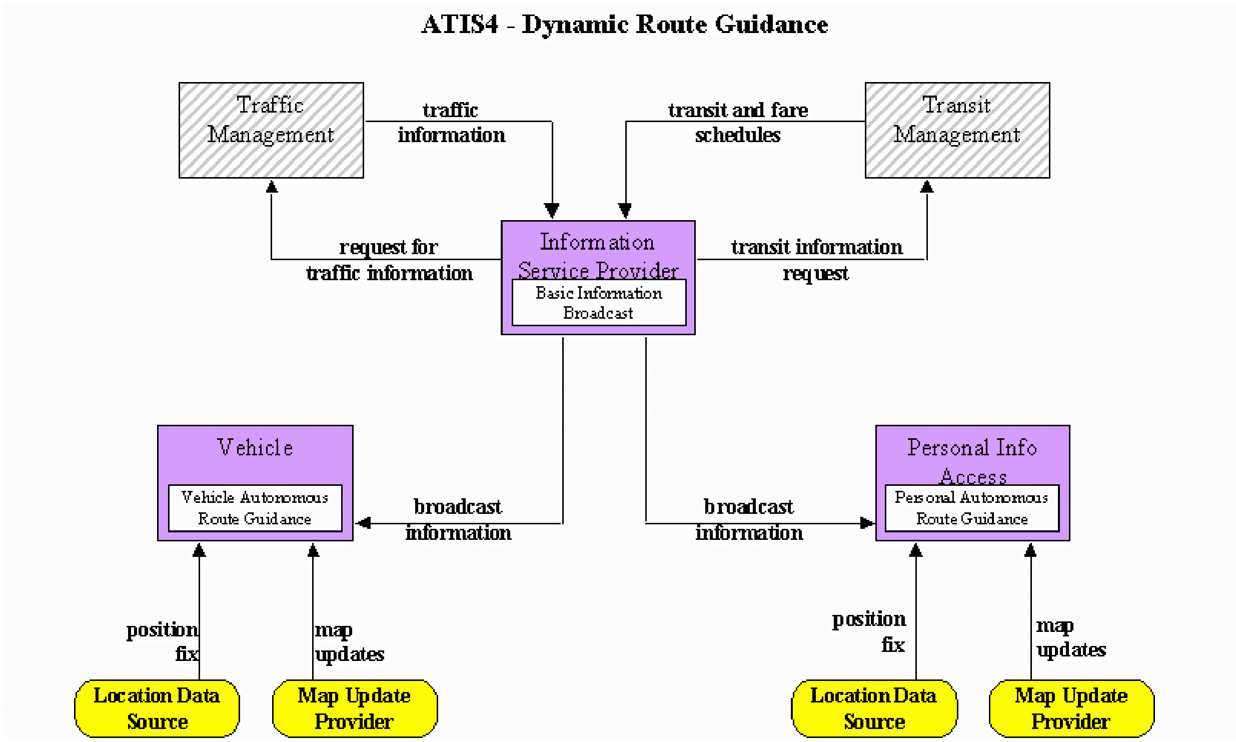

Figure 10. ATIS Market Package [10]

The National ITS System Architecture provides a framework for the design of ITS. It identifies transportation needs, and proposes solutions that can be implemented domestically. Since it does not specify technologies or specific implementation standards, the NSA can be modified to suit regional needs. The NSA can help the FHWA and USDOT in deploying a national ITS system.

Developing a Traveler Information System Using the National System Architecture

The tools available within the National System Architecture are intended to augment and support existing ITS project development. The NSA is not a process in and of itself, rather it contributes information and analysis to existing projects (e.g. cost-benefit

analysis). As a source of critical information early in the development stages, the NSA can lower project risks and costs while also improving the potential that the deployed project will be effective in the long term and support regional ITS integration.
Traveler Information Systems (TIS) are intended to support many categories of drivers and travelers. Many technologies are applied to allow customers to receive roadway, transit, and other information pertinent to their trip. This information assists users in selecting their mode of travel, route, and departure time. A TIS receives information from several subsystems, processes the information, and disseminates it to customers. Transit information can be retrieved from the Transit Management Subsystem. Roadway-based information is gathered using surveillance equipment, and then forwarded to local traffic management centers. Other information necessary for an effective TIS include map databases, emergency services information, and information on motorist services and tourist attraction and services. These technologies can be accessed via the home, office, vehicle, transit stations, or personal communications devices. Effective traveler information systems often strive to achieve the following goals: reduction of intermodal travel times and delays for individual travelers, reduction of traveler stress for trips to unfamiliar destinations, reduced crash risk and fatalities, and to reduce overall system travel times and delays.

The National System Architecture is a necessary tool in the development of a Traveler Information System. The NSA can be used in the following stages of development:

- Identification of needs or problems.
- Solution identification.
- Solution planning and design.
- Funding, procurement and implementation.

During the development of a TIS, current and future needs should be identified. Several of the goals and objectives delineated in the NSA's mission statement also pertain to traveler information systems.

- First, a need exists to increase operational efficiency and capacity of the transportation system. These needs include reducing stops and increasing speeds, reducing operating costs, and reducing delays.
- Second, it is necessary to enhance personal mobility and the convenience of the transportation system. Objectives included within this statement include decreasing discomfort and stress and increasing safety and personal security.
- Third, it is necessary to improve the overall safety of the transportation system by reducing fatalities and reducing the number and severity of accidents and vehicle thefts. The final objectives are to reduce energy consumption and energy costs, and to enhance the present and future economic productivity of individuals, organizations, and the economy as a whole.

These objectives correlate with the characteristics of an effective traveler information system, and can be used to define project goals when deploying a TIS.

The NSA is a very effective tool for identifying solutions for the given set of needs previously identified. The NSA provides two options for agencies. First, the NSA allows developers to identify user services that are necessary for an effective TIS. The necessary user services for a TIS are en-route driver information, route guidance, traveler services information, pre-trip travel information, ride matching and reservation, and en-route transit information. Agencies should identify which user services are integral to the local TIS, and carry these to the next step of project development. The second approach is to review which subsystems are involved with traveler information systems. Then, one can locate the appropriate market packages that are necessary for implementing the TIS. Within the NSA, the domain of traveler information systems is primarily represented by functions within 10 of the 19 subsystems. The following list defines the required subsystems:

- Personal Information Access Subsystem
- Remote Traveler Support Subsystem
- Information Provider Subsystem
- Traffic Management Subsystem
- Transit Management Subsystem

- Emergency Management Subsystem
- Roadway Subsystem
- Parking Management Subsystem
- Vehicle Subsystem
- Transit Vehicle Subsystem

The following ITS Market Packages, which span the above subsystems, can be used to develop a TIS.

- Network Surveillance
- Probe Surveillance
- Traffic Information Dissemination
- Traffic Network Performance Evaluation
- Broadcast Traveler Information
- Interactive Traveler Information
- Autonomous Route Guidance
- Dynamic Route Guidance
- ISP-Based Route Guidance
- Dynamic Ridesharing
- Yellow Pages and Reservation
- Emergency Routing
- In-Vehicle Signing
- Integrated Trans. Mgmt / Route Guidance

Identifying market packages is more convenient of the two approaches because evaluation information, such as cost-benefit analysis which can be found within NSA documentation, have already been established for these packages, and can be used as a further resource for project development and planning.

Planning and design of the solution is the most likely phase for applying the National ITS Architecture. The overall goal is for agencies to use the analysis already performed and to “have the opportunity to consider additional functions, interfaces, and information sharing possibilities beyond the initial project scope, which can be planned for now in anticipation of future needs.” The planning and design solutions inherent in the NSA are determining functional requirements, identifying information exchange requirements, and to identify standards. The NSA can be used as a resource when defining project or system function requirements. A more detailed analysis of the user services and market packages chosen in the previous step is necessary. From this analysis, evaluation of the applicability of the chosen items can be established. Additional performance requirements and other institutional decisions will be made at this stage. Finally, additional local needs, apart from the user services defined in the NSA, can be established and the appropriate packages created.

Two more uses of the NSA are available during the planning stage. First, the NSA can be used to identify information flows. The location and content of these flows is critical and should be determined as soon as possible. Also, information flows represent the relationship between different processes and agencies. Finally, the NSA can also be used to identify standards during the planning phase. The rapid growth of technology will introduce many new systems and tools in the transportation industry. As transportation and technology grow, standards will also have to evolve in order to ease integration and vendor interoperability.

Finally, in the funding and procurement stage, the NSA is necessary because of the already finished cost estimates of market packages and other functions. A series of documents provide the approximate non-recurring and recurring costs of equipment and market packages. Though these costs were developed in 1995, they can be used as guidelines for developing budgets.

The National ITS System Architecture is a powerful tool when developing and implementing ITS projects. Within the system architecture, solutions to various problems can be found, and ideas on the physical manifestations of the solutions are also present.

Other Regional System Architecture Projects

Greater Yellowstone Rural ITS (GYRITS) Priority Corridor Project – Tasks 6, 7, and 8 Regional Architecture Development [17]

This report describes the essential elements of a regional architecture, including priority rural market packages, geographic areas of focus, measures of effectiveness, and communication alternatives for the region. This project accomplishes three primary objectives. First, it identifies and describes the functionality that should be provided to make ITS work in this corridor. In essence, urban ITS concepts, designed to manage large traveler populations, must be modified in order to be successful in rural areas. Second, it identifies and prioritizes the market packages and groupings that are best suited for the GYRITS Corridor. This step involved discussing the selection and, in some cases, re-definition, of the NSA market packages. Each of these steps was based upon the GYRITS Corridor goals and objectives. The selections made were tailored for each goal. Finally, it reviews various communication technologies appropriate for the Corridor.

Greater Yellowstone Rural ITS Priority Corridor Project Task 11 – Define Regional Architecture [17]

This report further expands upon the findings of the previous report. The level of detail is significantly increased, as each market package and user service is thoroughly examined, and its relevance to overall project goals is discussed. The bulk of the report is spent presenting the GYRITS Regional Architecture by comparing it to the original ITS Architecture Sausage Diagram. The architecture incorporates many elements of ITS, including ATMS, ATPS, CVO, EM, and ATIS. The specific ATIS market packages delineated in this report are

- Broadcast Traveler Information
- Interactive Traveler Information
- Network Surveillance
- Probe Surveillance
- Dynamic Warning System

- Traffic Information Dissemination
- Automated Road Closure Management
- Road/Weather Information System
- Dynamic Warning Systems (customized package for this region)

A large amount of time is dedicated to presenting the interconnection devices to be used in the architecture. Finally, the responsibilities of the local traffic operations centers, known as virtual centers, are presented.

Regional Architecture For Albuquerque Metropolitan Planning Area (13)

This reports discusses in great detail, the Albuquerque system architecture. The architecture includes all of the important sections of ITS (i.e. ATMS, ATIS, CVO, EM, etc.) and also discusses communications. The report gives a step-by-step description of the design evolution of the architecture. First, it discusses high-level project goals. Next, specific user services are chosen, and their relevance is shown. Then, relevant market packages are discussed. In this case, no market package customization is necessary, as Albuquerque is a metropolitan environment, rather than a rural one. Detailed architecture flow diagrams for each market package are given as well. The entire system architecture is then presented. It is of interest to note that this report, as well as the previous one, presents its system architecture in comparison to the original ITS sausage diagram. Finally, the report shows the relevant ITS standards that are present in the Albuquerque system architecture. Also, this report is unique in that it presents the designed regional architecture database. The database consists of two linked MS Access databases, the physical architecture database and logical architecture database. The components of the database are presented, and the functionality of the database is shown. Unfortunately, the database itself is not available for public examination.

Pittsburgh Regional ITS Architecture (14)

This report is the most detailed Regional Architecture report examined so far in our study. It contains minutely detailed information concerning a variety of topics, including regional needs, architecture interconnections, flow diagrams and standards for market packages, and the actual regional architecture. The regional architecture is presented as an entire entity, and also in individual flow diagrams. Again, the authors presented the regional architecture by comparing it to the ITS sausage diagram. This type of presentation and design is important to the future of ITS. Since each region is designing its own regional architecture, the possibility exists that these architectures cannot be intertwined. However, since most architectures are designed using the principles given by ITS, compatibility is ensured. Again, the regional architecture presented in this report addresses all areas of ITS, from traffic management to traveler information to emergency planning.

Similarities and differences exist between the previously presented reports and this one. All of the reports focus on the necessary market packages required to accomplish a pre-defined goal. Second, all of the reports address the issue of ATIS. Third, all of the reports present sample system architectures, either regional or market package specific. However, general similarities end here. This report is focused on the development of an ATIS system architecture for New Jersey, whereas the other reports are focused upon developing regional architectures. Hence, the project scope of the other reports are much broader and much more detailed than this report. They must address all ITS concepts, including traffic management, public transportation systems management, commercial vehicle operations, vehicle safety, and emergency management, as well as ATIS. Hence, their level of detail is much greater. A regional architecture contains all of the relevant market packages, whereas the system architecture proposed in this study focuses primarily on information collection and dissemination, rather than all of the ITS concepts. Finally, communications alternatives are addressed in great length in each of these reports. For the purpose of this report, communication issues are relevant, though not addressed in detail. This report is focused on developing a high-level system architecture for ATIS in New Jersey, rather than a detailed ITS regional architecture.

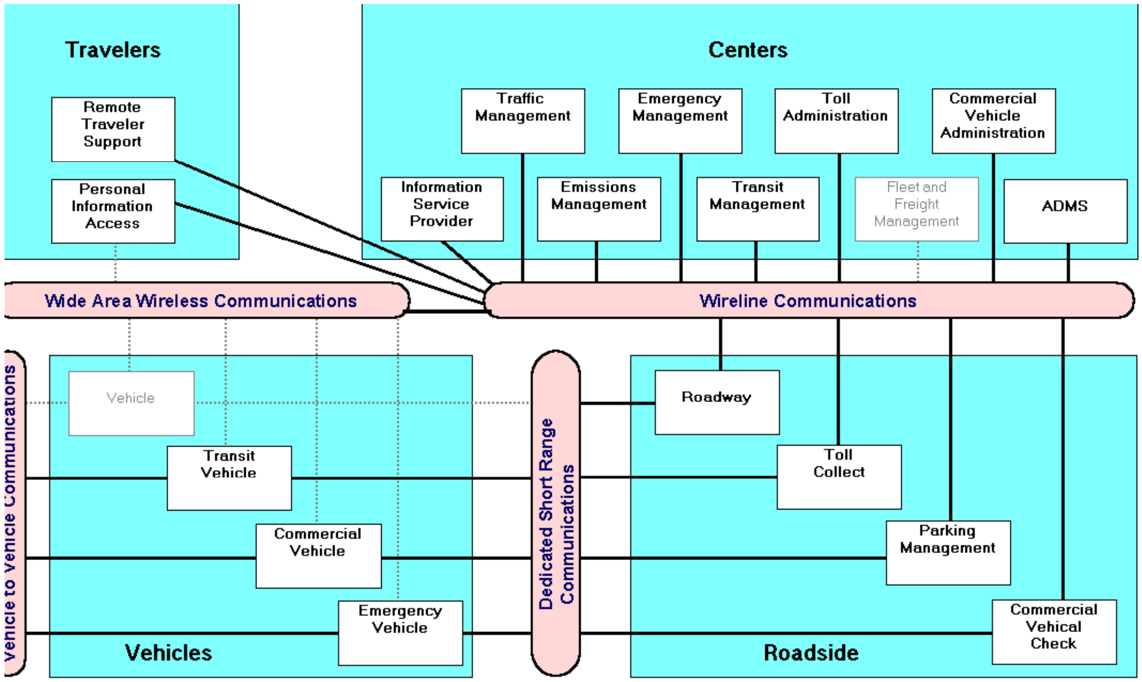

Figure 11. Architecture Entities (Sausage) Diagram for the Pittsburgh Region

Hence, this report presents issues in general terms, rather than dismissing concepts due to pre-defined criteria. Also, this report is focused on recognizing the various institutions that are integral in developing a traveler information database. Hence, the role of state agencies, and their available traveler information resources, is of extreme importance.

As seen in this section, the National System Architecture plays a vital role in developing any ITS project, specifically ATIS projects. By adhering to the guidelines set forth in the NSA, NJDOT will benefit by designing an ATIS system that addresses the needs of New Jersey's travelers. Furthermore, the NSA is a standard for ITS deployment and design, and therefore, by following the NSA, New Jersey can be assured that it's ATIS system will be able to effectively interact, in terms of hardware and software, with other ITS systems both locally and from neighboring states. The following section documents the methodology used in this report to design a high-level system architecture for an ATIS system in New Jersey using the National System Architecture.

HIGH-LEVEL SYSTEM ARCHITECTURES

This section is intended to satisfy the requirements of Task #2, as described in the proposal for "**MULTIPLE APPROACHES TO REAL TIME ROUTE INFORMATION**". In this task, we introduce a methodology for developing a high-level ATIS system architecture in New Jersey, and then present the architectures of New Jersey's transportation agencies. Furthermore, a sample ATIS High-Level System Architecture for the Garden State Parkway is developed using the presented methodology.

Methodology of Developing High-Level System Architecture

The surveys conducted in this project provide information about each agency's ITS capabilities. From this data, sausage diagrams of each agency's existing resources can be created which is briefly described in Section 5 and complete results are presented in Appendix B. The information required to create these high-level system architecture diagrams is obtained from a series of surveys and interviews. The diagrams created will mirror the NSA's sausage diagrams (i.e. Figure 8). The following methodology was used to create each sausage diagram.

Figure 12. The Methodology for Developing Customized System Architectures.

1. <u>Identify systems for system architecture diagram</u>

   The first step in developing a system architecture diagram is to determine existing ITS subsystems for each agency. These subsystems, which are very broad in scope, will house individual market packages. Examples of pertinent subsystems include roadway, TMC, emergency management, etc. Also, information exchange requirements should be determined. These requirements represent the flow of information between systems in the sausage diagram. This stage consists of identifying high-level information flows between systems, rather than detailed information flows between market packages. By developing information exchange requirements, the passage of data from systems will be easier to observe and analyze. This information can be obtained from the information gained in the surveys. The survey specifically asked about each agency's existing capabilities. Though the answers were not geared towards ITS terminology, the content of the response can be mapped to appropriate subsystems by matching the answers with the NSA subsystem definition.

2. Identify required user services

   After determining available subsystems, user services that can be satisfied by these subsystems should be determined. In doing so, the focus and the capabilities of the overall system can be clearly identified. This information can be obtained from the NSA directly.

3. Determine functional requirements

   In this stage, the functional requirements of the organization must be examined. An ATIS can benefit transportation organizations in many ways, but the exact areas in which it provides assistance must be determined. Also, the type of output given by the ATIS also has to be determined. In essence, the type of information to be provided to the public (i.e. incident, congestion, weather advisory, etc.) must be clearly defined. After the output is defined, then the agency's resources must be examined to see if the agency has the capabilities to provide specific types of information.

4. Selection of market packages

   At this stage, market packages can be selected that comprise the selected subsystems, and fulfill the user services and functional requirements previously defined.

5. <u>Create system diagram based on NSA Sausage Diagram or create uniquely</u>
   Finally, the sausage diagram can be drawn. High-level information flows between systems can be further detailed if necessary. Selected market packages should be placed in the appropriate system, and the information flows between each market package can be shown.

Following this methodology, the sausage diagrams seen in Figures 13-16 were generated. These diagrams illustrate the existing capabilities of NJDOT Traffic Operations North, the New Jersey Turnpike Authority, the Port Authority of New York & New Jersey, the New Jersey Highway Authority, and NJDOT Traffic Operations South, and are based upon data collected from the surveys. As per the methodology described above, Steps 1, 2, and 3 were conducted from interpreting the results of the interview. The results of Step 4 were based upon taking the results of Steps 1-3 and mapping them to the NSA. The final outcome, the sausage diagram (Step 5), is seen in the figures 13 to 16b.

NJDOT North currently uses 9 of the prescribed 19 subsystems of the National ITS Architecture. Of the nine determined subsystems, two vary from their given definition. The Vehicle subsystem, found in the Vehicles box, includes all single occupancy vehicles, vans, trucks, etc. However, NJDOT North does not posses the capability to communicate with all vehicles, rather, NJDOT North can communicate with vehicles equipped with communications devices, such as CB radio. The other subsystem in question is the Information Service Provider subsystem. In this case, the ISP is considered to be NJDOT North itself, rather than a private, third party organization. NJDOT North posts traveler information through the NJDOT web site, through other transportation agencies. Also, the DOT sends traveler information, via electronic communiqué, to TMAs in the area. Finally, NJDOT Traffic Operations North supports all forms of communications except for Vehicle-to-Vehicle communications.

The capabilities of the NJ Turnpike Authority mirror those of NJDOT North. However, since the Turnpike Authority is a toll agency, the toll administration and toll collection subsystems are applicable. Toll administration and toll collection refers to both manual toll collection and electronic toll collection systems, including E-Z Pass. The same conditions discussed previously concerning the Vehicle and the ISP subsystems also apply to the Turnpike Authority. The Turnpike Authority maintains its own web site, and traveler information is available from that site. NJTPK also supports all forms of communications except Vehicle-to-Vehicle communications.

The Port Authority of New York and New Jersey has very similar capabilities to that of the New Jersey Turnpike Authority. Both agencies deal with toll collection and also maintain their own websites. The Port Authority, however, is significantly larger than the NJTPK, and hence, has much more equipment.

Finally, the New Jersey Highway Authority, representing the Garden State Parkway, has the least ITS capabilities of all agencies. The agency is trying to move ahead by conducting analysis to develop market packages for its jurisdiction, as will be seen in the following section. NJHA's traffic management and roadway capabilities are limited to several CCTV's at various locations, and a weather detection system installed at one location.

Further information about these diagrams can be found at the following website: http://trans51.civeng.rutgers.edu/atis/.

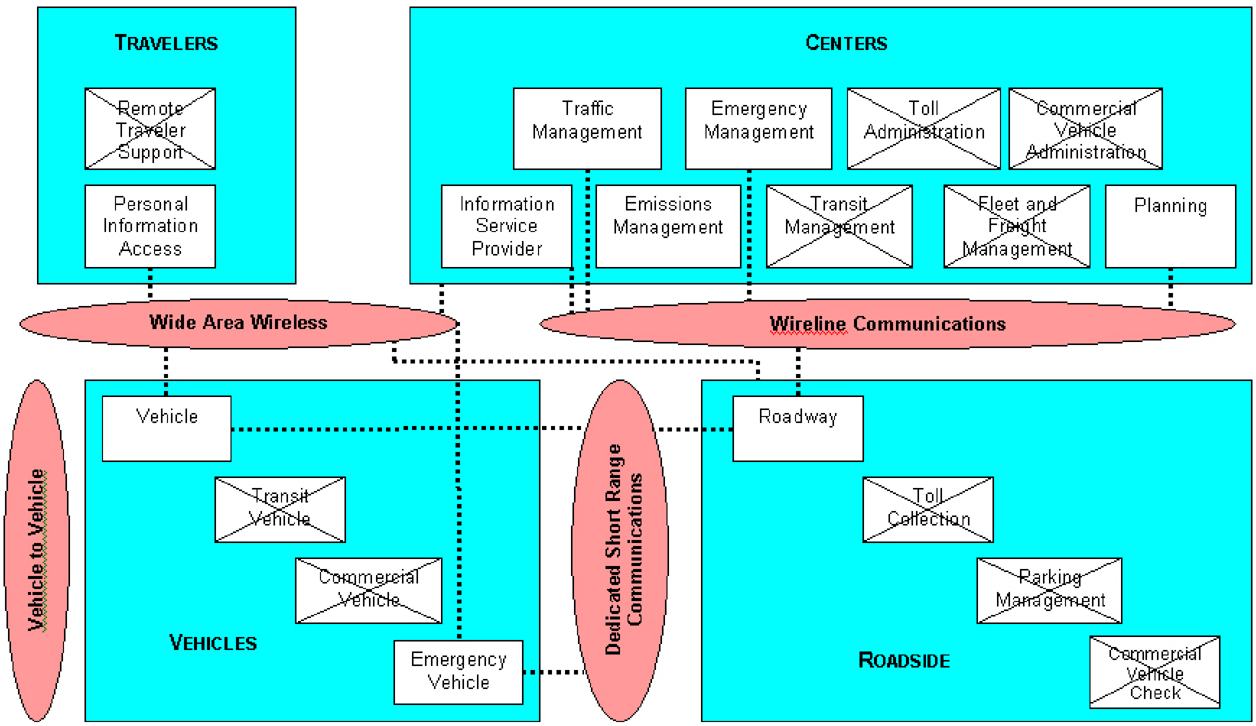

Figure 13. Existing physical entities for NJDOT Traffic Operations North

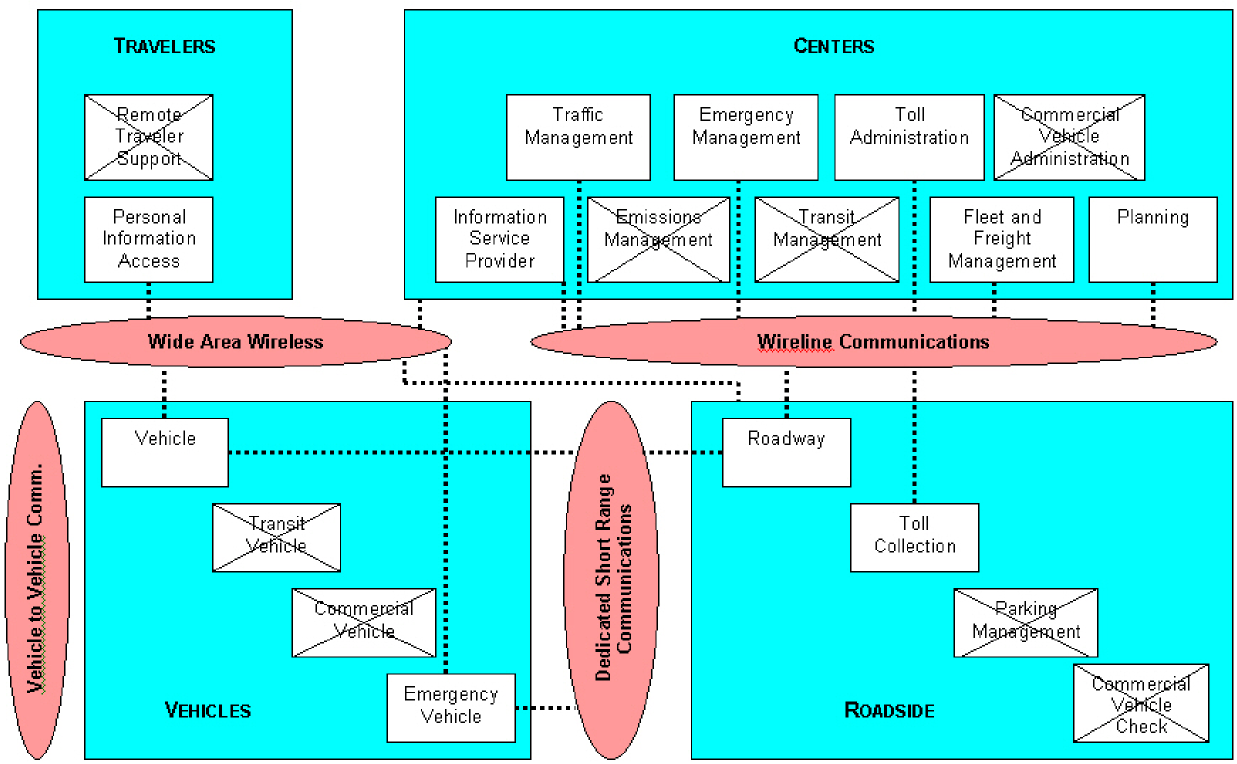

Figure 14. Existing physical entities for New Jersey Turnpike Authority

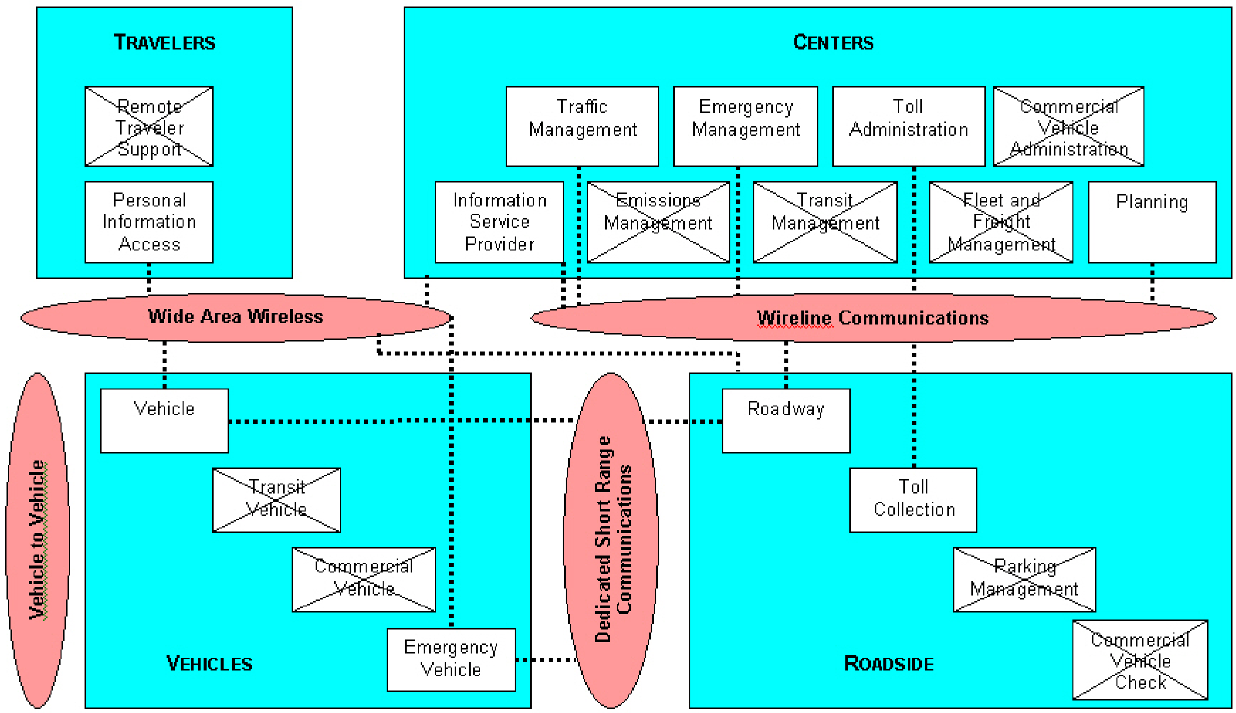

Figure 15. Existing physical entities for the Port Authority of NY & NJ

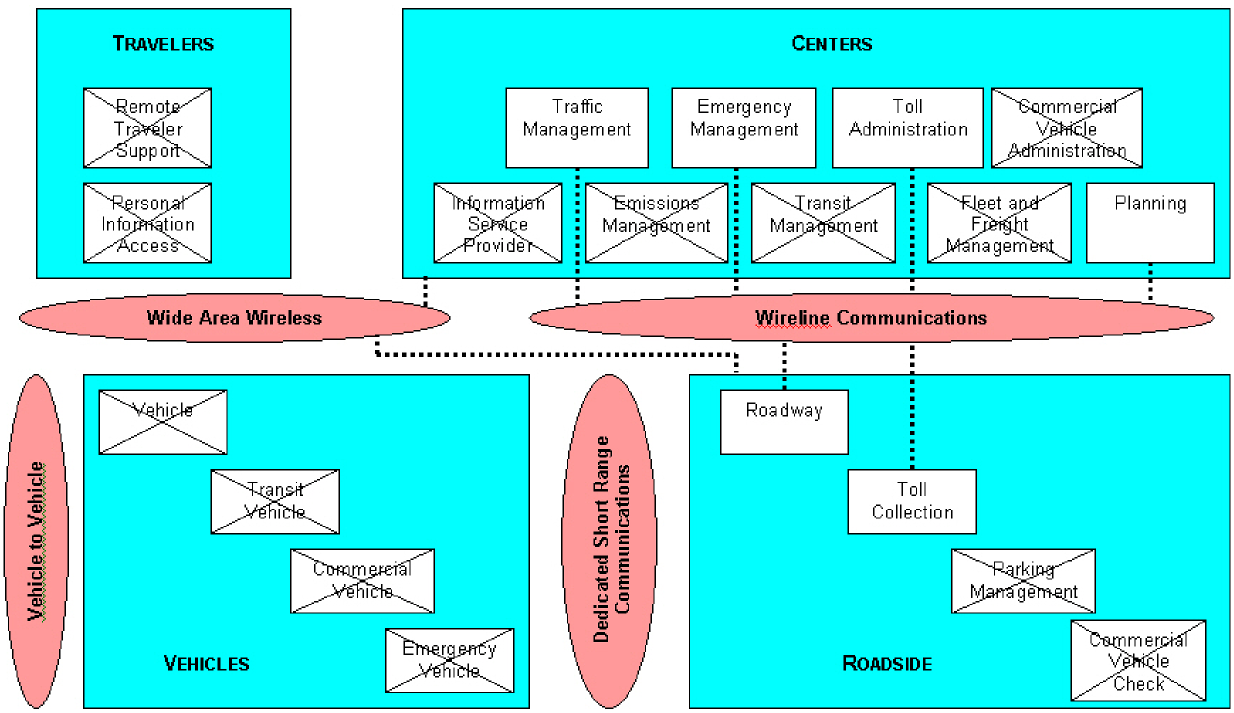

Figure 16a. Existing Physical Entities for the New Jersey Highway Authority

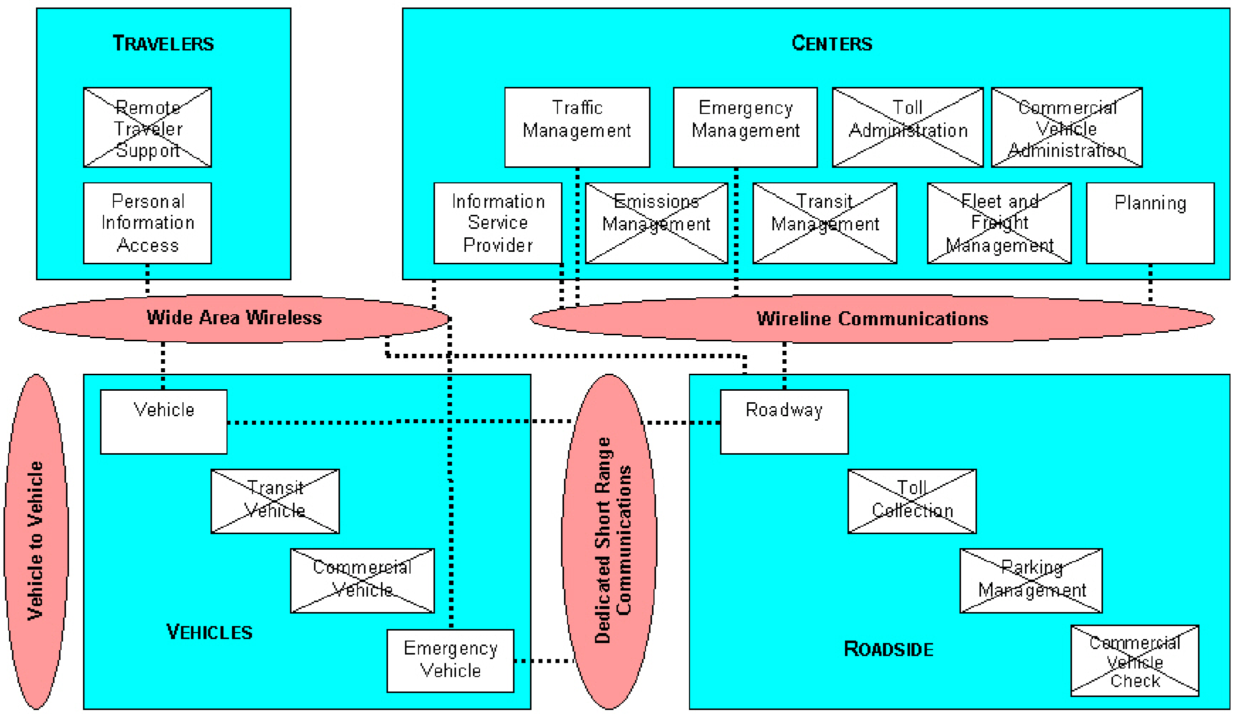

Figure 16b. Existing Physical Entities for NJDOT Traffic Operations South

Sample ATIS High-Level System Architecture for the Garden State Parkway

A sample high-level system ATIS System Architecture was developed for the Garden State Parkway. This system architecture is based upon an implementation study concerning ITS market package deployment on the GSP (NJHA 1997). In order to develop the system architecture, market packages relevant to Traveler Information Systems had to be chosen. The methodology used to develop the sausage diagrams in Figures 13-16 was again implemented here.

In the National ITS System Architecture, there are nine market packages devoted to *Advanced Traveler Information Systems*. Each of the market packages plays a unique role in the overall function of a TIS. The following describes each market package. Since we are concerned only with Traveler Information Systems, the selection of market packages (Step 4) is straightforward; only those market packages dealing with ATIS are considered.

- ATIS 1 - Broadcast Traveler Information.
  This market package provides the user with a basic set of ATIS services; its objective is early acceptance. It involves the collection of traffic conditions, advisories, general public transportation and parking information and the near real time dissemination of this information over a wide area through existing infrastructures and low cost user equipment (e.g., FM subcarrier, cellular data broadcast). Successful deployment of this market package relies on availability of real-time transportation data from roadway instrumentation, probe vehicles or other means.

- ATIS 2 - Interactive Traveler Information.
  This market package provides tailored information in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, transit services, traveler services, ride share/ride

match, parking management, and pricing information. A variety of interactive devices may be used by the traveler to access pre-trip or en-route traveler information to include phone, kiosk, Personal Digital Assistant, personal computer, and a variety of in-vehicle devices. Successful deployment of this market package relies on availability of real-time transportation data from roadway instrumentation, probe vehicles or other means.

- ATIS 3 - Autonomous Route Guidance.
  This market package relies on in-vehicle sensory, location determination, computational, map database, and interactive driver interface equipment to enable route planning and detailed route guidance based on static, stored information. No communication with the infrastructure is assumed or required. Identical capabilities are available to the traveler outside the vehicle by integrating a similar suite of equipment into portable devices.

- ATIS 4 - Dynamic Route Guidance.
  This market package offers the user advanced route planning and guidance that is responsive to current conditions. The package combines the autonomous route guidance user equipment with a digital receiver capable of receiving real-time traffic, transit, and road condition information that is considered by the user equipment in provision of route guidance.

- ATIS 5 - ISP Based Route Guidance.
  This market package offers the user advanced route planning and guidance which is responsive to current conditions. Different than the Dynamic Route Guidance Market Package, this market package moves the route planning function from the user device to the information service provider. This approach simplifies the user equipment requirements and can provide the infrastructure better information on which to predict future traffic and appropriate control strategies to support basic route planning with minimal user equipment. The package includes two-way data communications and optionally also equips the

vehicle with the databases, location determination capability, and display technology to support turn-by-turn route guidance.

- ATIS 6 - Integrated Transportation Management/Route Guidance.
  This market package allows a traffic management center to continuously optimize the traffic control strategy based on near-real time information on intended routes for a proportion of the vehicles within their network while offering the user advanced route planning and guidance which is responsive to current conditions. It would utilize the individual and ISP route planning information to optimize signal timing while at the same time providing updated signal timing information to allow optimized route plans.

- ATIS 7 - Yellow Pages and Reservation.
  This market package enhances the Interactive Traveler Information package by adding infrastructure provided yellow pages and reservation capabilities to tailored requests for information regarding traffic conditions, transit services, traveler services, ride share/ride match, parking management, and pricing information. The same basic user equipment is included; service or advertising fees should allow recovery of the ISP investment. This market package provides multiple ways for accessing information either while en-route in a vehicle using wide-area wireless communications or pre-trip via wire line connections.

- ATIS 8 - Dynamic Ridesharing.
  This market package enhances the Interactive Traveler Information package by adding infrastructure provided dynamic ridesharing capability to tailored requests for information regarding traffic conditions, transit services, traveler services, ride share/ride match, parking management, and pricing information.

- ATIS 9 - In Vehicle Signing.
  This market package supports distribution of traffic and travel advisory information to drivers through in-vehicle devices. It includes short-range

communications between roadside equipment and the vehicle and wire line connections to the Traffic Management Subsystem for coordination and control. This market package also informs the driver of both highway-highway and highway-rail intersection status.

Ideally, any ATIS System Architecture would contain all nine market packages. However, the implementation of all the ATIS market packages at this time cannot be expected due to technological and financial constraints. Based on the study concerning the GSP, seven of the nine market packages were deemed feasible. Market packages 6 and 9 were not recommended, and possible implementation was considered deferred.

A high level ATIS system architecture does not include just ATIS market packages. One must remember that an effective ATIS system supports multi-modal traveler information, which includes air, rail, bus, as well as the single occupant vehicle. Hence, in an effective ATIS system architecture, other market packages from other subsystems, such as ATMS and APTS, must be included.

An independent analysis of the Garden State Parkway provided information concerning the market packages most suited for implementation within 10 years (NJHA 1997). From this study, the market packages used in the development of the sample system architecture were chosen. The following list contains the short-term and medium-term user service market package candidate projects. These projects were classed based on three criteria: goal satisfaction rating, implementability rating, and the market package's responsiveness to user needs. These criteria make up the definitions of Steps 2 and 3 in the methodology introduced earlier in this section. Based on these criteria, the market packages were placed into three classes: short-term implementation projects (0-5 years), medium-term implementation projects (5-10 years), or deferred projects (10+ years). The ATIS system architecture derived in this report takes into account only the short-term and the medium-term market packages.

Short-Term User Service Market Packages [24]

1. *ATMS 1a - Network Surveillance of Parkway*
2. *ATMS1b – Network Surveillance on other roads*

   This market package provides fixed roadside surveillance equipment for collecting real-time information about the roadway and traffic conditions. Surveillance equipment may include CCTV cameras, loop detectors, acoustic detectors, or other technologies for gather roadway information.
3. *ATMS 2 – Probe Surveillance*

   This market package provides additional information about the roadway and traffic conditions based on vehicle-mounted electronic tags and tag readers located along the roadway. This ability enables traffic managers to monitor road conditions and identify incidents.
4. *ATMS 3 – Surface Street Control*

   This market package provides interconnection and control of signal systems and other traffic control devices on local and arterial streets.
5. *ATMS 6 – Traffic Information Dissemination*

   This package provides a basic infrastructure for disseminating traffic information to motorists via VMS, HAR broadcasts, and other fixed or mobile devices. This package could also provide information in a format suitable for media usage.
6. *ATMS 8 – Incident Management Systems*

   This market package provides emergency response functions in order to minimize incident response and clearance times. The package provides a coordinated response by police, fire, EMS, and traffic personnel responding to an incident.
7. *ATMS 10 – Dynamic Toll/Parking Fee Management*

   This market package provides toll operators with the capability of electronically collecting tolls and detecting and processing violators. It also provides traffic information such as volume and travel times.
8. *APTS 1 – Transit Vehicle Tracking*

   This market package provides real-time tracking of transit vehicles. Transit vehicle data is transmitted to a TMC for processing and dissemination to travelers and ISPs.

9. *APTS 7 – Multi-modal Coordination*

   This market package provides improved transit service and greater overall efficiency of the transportation network by coordinating traffic and transit service.

10. *ATIS 1 – Broadcast Interactive Traveler Information*

    See above.

11. *ATIS 2 – Interactive Traveler Information*

    See above.

12. *ATIS 3 – Autonomous Route Guidance*

    See above.

13. *EM 1 – Emergency Response*

    This package provides automatic emergency vehicle notification upon verification of incident nature and location by the TMC or Emergency Management Center (EMC).

14. *ITS 1 – ITS Planning*

    This market package provides the inter-agency planning and coordination, and institutional support, for an area-wide planning initiative for deploying, maintaining, and expanding ITS systems.

Medium-Term User Service Market Packages [24]

1. *ATMS 4 – Freeway Control*

   This market package provides control of ramp meters, lane use signals, and other traffic control devices on local and arterial streets.

2. *ATMS 5 – HOV and Reversible Lane Management*

   This market package provides control of ramp meters, lane use signals, and other traffic control devices that could be installed along the GSP.

3. *ATMS 11 – Emissions and Environmental Hazards*

   This market package provides monitoring of vehicle emissions and environmental hazards, such as icy road conditions, fog, and heavy rain.

4. *APTS 2 – Transit-Fixed Route Operations*

   This market package provides automated functions for operating a fixed-route transit service. It may include automatic transit vehicle routing and scheduling and driver monitoring.

5. *APTS 3 – Demand Response Transit Operations*

   This market package automates the functions needed for operating demand responsive transit service. It may include automatic route assignment based on real-time updates of scheduled passengers and optimal routing computations.

6. *APTS 4 – Transit Passenger and Fare Management*

   This market package provides transit operators with the ability to monitor the number of passengers and allows transit customers to pay fares electronically, either on the transit vehicle, at a transit stop, or at a remote location.

7. *APTS 5 – Transit Security*

   This package provides surveillance and/or passenger activated alarms at transit stops, Park & Ride lots, and other locations where passengers may need emergency assistance.

8. *ATIS 4 – Dynamic Route Guidance*

   See Above.

9. *ATIS 5 – ISP Based Route Guidance*

   See Above.

10. *ATIS 7 – Yellow Pages and Reservations*

    See Above.

11. *ATIS 8 – Dynamic Ridesharing*

    See Above.

12. *EM 2 – Emergency Routing*

    This market package provides dynamic routing of emergency vehicles and coordination with the TMC for signal preemption and optimal access routes.

These market packages were used to create a high-level system architecture for the Garden State Parkway. This system architecture can be used to trace information flows between various ITS components. The components specifically related to ATIS can be distinguished by their blue coloring.

Figure 17 depicts the sample architecture without specific market packages. Each of the large boxes can be viewed as an individual group, and the relationships between these groups are given. The arrows represent information flows, with the arrowhead pointing to the final destination of the information. Figure 18 fills in each of the main groups with the short-term or medium-term market packages identified above. Again, the arrows represent information flows. From these diagrams, one can determine the exchange of information within the entire system.

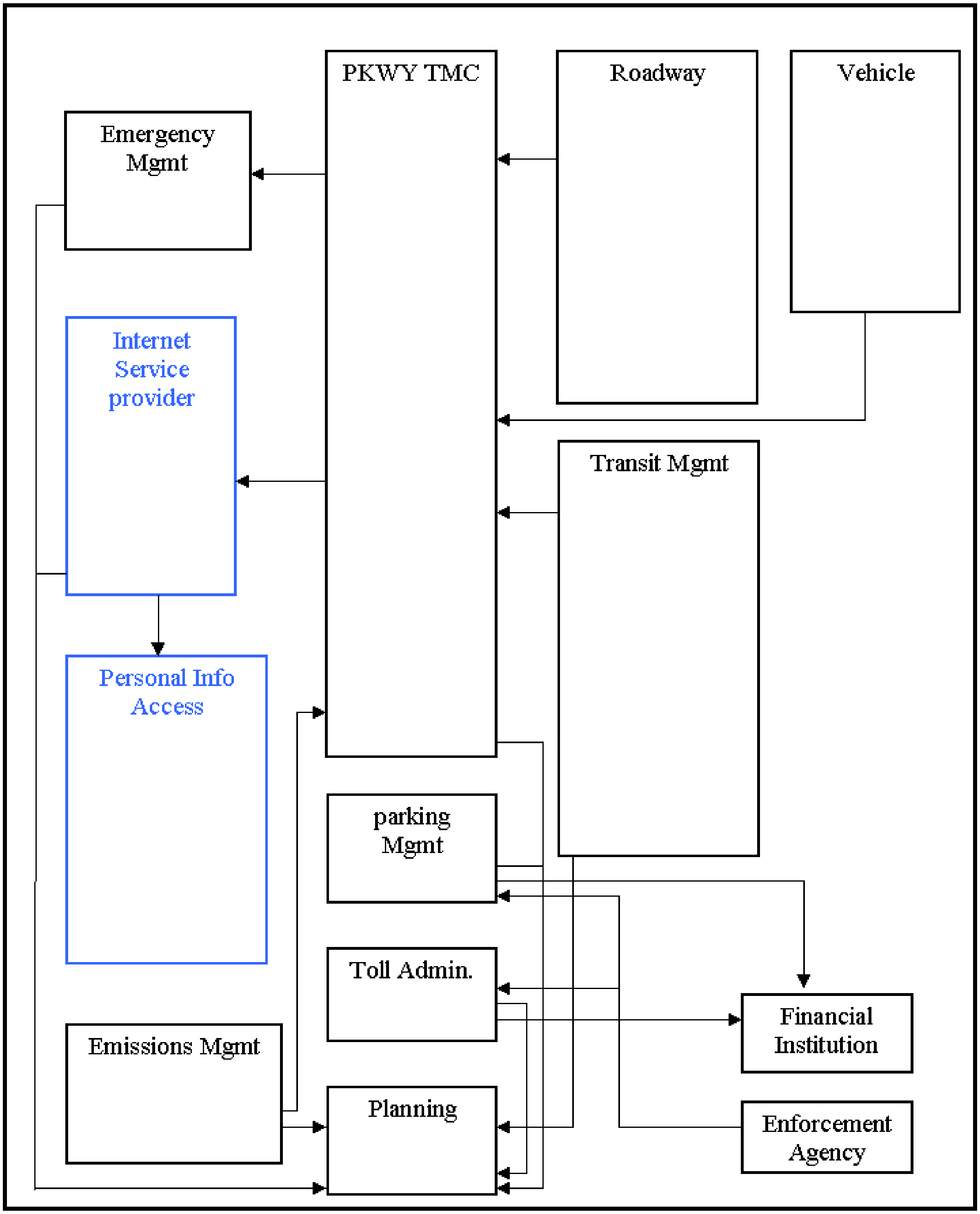

Figure 17. Sample ATIS System Architecture for Garden State Parkway Based Upon Proposed ITS Components

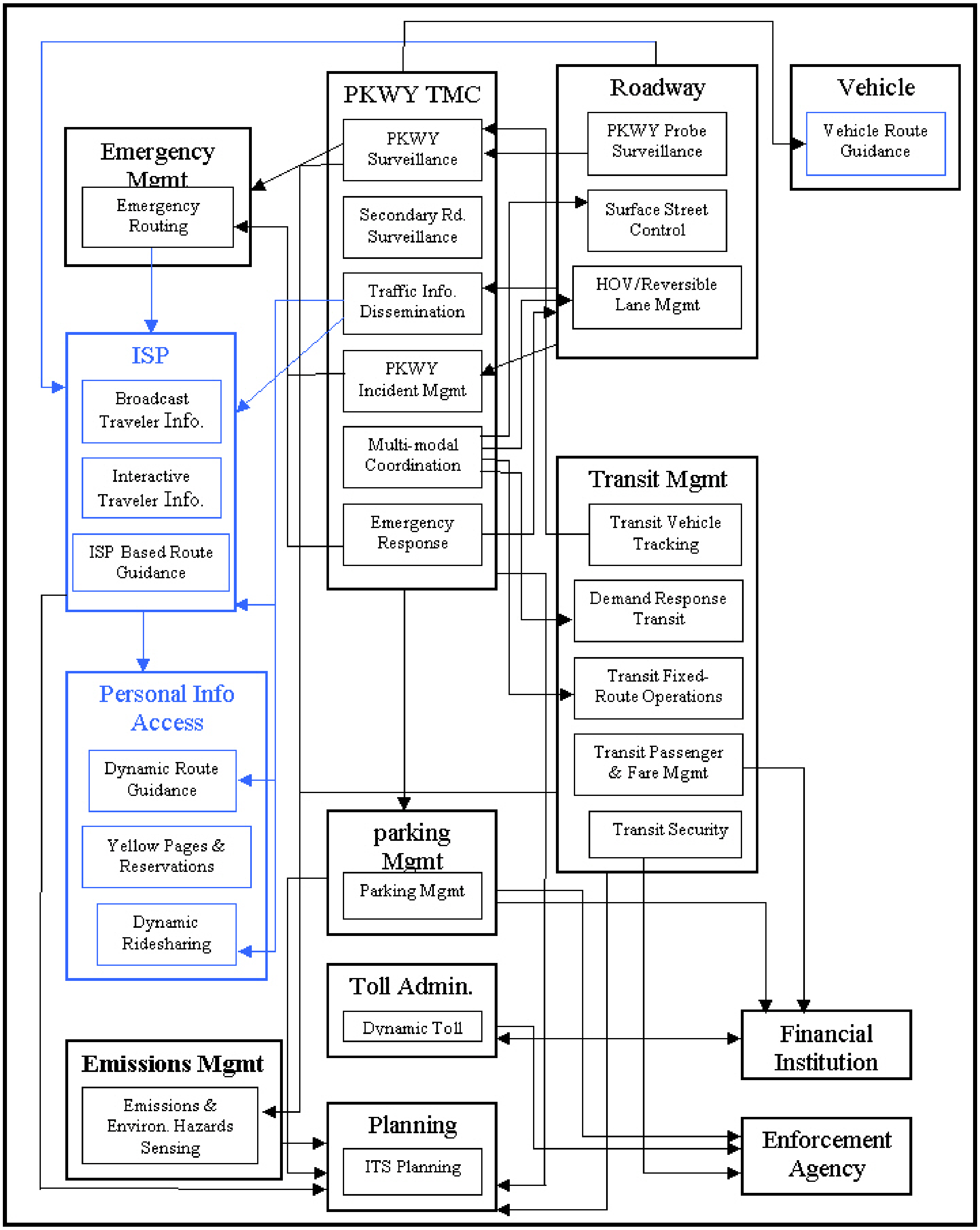

Figure 18. Sample Detailed ATIS System Architecture for Garden State Parkway Based Upon Proposed ITS Components

DISCUSSION OF SURVEY RESULTS

This section is intended to satisfy the requirements of Sub-Task #1.2, as described in the proposal for "**MULTIPLE APPROACHES TO REAL TIME ROUTE INFORMATION**". This section summarizes the results of the surveys and interviews conducted with transportation agencies in New Jersey. The following table details the agencies and persons contacted. The complete survey and its results can be found in Appendix B.

Table 9. Agencies and Contact Person for survey

Agency	Contact Person	Date	Result
NJDOT Traffic Operations North	Patricia Ott	12/22/99	Completed Survey Interview
CCTMA	William Ragozine	1/28/00	Completed Survey Interview
TRANSCOM	Tom Batz	2/9/00	Completed Survey Interview
MeadowLink TMA	Krishna Murthy	Contacted 2/10/00	No Reply
GMTMA	Sandra Brillhart	2/19/00	Completed Survey Interview
New Jersey Turnpike Authority	Robert Dale	3/2/00	Completed Survey via Fax
New Jersey Highway Authority	Rich Rash	3/7/00	Completed Survey Interview
Port Authority of NY & NJ (Tunnels & Bridges Division)	Mark Muriello Ira Huttner	4/19/00	Completed Survey Interview
Delaware Valley Regional Planning Commission	Ted Dahlburg	11/00	Completed Survey via Phone Interview
NJDOT Traffic Operations South	Jim Hogan	7/19/01	Completed Survey Interview

NJDOT - Traffic Operations North

NJDOT North is located in Mount Arlington, New Jersey. This Traffic Operations Center (TOC) is responsible for all state roadways in northern New Jersey, including roadways in Middlesex, Somerset, Hunterdon, Warren, Sussex, Morris, Essex, Hudson, Union, Passaic, and Bergen counties. The agency primarily uses two types of traffic sensing equipment: pavement loops and radar. The former is currently used in various locations throughout the northern region, while radar is being installed in the Route 80 Corridor. Data from these sensors is transmitted through leased phone lines and fiber optic lines. The agency also operates at least 60 video cameras in its jurisdiction, all with pan, zoom, and tilt capabilities. At this time, data collected using traffic sensing equipment and video cameras is not stored, but future plans include data collection and aggregation. This agency does not operate any weather sensing equipment, ETC, or weigh stations.

NJDOT North collects various types of traffic information useful for ATIS operations in New Jersey. Collected information includes incident data, traffic congestion data, and special event data. The agency also generates and disseminates traffic advisory information, and provides other public and private agencies with any required traffic data. Details concerning the type of information collected can be found in Appendix B. This information is stored, and is available to the general public and other government agencies. Information sharing is conducted using IEN, the Information Exchange Network. The IEN was designed to facilitate communications and information sharing among I-95 Coalition member agencies and with private entities. This shared information supports transportation management and traveler information on a regional (Maine to Virginia) and corridor wide (in this case, the I-95 Corridor) basis.

New Jersey Turnpike Authority

The New Jersey Turnpike Authority is located in New Brunswick, New Jersey. The TOC is responsible for traffic on the entire NJ Turnpike, which encompasses 122 linear miles plus two extensions totaling 14 miles. Traffic sensing equipment employed by the agency includes loop detectors, VIDS, and RTMS. These are all located between Interchange 8A to the northern terminus, and are used to collect speed, occupancy, volume, and vehicle classification data with a collection rate of 1 minute. Data is transmitted from these sensors via copper cable and microwave and stored with an aggregation level of 1 hour. The agency also operates Cohu video cameras in four locations, mileposts 100.0, 101.1, 105.8, and 106.4. All cameras have pan, tilt, and zoom capabilities. The agency does not operate any weather sensing equipment, ETC, or weigh stations.

The Turnpike Authority also collects traffic information that can be used in an ATIS system for New Jersey. Incident data, congestion data, and special event data is collected. However, though the information is collected, it is not stored in a singular data format. Therefore, it would be very difficult to extract specific data upon query. The agency also generates and disseminates traffic advisory data, and provides both public and private entities with traffic data. Details concerning the type of information collected can be found in the Specific Data Requirements section of the Survey Results. This data is stored, and analysis of traffic trends is conducted.

New Jersey Highway Authority

The New Jersey Highway Authority is located in Woodbridge, New Jersey. This agency is responsible for the New Jersey Parkway. The NJHA does not have an operational Traffic Operations Center for the Parkway. Rather, it uses a communications room within the agency to maintain the roadway. Two means of surveillance are primarily employed. First, the TRANSMIT program will cover the northern section of the Parkway and provide accurate traffic information. Video cameras in various locations on other stretches of the Parkway comprise the second form of surveillance. NJHA does not use any traffic sensing equipment. Video cameras are located at Interchanges 163, 82, 37 and at the Driscoll Bridge, but the data collected is not stored. Weather sensors are installed at the Driscoll Bridge, and data collected by this system includes wind speed, temperature of the pavement and air, humidity, and barometric readings. The agency also began Electronic Toll Collection operations in December of 1999. Installation of ETC on the Parkway is expected to be complete by late June of 2000. However, no traffic data, such as origin-destination data, will be collected by the ETC system. The NJHA does operate weigh stations, though permanent inspection stations do not exist. Random inspections of trucks using the Parkway occur, and state police conduct visual inspections when monitoring the Parkway and the rest stops.

The NJHA collects various types of traffic data concerning the Parkway. Incident data is collected, but only for major accidents or other such event. Traffic congestion data is not consistently collected, but the issue of congestion is addressed by a summer recreational study called SKYCOM. The New Jersey Parkway is the primary route used by travelers to access recreational facilities, such as the beach and other ports in southern New Jersey. SKYCOM is a study conducted to analyze the density of traffic during the peak summer periods. Aerial photographs are taken at each interchange on the Parkway. Level of service computation is performed using density measurements taken from the photographs. This study is conducted every five years, and the Parkway's performance is analyzed. NJHA also generates and disseminates traffic advisory data concerning travel conditions on the Parkway, and collects transportation mode data via toll collection. The agency has a database for traffic volumes, accident reports and lane closings, and scheduled lane closings and permits all public and private agencies to access transportation data for the Parkway.

Port Authority of New York & New Jersey

The PANYNJ is located in New York City. It must be noted that the response to this survey came from members of the Tunnels, Bridges, and Terminals Department of the Port Authority. Rather than having one central TOC, each of the facilities under this department's jurisdiction has its own TOC. This department employs a wide range of traffic sensing equipment. Loop detectors, video, and microwave radar are among the tools used. Loop detectors are used to cover the ramps to and from bridges and tunnels; video is primarily used at airport terminals, and the microwave radar is in use at the George Washington Bridge. CCTV is used at all bridges and tunnels. All CCTVs will soon have pan, tilt, and zoom capabilities and will be in color. Data is transmitted from the TOCs using hardwire, fiber optics, microwave radar, and leased lines. In several cases, the department borrows bandwidth from other agencies to communicate effectively. Data collected by these types of equipment include volume, occupancy, speed, and vehicle classification. Collected data is stored in raw form. The challenge facing the department is the aggregation level for the large amounts of data already collected. The department also uses weather sensors at the George Washington Bridge to ensure safe travel situations. Electronic Toll Collection is operational at most of the facilities, and is used to obtain traffic information such as vehicle classification and travel time between tollbooths. The department does not operate weigh stations, nor does it collect or distribute transit system information.

The Port Authority collects various types of traffic information from its facilities. Incident data and special event data is collected from all facilities. Though the agency does not specifically collect congestion data (i.e. source of congestion or congestion levels), it does collect volume, occupancy, and speed data from its traffic sensing equipment. The department generates and disseminates traffic advisory data, and also collects transportation mode data. It provides all collected information to public and private companies upon request. Primarily, the department works with TRANSCOM to disseminate traveler information.

TRANSCOM

TRANSCOM is a regional transportation consortium that includes the New York State Department of Transportation, the Connecticut Department of Transportation, Metropolitan Transportation Authority, MTA Bridges & Tunnels, New Jersey Department of Transportation, New Jersey Highway Authority, New Jersey Transit Corporation, New Jersey Turnpike Authority, New York City Department of Transportation, New York State Police, New York State Thruway Authority, Port Authority of New York and New Jersey, Port Authority Trans-Hudson Corporation, and Palisades Interstate Park Commission. Located in Jersey City, NJ, TRANSCOM is administratively and legally a unit of its host agency, the Port Authority of New York and New Jersey, though it is governed, funded and staffed by all of its member agencies. TRANSCOM's TOC oversees traffic from central Connecticut through New York State and into southern New Jersey, stopping at Trenton.

Presently, TRANSCOM is establishing the TRANSMIT program. The TRANSMIT system utilizes Electronic Toll and Traffic Management equipment, commonly used for

E-Z Pass Systems, to perform traffic surveillance and incident detection. E-Z Pass is an electronic toll collection system currently in operation in several locations in New Jersey. Motorists using E-Z Pass have an E-Z Pass tag in their vehicle. The TRANSMIT program relies on vehicles equipped with E-Z Pass tags. The TRANSMIT system is operational between the Hillsdale Toll Plaza on the Garden State Parkway to the New York State Thruway. Along the NYST, TRANSMIT extends from the Tappen Zee Bridge to the Spring Valley Toll Plaza. On this route, tag readers, or a RoadSide Terminal (RST), are installed at 0.5 to 2.1 mile intervals. Each time an E-Z Pass tag equipped vehicle passes an RST location, the reader interrogates the tag inside the vehicle. The vehicle tag responds by sending its identification number. At this point, data is transmitted from the RST to the Operations Information Center (OIC) in Jersey City, NJ. Data includes tag ID, location and lane position. Such surveillance data is recorded continuously at 22 RST locations. The vehicle travel times are determined from the stored data at the OIC. An incident detection algorithm uses this data to determine if an incident has occurred. The algorithm is based upon statistical comparison of real-time estimated travel times with updated historical travel times for the same time period of day and type of day.

NJDOT - Traffic Operations South

NJDOT Traffic Operations South is responsible for southern New Jersey's transportation network, which includes Mercer, Monmouth, Burlington, Ocean, Camden, Gloucester, Atlantic, Salem, Cumberland, and Cape May counties. The agency uses a variety of sensors to collect traffic data, including loop detectors, VIDS, cameras, and their own service patrol. As of the interview date, all sensory equipment, except for the VIDS, was operational. NJDOT South's service patrol is by far the most wide-ranging means to collect traffic data. The service patrol consists of eleven trucks, six of which cover southern New Jersey, while the remaining trucks cover central New Jersey. The trucks are operational for 16 hours/day for 5 days/week. Each group of trucks, i.e. the central and southern group, reports to a supervisor who collects incident data and stores it in a database. The loop detectors and video cameras are operational 24 hours/day for 7 days/week. Usually, these devices are deployed in pairs in order to provide reliability and redundancy in the data collection and analysis process. Data is transmitted from these devices to the TOC through fiber optic lines and T1 lines, and the data collected by the loop detectors is stored at an aggregation level of 5-15 minutes. The video cameras all have pan, tilt, and zoom capabilities. Traffic Operations South also employs weather sensors to collect precipitation data. Currently, there are twelve weather sensors in the field, and they collect data concerning precipitation type (rain, snow, ice), atmospheric data (wind speed), temperature data, including atmospheric and pavement temperatures. Traffic Operations South does not operate weight stations or ETC.

NJDOT South collects various types of traffic information useful for ATIS operations in New Jersey such as incident data and special event data. The agency also generates and disseminates traffic advisory information, and provides other public and private agencies with any required traffic data. Details concerning the type of information collected can be found in Appendix B. NJDOT South has also established relations with a traffic information ISP (Information Service Provider), SmartRoute Systems. As a result of this relationship, NJDOT South passes their traffic information onto SmartRoute for public dissemination, while SmartRoute passes traffic data collected by their own traffic sensors to NJDOT South. Furthermore, NJDOT South promotes information sharing by taking part in the IEN, the Information Exchange Network, which was described previously.

Cross County Connection (CCTMA)

Cross County Connection is located in Marlton, New Jersey and influences much of southern New Jersey's transportation system. CCTMA's primary service area is Burlington and Camden counties, but also provides for Gloucester, Salem, Cumberland, Atlantic, and Cape May counties. The TMA is funded by NJDOT, NJTRANSIT, and the dues of its membership organization, which currently consists of 45 businesses. The businesses in the TMA's membership organization can be found at the TMA's website. CCTMA strives to improve the quality of life in southern New Jersey through transportation solutions. The organization is working towards gaining recognition for making a visible, well-defined change in traffic congestion in southern NJ. The organization hopes to achieve this goal by promoting the use of alternatives to the single occupancy vehicle. The TMA gathers its transportation data through NJDOT Traffic Operations South and through NJTRANSIT. Gathered data includes information on construction projects, non-recurring incidents and congestion, and occasional special event and traffic advisory data. CCTMA also collects and distributes transit schedules for all forms of transit. All transit information is derived from NJ Transit. Collected data is usually amended before being transmitted to members, and occasionally information is added such as incident duration. Traveler information is disseminated through various mediums, including email, faxes, and always through the website. The website is updated twice daily with information such as incidents, locations of maintenance activities and construction projects. A study concerning the usage of traveler information by CCTMA's member organizations will be conducted in the near future.

Greater Mercer (GMTMA)

The Greater Mercer TMA is located in Princeton, New Jersey. Greater Mercer currently services the entire Mercer county area, and parts of Middlesex and Somerset counties. GMTMA is also funded by NJDOT and NJTRANSIT. Membership dues supplement this funding. The TMA's website provides a list of its membership organization. GMTMA works with employers, both public and private, to improve mobility and reduce traffic congestion in the Mercer county area by developing options to the single occupancy vehicle. The TMA gathers its traffic data from NJDOT, NJDOT North, NJTPK, and from the counties and municipalities it services. The data consists of incident information, traffic congestion data, transit information, special event data, and construction information. Data collected is slightly modified before being distributed to the membership organization. Modifications include providing exact street locations and informing customers of alternate routes due to incidents. Information dissemination occurs using faxes, email, and the TMA's website. Information is sent either to individual employees or to a company coordinator. Traveler information is updated as needed, and at the minimum, once a week. For example, long-term construction information is posted and updated on the website, whereas serious non-recurring congestion information is disseminated immediately. A study concerning the usage of

GMTMA’s traveler information is being conducted in conjunction with NJDOT. The TMA itself has conducted surveys previously. In general, their customers have found the information valuable, and have given positive feedback. However, customers have noted that some information is not applicable to their location.

Open Ended Questions

Open-ended questions were asked to help determine useful information for developing an ATIS in New Jersey. Several of the questions will be discussed, but each participant’s response to all questions can be found in the New Jersey ITS Information and General ITS/TIS Questions sections of the Survey Results. The first topic concerns the use of probe vehicles to gather traffic information. Probe vehicles can determine traffic flow characteristics in real-time and with high levels of accuracy. In a TIS, probe vehicles can be used to verify data received by traffic sensors, and also to collect data in areas where traffic sensors are not available. Probe vehicles are versatile and reliable data collection tools. NJDOT North and NJTPA gather probe vehicle information through TRANSCOM’s TRANSMIT program. The Port Authority uses its own probe vehicles to gather data, including origin-destination information and travel times. Though NJHA does not gather probe vehicle information, similar traffic analysis is done using SKYCOM.

The second issue to be addressed is incident detection and incident management. Incidents can disrupt traffic flow for hours, and affect an entire transportation network. Hence, each agency’s incident detection and management capabilities are quite important. NJDOT North and NJTPA are involved in both incident detection and management. DOT North has Incident Management Response Teams (IMRTs) that respond to major incidents along state highways. A NJSP Sergeant is located within the agency to assist the IMRT efforts. Future plans concerning incident management include developing pre-planned county diversion routes. NJTPA is involved in incident management throughout the course of the incident. The agency has field personnel at the incident site to assist in clearing the incident. The Port Authority also has field personnel attend major incidents at its facilities. NJHA is not involved in incident management. Incident detection is accomplished using a variety of tools, most prevalent being facility staff. Toll collectors, NJSP, maintenance and operations personnel, emergency personnel, and finally motorists all contribute to incident detection. Motorists can report incidents to toll collectors, or can report the accident to the appropriate agency, NJSP, or can use 911. ITS technologies are also used to detect incidents. NJDOT North and the Port Authority currently use cameras to detect incidents. NJHA plan on using the TRANSMIT program for incident detection. Finally, TRANSCOM does not partake in incident management tasks, but rather distributes incident information that it gathers from member agencies and various other ATMS programs.

The third issue that requires attention is information dissemination. Does each agency distribute traveler information after incident detection, and if so, through what medium and what type of content? All of the surveyed agencies distribute traveler information, but the medium used and the content delivered varies greatly. NJDOT North distributes information using CMS, VMSD, radio, and the media. Information delivered often includes location of the incident, anticipated duration, time, and existing traffic conditions. Also, this agency distributes weekly construction reports via email to TRANSCOM and relevant TMAs to forewarn the public about expected delays. TRANSCOM distributes traveler information only under certain conditions, such as a major accident, and does so through CMS, radio, media, and kiosks. The information content is similar to the DOT North's information. Also, TRANSCOM distributes to Weekly Traffic & Transit Advisories containing construction and special event information gathered from its member agencies. At the moment, NJTPA disseminates information via CMS, VMSD, radio, media, HAR, and HAT. The information contains the location and extent of congestion, and length of delay if available. The Port Authority disseminates information only through CMS and VMSD. However, future plans include posting traveler information on its website and through TRANSCOM. PANYNJ informs travelers of the length of delay, travel time, and location of congestion. Finally, the NJHA currently disseminates information through the media and its website. Future options include using TRANSCOM's kiosks to deliver information to the public. Unfortunately, the content of the information is unavailable.

The next issue that requires attention concerns TIS data itself. Should the state be responsible for traveler information, or should each county be responsible for its own data. Except for TRANSCOM, all agencies, including the TMAs, felt that the state should be responsible for TIS data. The participant's from the Port Authority also suggested that TRANSCOM should be responsible, instead of the state. Several reasons were given to support the conclusion that the state should be responsible. First, counties do not have enough power or resources to obtain accurate and detailed traveler information. Second, many incidents are not formally reported, but cause congestion. The state's resources will be more efficient in tracking the effects of these incidents than the counties. Finally, the New Jersey State Police, a state agency, is a powerful ally for TIS. NJSP can report incidents, traffic conditions, and other valuable traveler information. Counties do not have such strong, individual police forces. Finally, the state can act as a centralized depository for a wealth of traveler information. Accessing information from a variety of sources is difficult, but if all the information is compiled, then travelers are more likely to take advantage of this new resource. Instead of allowing the state or the counties to be responsible for TIS data, the Port Authority suggested that TRANSCOM be responsible due to its regional scope. TRANSCOM already collects traveler information for much of this region, and can be the hub for TIS in New Jersey.

The last two questions to be examined involved the needs or problems that a TIS can solve for each agency, and the agencies that should be involved in a TIS in New Jersey. The former question received a variety of answers. NJTPA believes that a TIS can reduce congestion, improve safety, reduce emissions, and reduce driver stress, thereby improving the New Jersey Turnpike. NJHA hopes that pre-trip traveler information, distributed by a TIS, will reduce congestion and reduce travel times. The PANYNJ stated that a TIS could reduce overall congestion in the region's transportation network, and help in route planning and diversion strategies. NJDOT North questioned its role in a Traveler Information System. It believed that other groups could handle the problem better, specifically TRANSCOM. Also, the ATIS field is becoming a rapidly growing business enterprise, and private companies are involved as a for-fee personalized traveler information service. A government agency may not be able to compete in such an environment. The TMAs also had a relevant response to this question. CCTMA stated that a TIS could distribute traveler information to the public quickly and efficiently, thereby supplementing their own information dissemination. GMTMA felt that a TIS could support their goal of promoting alternate modes of transportation. The latter question, however, received very similar answers. The consensus opinion was that all transportation agencies, ranging from the DOT, toll agencies, TRANSCOM, NJSP, & NJTRANSIT be involved in TIS development.

User Service Rankings

Each of the agencies surveyed was asked to rate 30 user services as a high, medium, or low priority. The results varied extremely, with agencies emphasizing different user services. However, seven user services consistently received high ratings. They are pre-trip travel information, en-route driver information, route guidance, traveler information services, traffic control, travel demand management, and hazardous material incident response. The following is a brief description of these user services.

- Pre-Trip Travel Information assists travelers in making mode choices, travel time estimates, and route decisions prior to trip departure. It consists of four major functions, which are, (1) Available Services Information, (2) Current Situation Information, (3) Trip Planning Service, and (4) User Access. Information is integrated from various transportation modes and presented to the user for decision-making.
- En-Route Driver Information function provides vehicle drivers with information, while en-route, which will allow alternative routes to be chosen for their destination. Driver Information consists of two major functions, which are (1) Driver Advisory and (2) In-vehicle Signing. The potential decrease in traffic may also provide benefits in highway safety, reduced air pollution, and decreased congestion.

- Route Guidance will provide travelers with directions to selected destinations. Four functions are provided which are (1) Provide Directions, (2) Static Mode, (3) Real-Time Mode, and (4) User Interface.
- Traveler Information Services provides travelers with service and facility data for the purpose of assisting prior to embarking on a trip or after the traveler is underway. The functions included in this capability are Information Receipt and Information Access. This will provide the traveler with a "yellow pages" type of capability.
- Traffic Control provides the capability to efficiently manage the movement of traffic on streets and highways. Four functions are provided which are (1) Traffic Flow optimization, (2) Traffic Surveillance, (3) Control Function, and (4) Provide Information. This will also include control of network signal systems with eventual integration of freeway control.
- Incident Management will identify incidents, formulate response actions, and support initiation and ongoing coordination of those response actions. Six major functions are provided which are (1) Scheduled Planned Incidents, (2) Identify Incidents, (3) Formulate response Actions, (4) Support Coordinated Implementation of Response Actions, (5) Support Initialization of Response to Actions, and (6) Predict Hazardous Conditions.
- Travel Demand Management will generate and communicate management and control strategies that will support and facilitate the implementation of TDM programs, policies and regulations. It consists of two major functions, which are (1) Increase Efficiency of Transportation System and (2) Provide Wide Variety of Mobility Options.
- Hazardous Material Incident Response will provide response to incidents involving hazardous materials.

The fact that these user services were ranked so high is not a coincidence. All of the existing ATIS programs fulfill these user service requirements. Pre-trip travel information, en-route trip information, and route guidance are user services that provide travelers with information before and during their travels. Modifications to their planned route can be made at any time, and travelers can receive directions in unfamiliar areas. Traffic control, incident management, and travel demand management are ATMS strategies that improve the efficiency of a transportation network. By improving the transportation network using ATMS strategies, and transmitting traveler information using ATIS concepts, travelers receive the most benefit.

As can be seen from the summaries presented above, much of the information required to develop a high-level ATIS system architecture, as per the methodology given in the previous section, can be interpreted from the survey results. For example, the first step in the methodology is to identify the systems for the sausage diagram, which can be found from the answers to the agency questions in the survey. Next, the required user services (Step 2 in the methodology) can be found from the user service rankings. Then, the functional requirements or each organization are construed from the open-ended questions. Finally, the market packages and the sausage diagram itself can be developed from the results of these three steps.

GENERATING TRAVELER INFORMATION SYSTEM SCENARIOS

ATIS Market Packages

In order to generate scenarios to test a traveler information system, several concepts must be further reviewed. First, detailed analysis of all nine ATIS market packages should be finished. The following figures (Figure 19-27), taken directly from the National ITS Architecture, detail the information flows for each market package. The larger boxes in each figure represent subsystems, while the smaller boxes inside the subsystem represent equipment packages. Finally, arrows represent information flows.

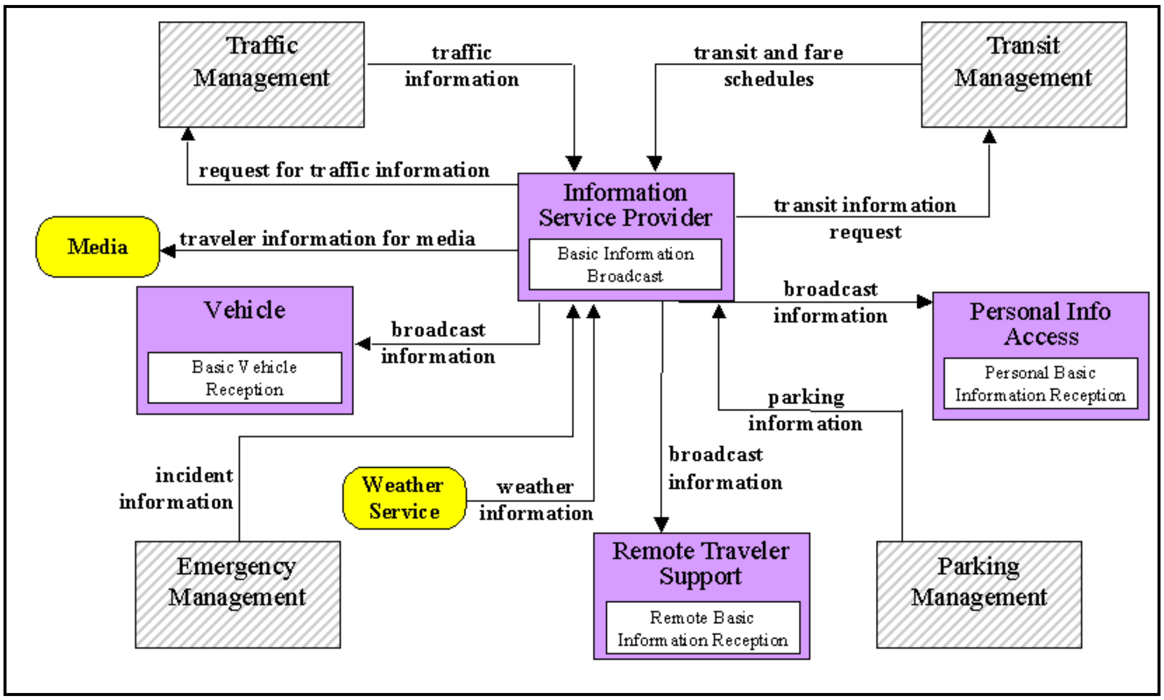

Figure 19. ATIS 1 - Broadcast Traveler Information [(13)]

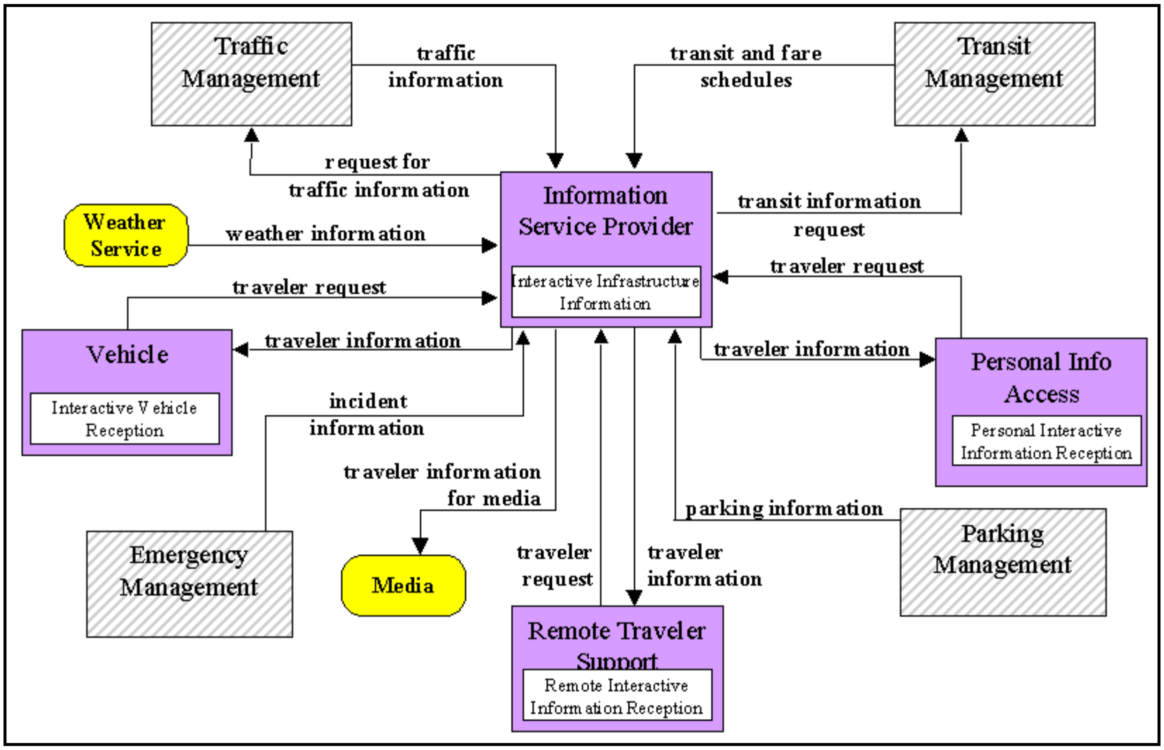

Figure 20. ATIS 2 - Interactive Traveler Information [13]

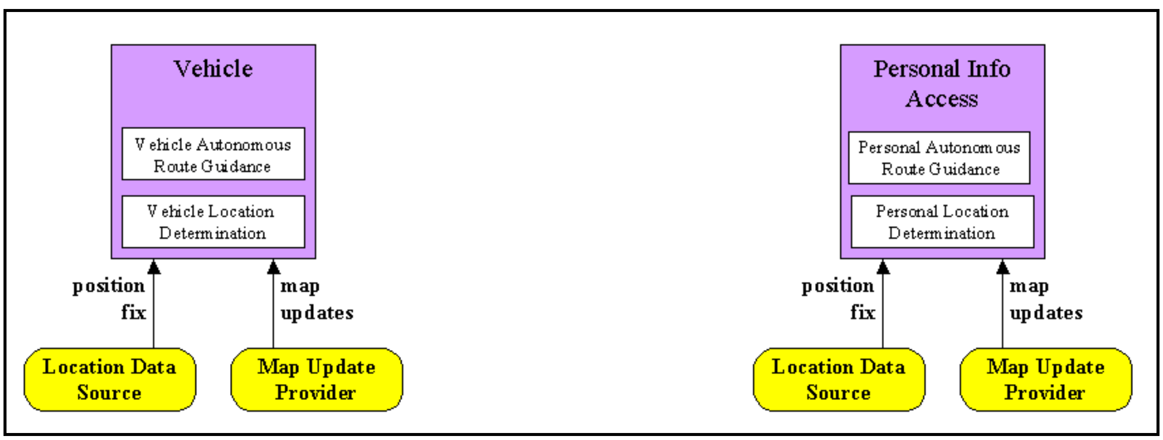

Figure 21. ATIS 3 - Autonomous Route Guidance [13]

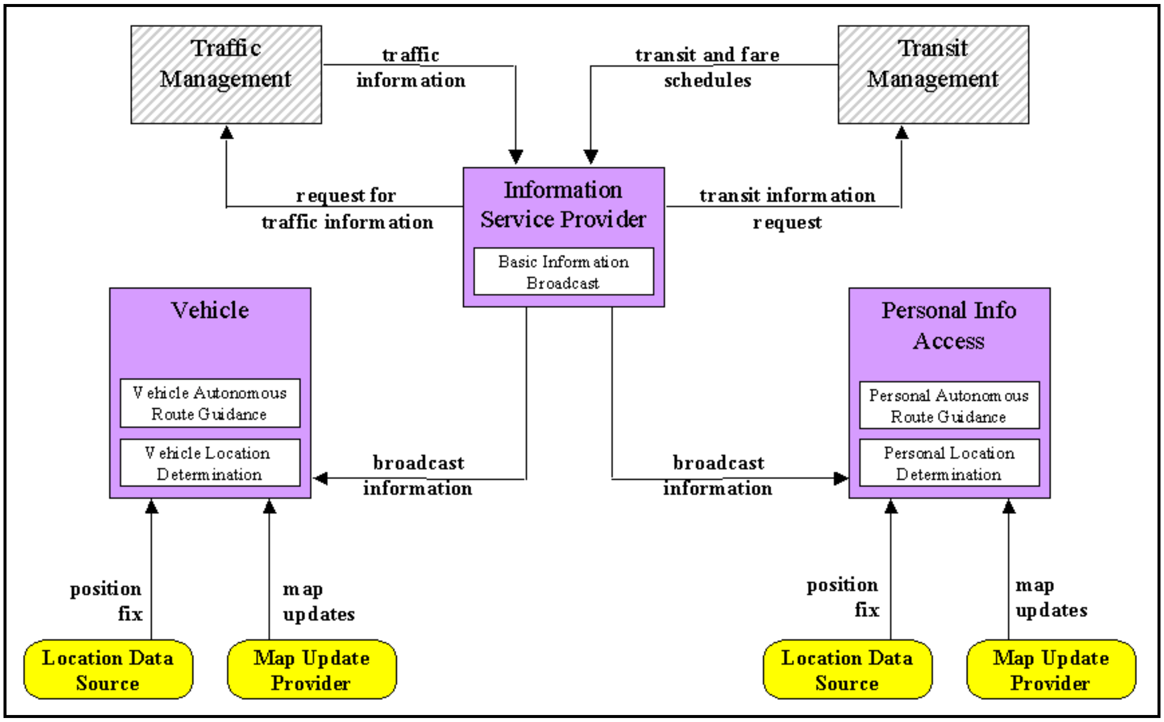

Figure 22. ATIS 4 - Dynamic Route Guidance (13)

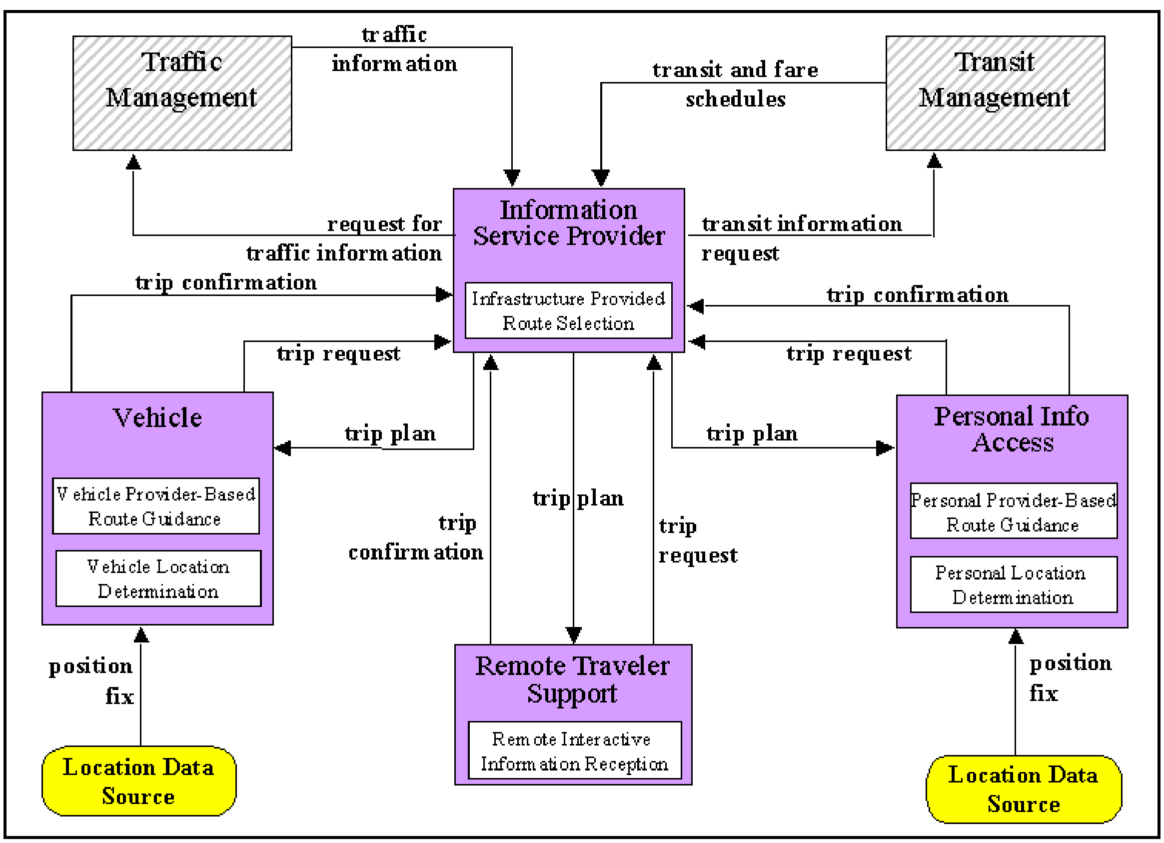

Figure 23. ATIS 5 - ISP Based Route Guidance (13)

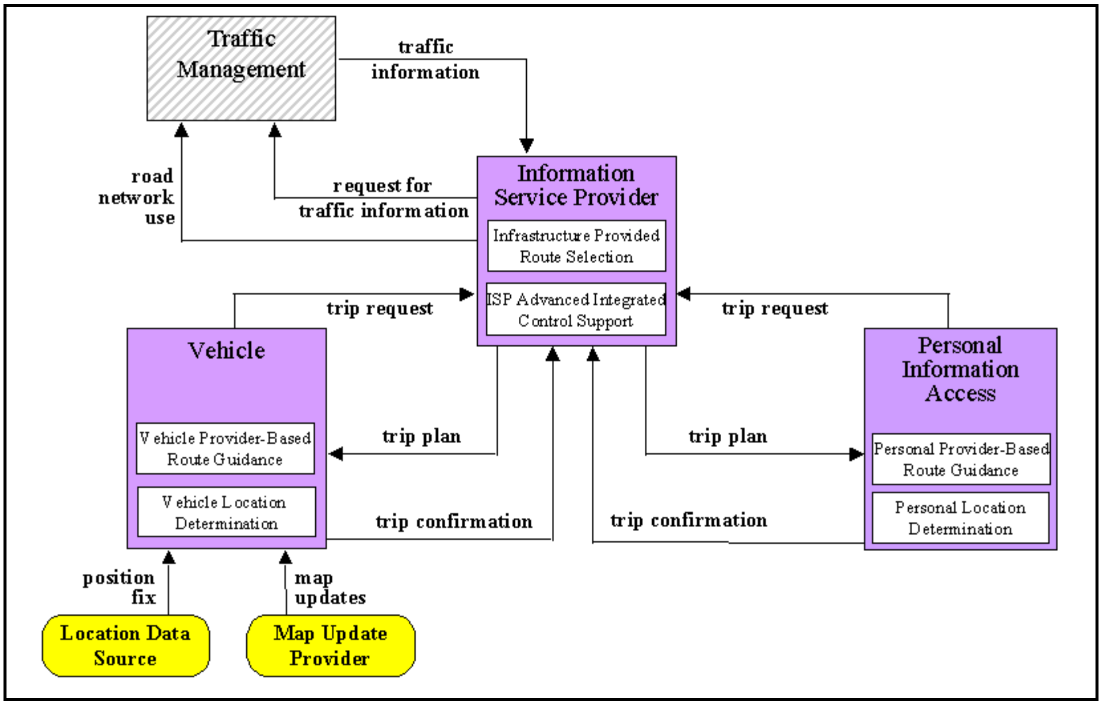

Figure 24. ATIS 6 - Integrated Transportation Management/Route Guidance (13)

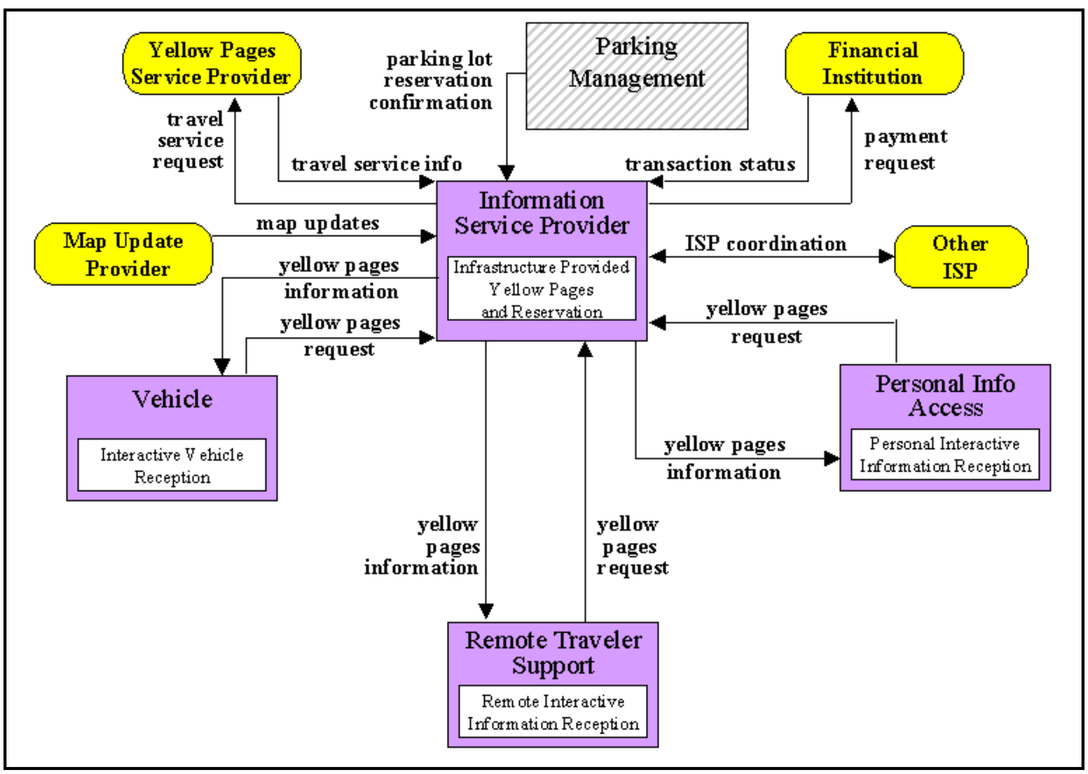

Figure 25. ATIS 7 - Yellow Pages and Reservation (13)

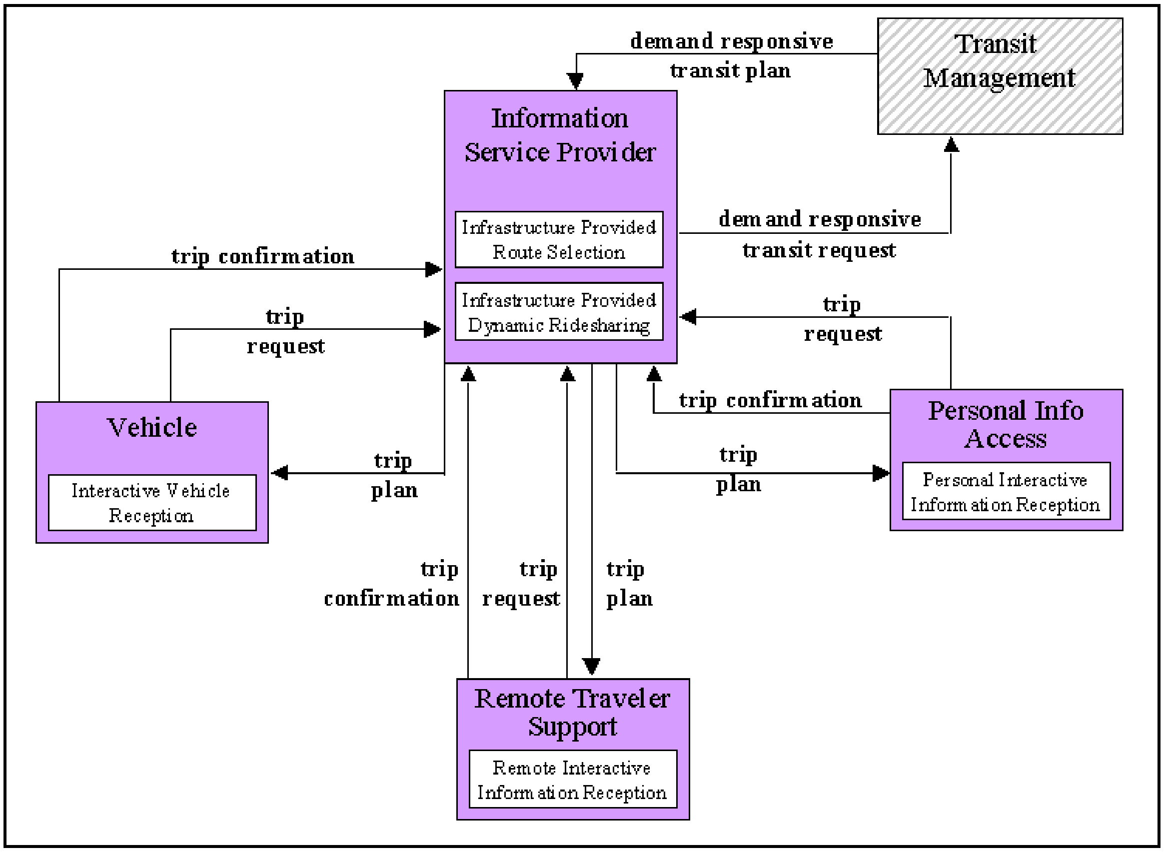

Figure 26. ATIS 8 - Dynamic Ridesharing (13)

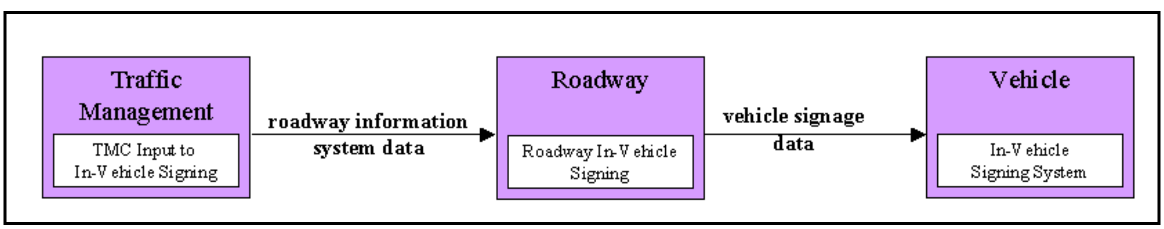

Figure 27. ATIS 9 - In Vehicle Signing (13)

ATIS Related Subsystem Descriptions

This section gives a brief description of the 10 subsystems that comprise an Advanced Traveler Information System, as given in the National ITS System Architecture. These subsystems can be seen in the ATIS market package graphics in the previous section. Since each subsystem plays a role in the various ATIS market packages, a thorough understanding of each subsystem is required. The following sections briefly describe each subsystem.

Personal Information Access Subsystem

This subsystem provides the capability for travelers to receive formatted traffic advisories from their homes, place of work, major trip generation sites, personal portable devices, and over multiple types of electronic media. These capabilities shall also provide basic routing information and allow users to select those transportation modes that allow them to avoid congestion, or more advanced capabilities to allow users to specify those transportation parameters that are unique to their individual needs and receive travel information. This subsystem shall provide capabilities to receive route planning from the infrastructure at fixed locations such as in their homes, their place of work, and at mobile locations such as from personal portable devices and in the vehicle or perform the route planning process at a mobile information access location. This subsystem shall also provide the capability to initiate a distress signal and cancel a prior issued manual request for help.

Remote Traveler Support Subsystem

This subsystem provides access to traveler information at transit stations, transit stops, other fixed sites along travel routes, and at major trip generation locations such as special event centers, hotels, office complexes, amusement parks, and theaters. Traveler information access points include kiosks and informational displays supporting varied levels of interaction and information access. At transit stops, simple displays providing schedule information and imminent arrival signals can be provided. This basic information may be extended to include multi-modal information including traffic conditions and transit schedules along with yellow pages information to support mode and route selection at major trip generation sites. Personalized route planning and route guidance information can also be provided based on criteria supplied by the traveler. In addition to traveler information provision, this subsystem also supports public safety monitoring using CCTV cameras or other surveillance equipment and emergency notification within these public areas. Fare card maintenance, and other features that enhance traveler convenience may also be provided at the discretion of the deploying agency.

Information Service Provider Subsystem

This subsystem collects, processes, stores, and disseminates transportation information to system operators and the traveling public. The subsystem can play several different roles in an integrated ITS. In one role, the ISP provides a general data warehousing function, collecting information from transportation system operators and redistributing this information to other system operators in the region and other ISPs. In this information redistribution role, the ISP provides a bridge between the various transportation systems that produce the information and the other ISPs and their subscribers that use the information. The second role of an ISP is focused on delivery of traveler information to subscribers and the public at large. Information provided includes basic advisories, real time traffic condition and transit schedule information, yellow pages information, ride matching information, and parking information. The subsystem also provides the capability to provide specific directions to travelers by receiving origin and destination requests from travelers, generating route plans, and returning the calculated plans to the users. In addition to general route planning for travelers, the ISP also supports specialized route planning for vehicle fleets. In this third role, the ISP function may be dedicated to, or even embedded within, the dispatch system. Reservation services are also provided in advanced implementations. The information is provided to the traveler through the Personal Information Access Subsystem, Remote Traveler Support Subsystem, and various Vehicle Subsystems through available communications links. Both basic one-way (broadcast) and personalized two-way information provision is supported. The subsystem provides the capability for an informational infrastructure to connect providers and consumers, and gather that market information needed to assist in the planning of service improvements and in maintenance of operations.

Traffic Management Subsystem

The Traffic Management Subsystem operates within a traffic management center or other fixed location. This subsystem communicates with the Roadway Subsystem to monitor and manage traffic flow. Incidents are detected and verified and incident information is provided to the Emergency Management Subsystem, travelers (through Roadway Subsystem Highway Advisory Radio and Dynamic Message Signs), and to third party providers. The subsystem supports HOV lane management and coordination, road pricing, and other demand management policies that can alleviate congestion and influence mode selection. The subsystem monitors and manages maintenance work and disseminates maintenance work schedules and road closures. The subsystem also manages reversible lane facilities, and processes probe vehicle information. The subsystem communicates with other Traffic Management Subsystems to coordinate traffic information and control strategies in neighboring jurisdictions. It also coordinates with rail operations to support safer and more efficient highway traffic management at highway-rail intersections. Finally, the Traffic Management Subsystem provides the capabilities to exercise control over those devices utilized for AHS traffic and vehicle control.

Transit Management Subsystem

The Transit Management Subsystem manages transit vehicle fleets and coordinates with other modes and transportation services. It provides operations, maintenance, customer information, and planning and management functions for the transit property. It spans distinct central dispatch and garage management systems and supports the spectrum of fixed route, flexible route, and paratransit services. The subsystem's interfaces allow for communication between transit departments and with other operating entities such as emergency response services and Traffic Management Systems. This subsystem receives special event and real-time incident data from the Traffic Management Subsystem. It provides current transit operations data to other center subsystems. The Transit Management Subsystem collects and stores accurate ridership levels and implements corresponding fare structures. It collects operational and maintenance data from transit vehicles, manages vehicle service histories, and assigns drivers and maintenance personnel to vehicles and routes. The Transit Management Subsystem also provides the capability for automated planning and scheduling of public transit operations. It furnishes travelers with real-time travel information, continuously updated schedules, schedule adherence information, transfer options, and transit routes and fares. In addition, the monitoring of key transit locations with both video and audio systems is provided with automatic alerting of operators and police of potential incidents including support for traveler activated alarms.

Emergency Management Subsystem

The Emergency Management Subsystem operates in various emergency centers supporting public safety including police and fire stations, search and rescue special detachments, and HAZMAT response teams. This subsystem interfaces with other Emergency Management Subsystems to support coordinated emergency response involving multiple agencies. The subsystem creates, stores, and utilizes emergency response plans to facilitate coordinated response. The subsystem tracks and manages emergency vehicle fleets using automated vehicle location technology and two-way communications with the vehicle fleet. Real-time traffic information received from the other center subsystems is used to further aide the emergency dispatcher in selecting the emergency vehicle(s) and routes that will provide the timeliest response. Interface with the Traffic Management Subsystem allows strategic coordination in tailoring traffic control to support en-route emergency vehicles. Interface with the Transit Management Subsystem allows coordinated use of transit vehicles to facilitate response to major emergencies.

Roadway Subsystem

This subsystem includes the equipment distributed on and along the roadway that monitors and controls traffic. Equipment includes highway advisory radios, dynamic message signs, cellular call boxes, CCTV cameras and video image processing systems for incident detection and verification, vehicle detectors, traffic signals, grade crossing warning systems, and freeway ramp metering systems. This subsystem also provides the capability for emissions and environmental condition monitoring including weather sensors, pavement icing sensors, fog etc. HOV lane management and reversible lane management functions are also available. In advanced implementations, this subsystem supports automated vehicle safety systems by safely controlling access to and egress from an Automated Highway System through monitoring of, and communications with, AHS vehicles. Intersection collision avoidance functions are provided by determining the probability of a collision in the intersection and sending appropriate warnings and/or control actions to the approaching vehicles.

Parking Management Subsystem

The Parking Management Subsystem provides electronic monitoring and management of parking facilities. It supports a DSRC communications link to the Vehicle Subsystem that allows electronic collection of parking fees. It also includes the instrumentation, signs, and other infrastructure that monitors parking lot usage and provides local information about parking availability and other general parking information. This portion of the subsystem functionality must be located in the parking facility where it can monitor, classify, and share information with customers and their vehicles. The subsystem also interfaces with the financial infrastructure and broadly disseminates parking information to other operational centers in the region. Note that the latter functionality may be located in a back office, remote from the parking facility.

Vehicle Subsystem

This subsystem resides in an automobile and provides the sensory, processing, storage, and communications functions necessary to support efficient, safe, and convenient travel by personal automobile. Information services provide the driver with current travel conditions and the availability of services along the route and at the destination. Both one-way and two-way communications options support a spectrum of information services from low-cost broadcast services to advanced, pay for use personalized information services. Route guidance capabilities assist in formulation of an optimal route and step-by-step guidance along the travel route. Advanced sensors, processors, enhanced driver interfaces, and actuators complement the driver information services so that, in addition to making informed mode and route selections, the driver travels these routes in a safer and more consistent manner. Initial collision avoidance functions provide “vigilant co-pilot” driver-warning capabilities. More advanced functions assume limited control of the vehicle to maintain safe headway. Ultimately, this subsystem supports completely automated vehicle operation through advanced communications with other vehicles in the vicinity and in coordination with supporting infrastructure subsystems. Pre-crash safety systems are deployed and emergency notification messages are issued when unavoidable collisions do occur.

Transit Vehicle Subsystem

This subsystem resides in a transit vehicle and provides the sensory, processing, storage, and communications functions necessary to support safe and efficient movement of passengers. The Transit Vehicle Subsystem collects accurate ridership levels and supports electronic fare collection. An optional traffic signal prioritization function communicates with the roadside subsystem to improve on-schedule performance. Automated vehicle location functions enhance the information available to the Transit Management Subsystem enabling more efficient operations. On-board sensors support transit vehicle maintenance. The Transit Vehicle Subsystem also furnishes travelers with real-time travel information, continuously updated schedules, transfer options, routes, and fares.

Information Flows Between Subsystems

Figures 28-32 contain the information flows between the physical subsystems of the NSA. The subsystems diagramed below are relevant to ATIS functionality. The superscripted numbers next to information flows represent the agencies that have this capability. Agency capabilities were determined from the survey results. The legend is as follows:

1	TRANSCOM
2	NJDOT Traffic Operations North
3	NJ Turnpike Authority
4	NJ Highway Authority
5	Port Authority of New York & New Jersey
6	CCTMA
7	GMTMA

Figures 28-32 illustrate the existing capabilities of New Jersey transportation agencies. Though many subsystems relationships exist, the following relationships have been clearly identified at this time. As research continues, other subsystem relationships can be further detailed. Again, these figures were generated using the results from the Traveler Information Survey.

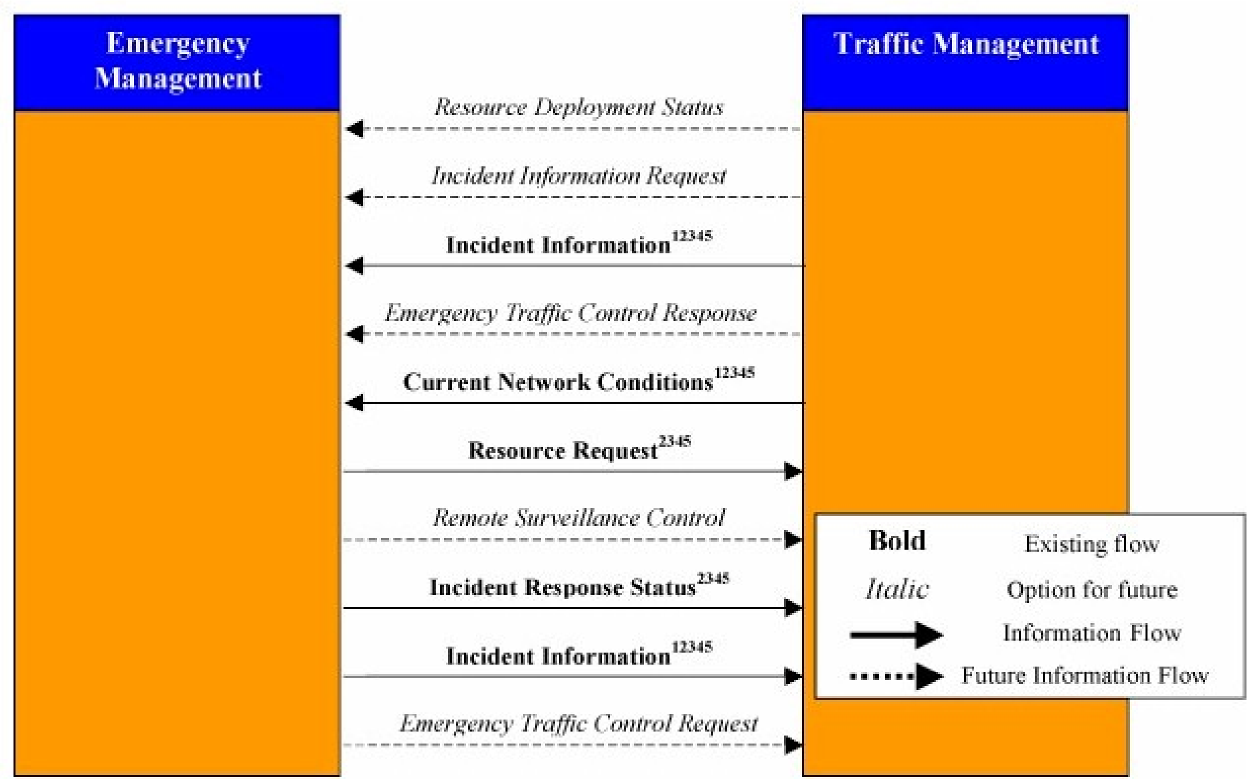

Figure 28. Emergency Management/Traffic Management

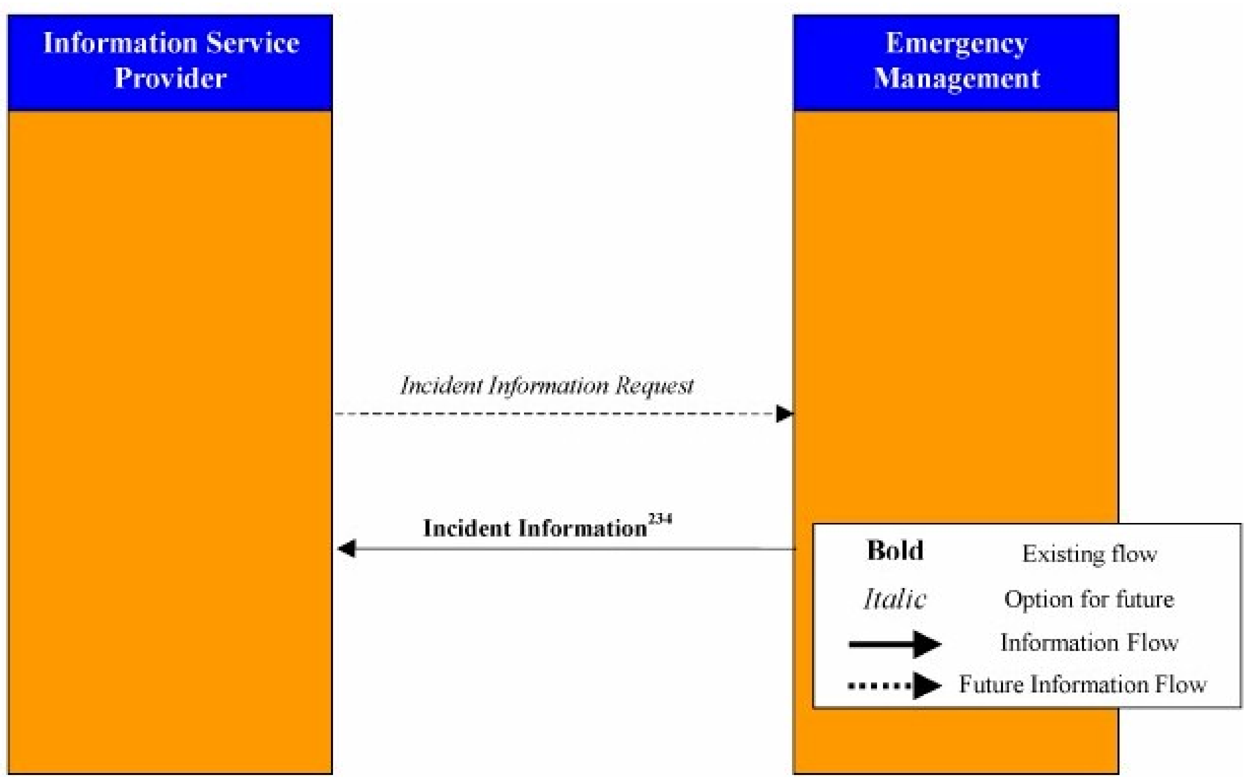

Figure 29. Information Service Provider/Emergency Management

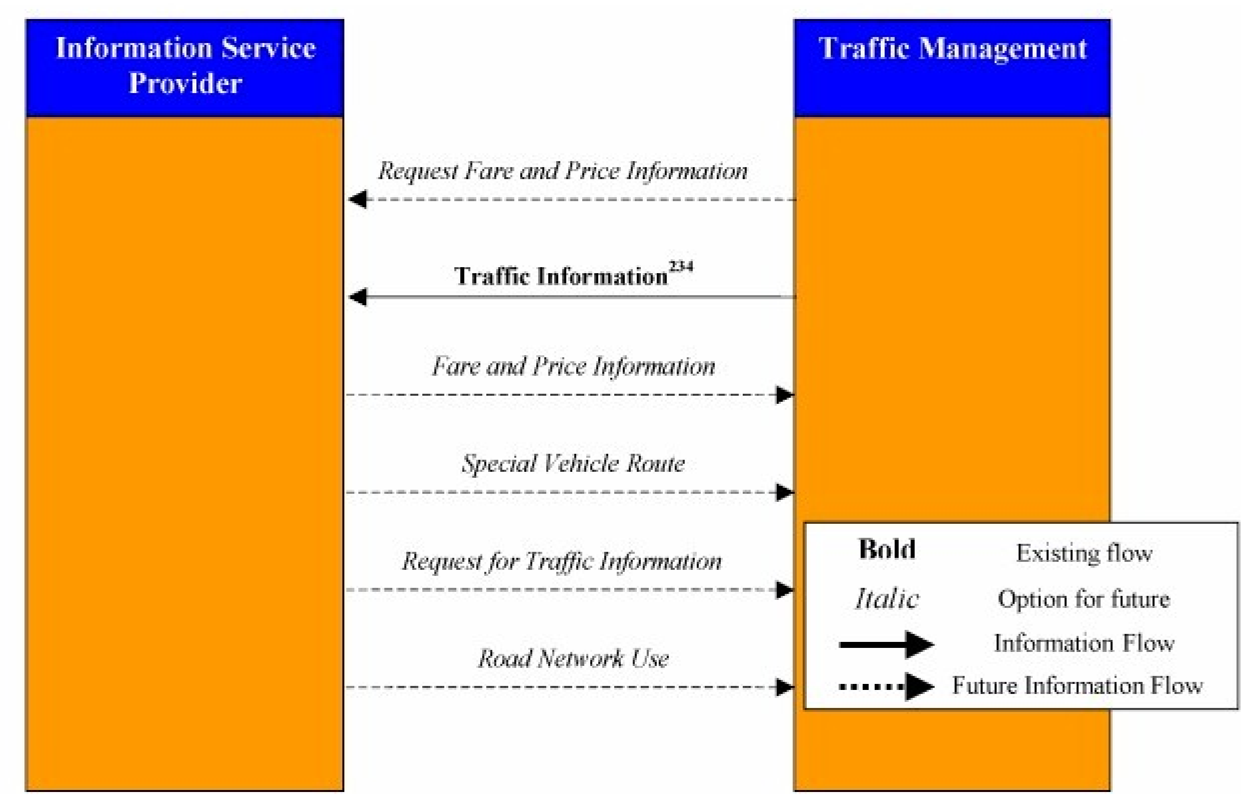

Figure 30. Information Service Provider/Traffic Management

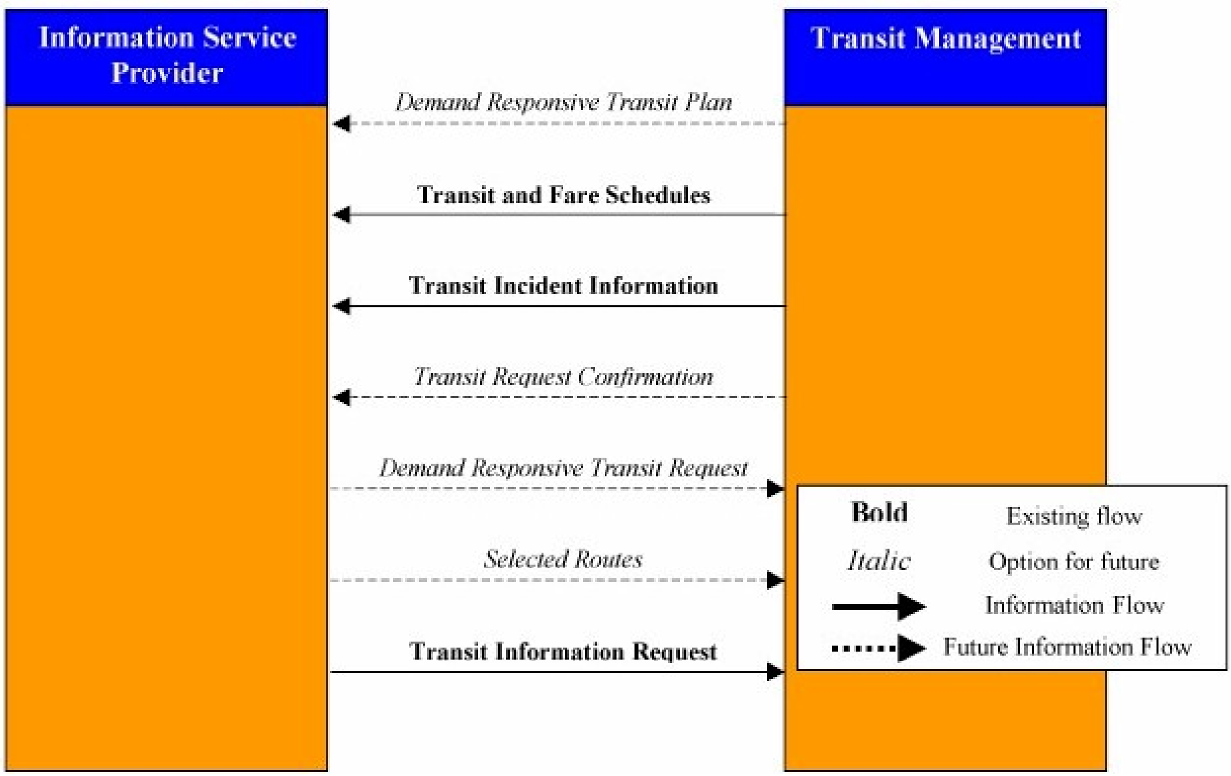

Figure 31. Information Service Provider/Transit Management

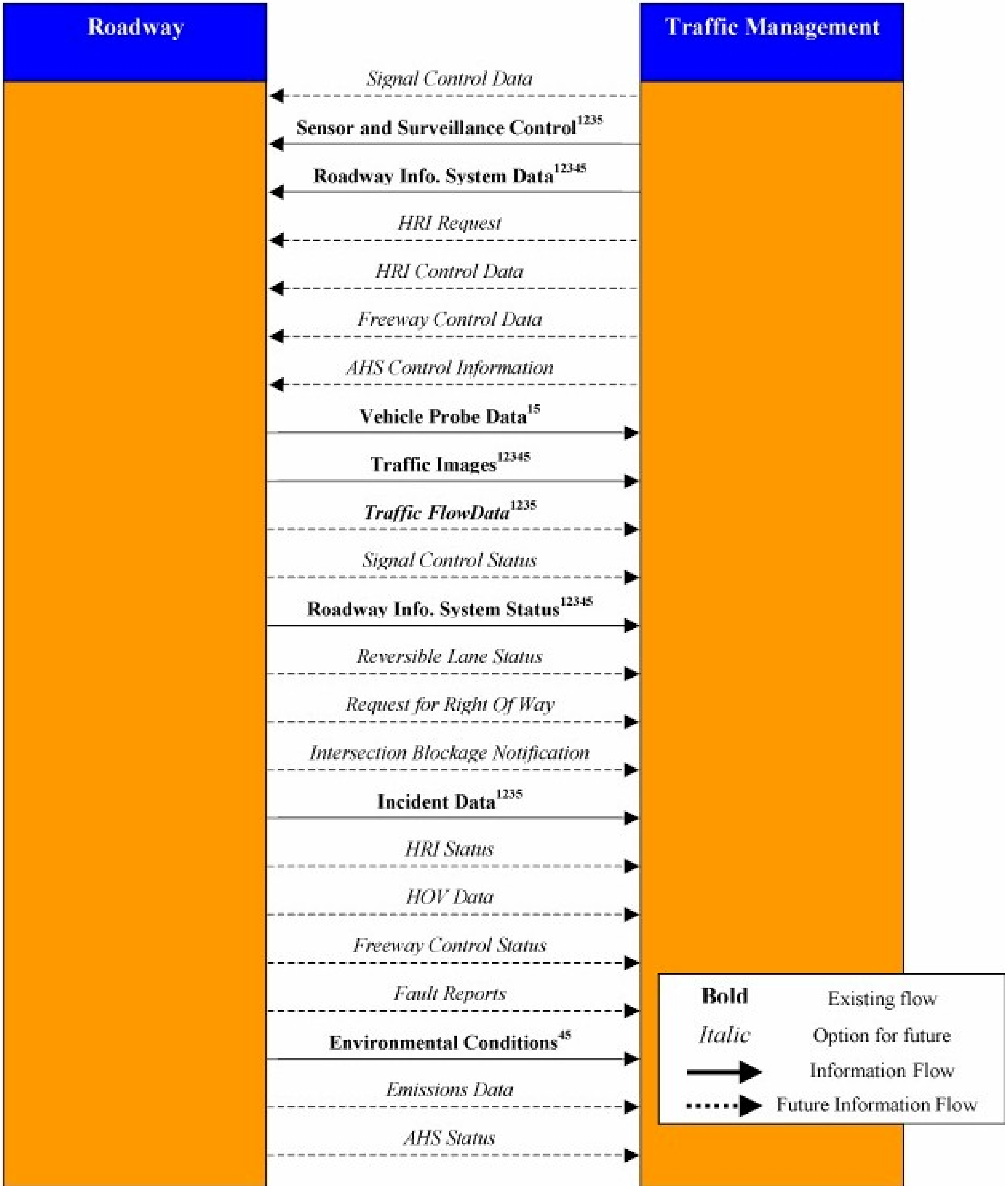

Figure 32. Roadway/Traffic Management

ATIS SCENARIOS

This section is intended to satisfy the requirements of Task #3, as described in the proposal for "MULTIPLE APPROACHES TO REAL TIME ROUTE INFORMATION". In this task, we attempt to build and test several ATIS implementation scenarios using the developed ATIS high level system architecture and data obtained from the surveys conducted by RITS researchers.

Before the scenarios will be presented, an integral point must be addressed. ATIS services require that certain ATMS functions be fulfilled. Though this report does not cover NJDOT's ATMS capabilities, some preliminary notes can be developed from the results of the surveys conducted by R.I.T.S researchers. The following table illustrates the relationship between the required ATMS functions to fulfill the goals of the nine ATIS market packages.

Table 10. Required ATMS Services to Fulfill ATIS Market Packages

ATMS Market Packages	ATIS Market Packages	Required ATMS Services for ATIS functions	Availability of Required ATMS Services
Network Surveillance	Broadcast Traveler Information	Traffic Flow	Yes
Probe Surveillance	Interactive Traveler Information	Traffic Images	Yes
Surface Street Control	Autonomous Route Guidance	Sensor and Surveillance Control	Yes
Freeway Control	Dynamic Route Guidance	Road Network Use	Yes
HOV Lane Management	ISP Based Route Guidance	Signal Control Status/Data	No
Traffic Information Dissemination	Integrated Transportation Management/Route Guidance	Freeway Control Status/Data	Yes
Regional Traffic Control	Yellow Pages and Reservation	HOV Data	Not Applicable
Incident Management System	Dynamic Ridesharing	Roadway Information System Status/Data	Yes

Table 10. Continued

Traffic Forecast and Demand Management	In Vehicle Signing	Incident Notification	Yes
Electronic Toll Collection		Incident Information	Yes
Emissions Monitoring and Management		Road Closure Requests/Confirmations	No
Virtual TMC and Smart Probe Data		Incident Data	Yes
Standard Railroad Grade Crossing		Toll Data	Yes
Advanced Railroad Grade Crossing		Vehicle Probe Data	Yes
Railroad Operations Coordination		Parking Requests/Availability	No
Parking Facility Management		Reversible Lane Status/Control	Not Applicable
Reversible Lane Management		Weather Information	Not Applicable
Road Weather Information System			
Regional Parking Management			

Scenario #1. Incident on Route 80 Corridor in Northern New Jersey

Northern New Jersey is one of the heavily populated areas in N.J. Through northwestern New Jersey, travelers commute to and from New York City. Route 287, Route 80, Routes 1 & 9, Route 46 and other various state roads carry large volumes of travelers everyday. Incidents occurring on these roads can significantly affect the area's transportation system. For example, an incident in the Route 80 corridor, covered by NJDOT North and TRANSCOM, could hamper traffic for miles in all directions. For this scenario, it will be assumed that an incident occurred on Route 80 in northern New Jersey, east of the Parsippany-Troy Hills area. The exact scenario location is shown below in Figure 33.

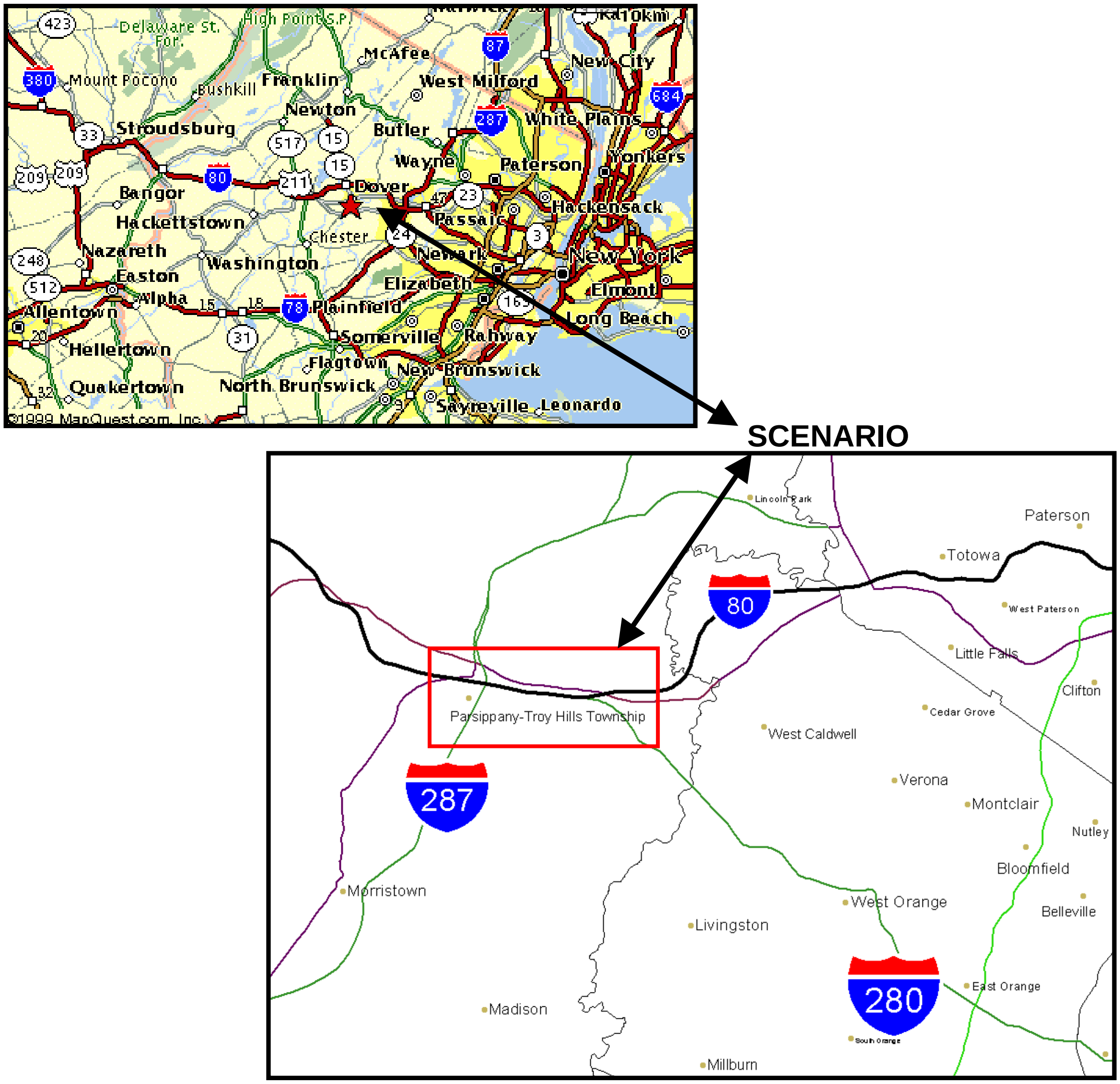

Figure 33. Anticipated Location of Accident on Route 80 Corridor

The anticipated issues stemming from an incident occurring on this segment of Route 80 are as follows:

- Detection and verification of the incidents.
- Identification and dispatch of appropriate personnel, such as police and ambulances must arrive at the scene.
- Reduction of freeway capacities and vehicle speeds for the duration of the incident.
- Occurrence of heavy congestion on the freeway and on neighboring arterials.

- Timely clearance of the incident and return to normal traffic conditions.
- Providing travelers with pre-trip and en-route delay information.

Many ITS programs, already existing within the state can provide the necessary capabilities to address the above issues. The use of an adequate traveler information system to address the last issue in the above list is the focus of this section. Traveler information can be disseminated to travelers before they start their trip. In this case, there are several ways to distribute this information, including television, radio, and the Internet. For travelers already en-route, the most effective way for information dissemination is the use of VMS or HAR. However, before traveler information can be disseminated, it must first be collected. The following discussion will concern the collection, processing, and presentation of traveler information that constitutes the most important aspect of ATIS.

Objectives

The primary objective of this effort is simply to minimize the impact of the incident on travelers by providing traveler information. The information provided must be timely, accurate, reliable, and easily comprehensible by travelers. The definition of each of these criteria is as follows.

- Timely

  Incidents are time dependent events. The time it takes between the occurrence and detection of an is of very high importance since the earlier the incident is detected, the more travelers can be informed of the delay caused by the incident. For users of traffic information, timely information provides them the opportunity to avoid delay by changing their trip departure time to a later time or changing their travel route to avoid the incident. Timely information will help users save considerable amounts of travel time. However, if the incident information is not disseminated in a timely fashion, the number of travelers affected by the incident may increase exponentially, depending upon the time of day, the severity of the accident, etc.
- Accuracy and reliability

It is not enough to warn travelers of just the existence of an incident, but additional information should also be included, such as the location, expected duration, and delay. The accuracy of this information, specifically the duration and delay times, is very important to the user. Several studies have concluded that generic warning messages, such as “Congestion Ahead”, reduce the confidence of travelers in these messages and therefore, travelers do not heed the warnings. Another problem is giving erroneous information, such as estimating the delay as 30 minutes, whereas in reality, the delay may be more than 2 hours.

- Comprehensible

  Comprehensible information is information that is brief, detailed, and easy to understand. This type of information is especially important for users en-route, who must read the information and then make a quick decision, such as a change of route.

In order to meet this objective, analysis of the existing ITS capabilities, specifically ATIS, of transportation agencies in this region will be conducted to determine if traveler information can be provided to reduce congestion and prevent delays for travelers departing soon after the incident has occurred.

Required Systems Based On Research

Based on conducted research by RITS researchers, ten ITS subsystems are required to implement an effective Traveler Information System. However, to fulfill the goals of this scenario, not all of these subsystems are required. The transit management (specifically concerning trains), transit vehicle, remote traveler support, and parking management subsystems are not required since this scenario deals with incidents occurring on freeways. These exclusions leave the following systems accountable, along with these specific equipment packages (Table 11).

Table 11. Required ATIS Subsystems From ITS System Architecture

Subsystems in National ITS System Architecture	Required Equipment Packages	Availability of Required Equipment Packages
Personal Information Access Subsystem	Traveler Requests	Yes
	Traveler Information Receipt	Yes
Information Provider Subsystem	ISP Data Collection Basic Information Broadcast	No Yes
Traffic Management Subsystem	Traffic Surveillance Incident Detection Incident Dispatch Coordination	Yes Yes Yes
Emergency Management Subsystem	Emergency Dispatch Emergency Response Management	Yes Yes
Roadway Subsystem	Roadway Surveillance Roadway Incident Detection	Yes Yes
Transit Management (buses)	Transit Center Tracking and Dispatch	Not Known

Aside from these subsystems, specific services from the nine ATIS market packages are also necessary to provide traveler information in the event of an incident. The specific services required are listed below, along with the available market packages. As can be seen from the table, not all of the services provided by these market packages are required. Rather, customization of the National ITS System Architecture based upon the needs of the local region is necessary. The services defined in the ITS System Architecture are generic, and all the defined services are not required to provide the functionality defined for a specific region. For the region defined in this scenario, the following services are necessary to provide traveler information and help alleviate the effects of an incident (Table 12).

Table 12. Required ATIS Market Package Services From ITS System Architecture

ATIS Market Packages in National ITS System Architecture	Required Services From ATIS Market Packages	Current Availability of Required Services
Broadcast Traveler Information Interactive Traveler Information Autonomous Route Guidance Dynamic Route Guidance ISP Based Route Guidance Integrated Transportation Management/Route Guidance Yellow Pages and Reservation Dynamic Ridesharing In Vehicle Signing	Traffic Information	Yes
	Incident Information	Yes
	Broadcast Information	Yes
	Traveler Information	Yes
	Traveler Request for Traffic Information	Yes
	Route Guidance	No

Existing Systems

Currently, the northern New Jersey area has a number of existing ITS systems, spearheaded by TRANSCOM and NJDOT Traffic Operations North. Figure 13 displays the relationships between all existing subsystems for NJDOT North. These systems and additional considerations associated with the dissemination of traveler information are discussed below.

Information Dissemination Interface

Currently, both agencies disseminate information in the event of an incident. As per survey results conducted by Rutgers researchers, information is provided through CMS, VMS, radio, and the media. TRANSCOM possesses the further ability of disseminating information via kiosks. Interaction between these transportation agencies and these media sources is not completely automated. Rather, personnel must disseminate the appropriate information to these sources, either by fax or by telephone. Technology also exists to pass information to travelers via NJDOT's web site. Furthermore, NJDOT North provides alternate routing in the case of extreme emergencies, and can pass this information immediately to travelers via VMS. These capabilities account for the following services defined in Tables 7 and 8: Broadcast Information, Traveler Information, and ISP Data Collection.

Traffic Management Systems

NJDOT North and TRANSCOM both have significant traffic management capabilities. As discussed earlier, both agencies have traffic operations centers. From these locations, traffic information is gathered from various sources. TRANSCOM's traffic management capabilities stem from a variety of existing or planned ATMS projects. Furthermore, TRANSCOM serves as the hub of all traffic information of its member agencies. Both agencies deploy field equipment, including pavement loops, radar, video cameras, etc. Unfortunately, this region lacks weather sensors. These capabilities account for the following services defined in Tables 7 and 8: Traffic Surveillance, Incident Detection, Incident Dispatch Coordination, Roadway Surveillance, Roadway Incident Detection, and Incident Information.

Emergency Management Systems

A number of emergency management systems are in operation throughout the region. Both agencies are in contact with emergency operations, either agency owned or municipality owned. These systems can be contacted via the traffic operations center located at each agency, or in some cases, travelers on the roadway itself can contact these agencies by dialing emergency numbers such as 911. These capabilities account for the following services defined in Tables 7 and 8: Emergency Dispatch, and Emergency Response Management.

Personal Information Access

Neither of the agencies included in this scenario directly possess this capability. Rather, traffic management associations, such as Cross County TMA and Greater Mercer TMA provide these capabilities to their membership. These agencies can distribute information concerning incidents and other forms of non-recurring congestion to their members, including private companies and persons. Also, TMAs can accommodate individual requests for traveler information. If a customer requests daily updates concerning the status of a particular roadway, the TMA can provide such information. These capabilities account for the following services defined in Tables 7 and 8: Traveler Information and Traveler Requests for Traffic Information.

As can be seen, the existing ITS/ATIS capabilities of TRANSCOM and NJDOT North can sufficiently manage and control an incident on the Route 80 Corridor. Detection of the incident will occur using the various sensors installed throughout the corridor. After incident detection, either agency can forward the appropriate personnel to the vicinity to manage the incident and also manage traffic. Traffic information can be distributed via various channels to the public to warn of the incident and its detail, such as location and severity. From this information, travelers can avoid the incident, and therefore, help avoid further congestion due to the incident.

Scenario #2. Incident on Route 287 in Northern New Jersey

The details of this scenario are similar to those in Scenario 1. The location of this scenario will be assumed to be Route 287, south of the Morristown area. The major agencies involved in this scenario would be NJDOT Traffic Operations North and TRANSCOM. Various TMAs also have representation in this region, as Morristown is a central business district in Morris County. Again, an incident would cause severe congestion problems, as Route 287 intersects other major highways near this region. The problems faced by transportation agencies in this jurisdiction include incident detection, incident response, traffic data collection, and dissemination of appropriate traveler information throughout the life of the incident. The region proposed in this scenario can be seen in Figure 34.

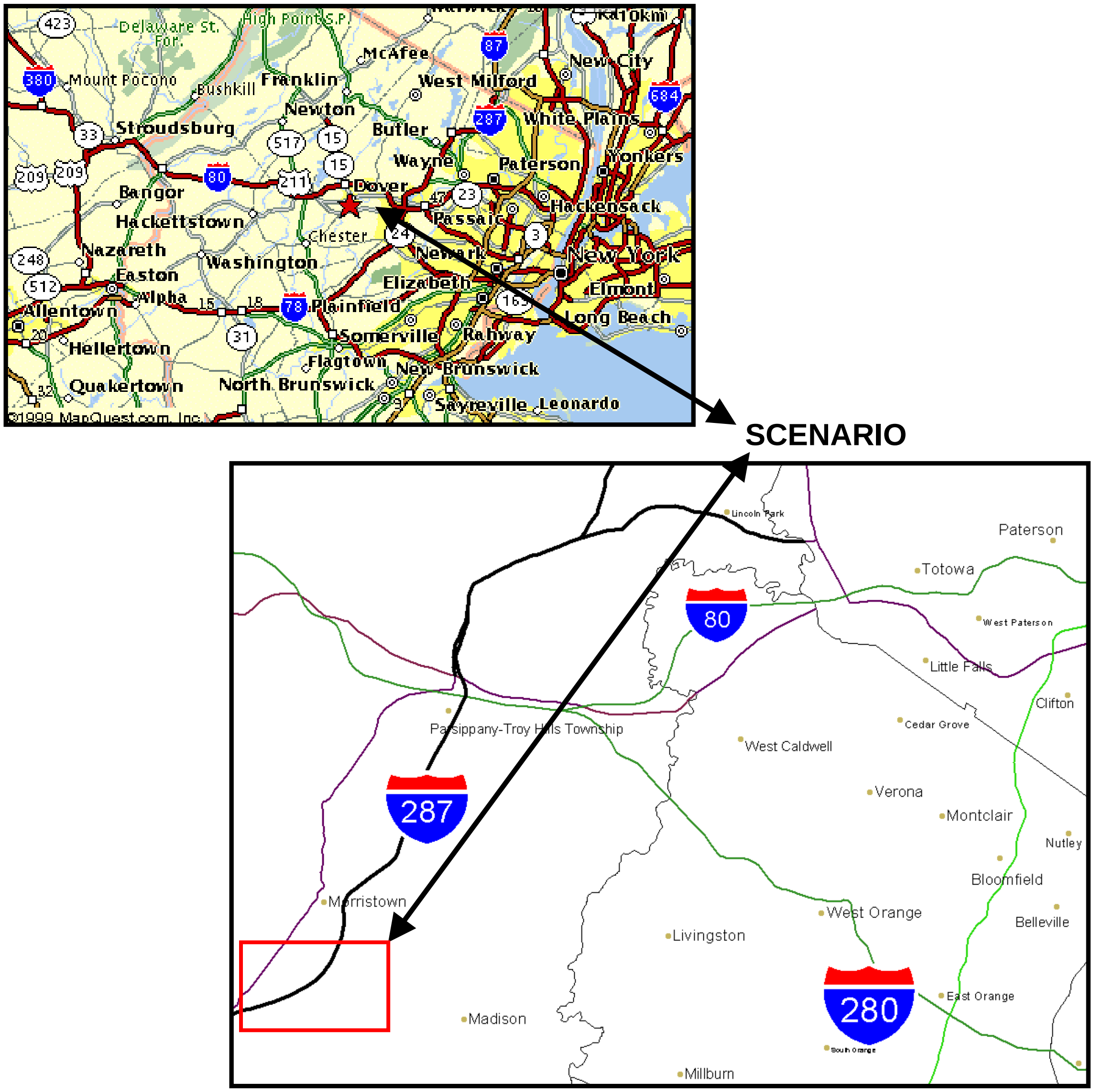

Figure 34. Anticipated Location of Incident on Route 287

Since these scenarios are concerned with ATIS, the ITS requirements given in Tables 7 and 8 remain the same. In order to disseminate adequate traveler information, these minimum requirements must be fulfilled. Unfortunately, based on the information provided through surveys conducted by Rutgers researchers, Route 287 is not under adequate surveillance to provide timely traveler information. An incident on Route 287 can back up traffic on major arterials, including Route 80, Route 26, Routes 202/206, Route 24, etc. The TRANSMIT program, sponsored by TRANSCOM, will cover sections of Route 287, specifically the northern sections north of the Morristown CBD, with adequate traffic sensing equipment, such as pavement loops, radar, and video cameras. Yet, sections in central New Jersey, south of the Morristown CBD, remain without adequate traffic sensing equipment, and hence, adequate means to detect an incident. Without real-time incident detection, real-time traveler information, considered the most valuable type of traffic information by travelers, cannot be disseminated.

However, the inability to quickly detect an incident does not hinder dissemination of traveler information entirely. The use of other existing ITS subsystems, specifically emergency management, traffic management, personal information access, and the ISP can provide travelers with traffic information. After the incident has been detected, traffic information gathered from the traffic management subsystem can be passed on to either TMAs for distribution to their membership or posted on NJDOT's web site for travelers to access. Traffic information can also be provided for broadcast via local new networks or cable television stations. TRANSCOM and NJDOT Traffic Operations North have the ability to provide traffic information, despite the location of the incident. However, the timeliness, and therefore its reliability, may not be tolerable.

In this scenario, travelers can be provided with traveler information depending upon the time at which incident detection occurs. ITS subsystems, specifically the Personal Information Access and the ISP subsystems, can route traffic information to the travelers. Unfortunately, the Roadway and Traffic Management subsystems do not provide adequate traffic sensing equipment for incident detection. Hence, though information can be supplied, the timeliness and reliability of the traffic information will be questioned.

<u>Application 0f This Scenario To Other Roadways</u>

Unfortunately, these scenarios could cause significant problems on other roadways, such as the Garden State Parkway. Currently, research indicates that the Parkway Authority does not have adequate traffic surveillance capabilities of its entire jurisdiction. The NJHA covers only three interchanges using video cameras, and the Driscoll Bridge.

Furthermore, the NJHA does not employ traffic sensors to collect traffic characteristics data, such as speed and flow. If an incident were to occur at the locations with video cameras, NJHA could manage the incident. However, if an incident were to occur outside of these locations, the effects of the incident would be severe.

Based on the analysis of these scenarios, an ATIS system in New Jersey can help prevent congestion due to incidents. The current capabilities of NJDOT North and TRANSCOM can sufficiently manage an incident by helping clear the incident and distributing traveler information to the public for the Route 80 Corridor. However, for other sections of roadway in New Jersey, such as the Garden State Parkway and sections of Route 287, the existing systems could not fulfill the expected goals.

Scenario #3. Recurring Congestion

This scenario addresses issues of recurring congestion on New Jersey highways. For this case, northern New Jersey will be considered the study area. Analysis of recurring congestion can be performed in two ways. First, it can be analyzed locally as in the previous scenarios. However, recurring congestion affects the entire region. Therefore, it should be analyzed on a regional basis. For this scenario region, as seen in Figure 35, the relevant transportation agencies include TRANSCOM, NJDOT Traffic Operations North, the Port Authority of New York and New Jersey, the New Jersey Turnpike Authority, and the New Jersey Highway Authority. In order to disseminate traveler information concerning recurring congestion, the requirements given in Tables 7 and 8 must be fulfilled.

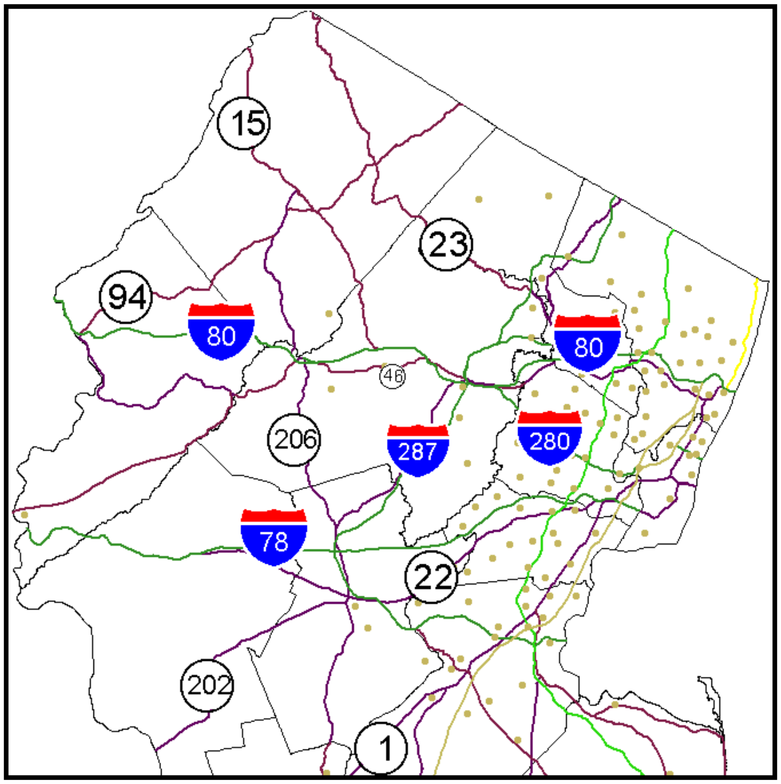

Figure 35. Scenario Area for Scenario #3 and #4

Therefore, it should be analyzed on a regional basis. For this scenario region, as seen in Figure 35, the relevant transportation agencies include TRANSCOM, NJDOT Traffic Operations North, the Port Authority of New York and New Jersey, the New Jersey Turnpike Authority, and the New Jersey Highway Authority. In order to disseminate traveler information concerning recurring congestion, the requirements given in Tables 7 and 8 must be fulfilled.

Traveler information can be provided by most of these agencies for their respective jurisdictions. NJDOT North has traffic surveillance equipment in several locations throughout this region, specifically on Route 202/206, Route 1, and sections of Route 46. The TRANSMIT program, conducted by TRANSCOM, provides surveillance of the Route 80 corridor, including Route 280. The Port Authority of New York and New Jersey conducts traffic surveillance at all bridges and tunnels, including approaches, leading into and out of New York City. NJTPK provides traffic sensing equipment from Exit 8A to the northern terminus, which covers northern New Jersey. Unfortunately, NJHA does not provide any traffic sensing equipment for the Garden State Parkway, as determined from the survey conducted by R.I.T.S researchers. Based on these observations, the requirements of the Traffic Management and Roadway subsystems, as given in Table 7, are fulfilled. These systems allow the respective agencies to monitor current traffic conditions, and distribute that data to various sources.

Next, the ATIS market package requirements, given in Table 8, must be addressed. Traffic information and incident information can be provided from the ITS subsystems as discussed previously. The information must then be disseminated via several sources. The information must then be available for broadcast. Each of the agencies posses the ability to disseminate traffic information independently, either via web site, VMS, or providing this information to the general media, including radio and television. Individual requests for traveler information are managed by TMAs within the vicinity. Of the TMAs surveyed for this report, Greater Mercer TMA provides coverage for portions of the scenario region. This agency provides traffic information for both recurring and non-recurring congestion to its membership, and can accommodate individual requests for traveler information.

Analysis of Scenario #3 reveals that New Jersey can distribute traveler information for non-recurring congestion for certain segments of the transportation network. All agencies besides NJHA can provide traffic information, and in turn, traveler information. This information can be used by travelers to avoid recurring congestion. The bridges and tunnels leading into New York City, a major OD point for this region, are thoroughly monitored, and information is provided concerning non-recurring and recurring congestion.

Scenario #4. Out-of-State Travelers in New Jersey

This scenario addresses the concerns of travelers who are foreign to New Jersey's transportation system. An ATIS system should be able to assist in-state and out-of-state travelers equally. Out-of-state travelers are concerned with the same issues as in-state travelers, including congestion, travel times, and shortest/quickest routes. However, out-of-state travelers have additional concerns, such as unfamiliarity with New Jersey's following services:

- Highway system
- Transit system
- Recreational locations
- Business locations
- Parking locations
- Restaurants
- Rest stops

In order to accommodate the needs of such travelers, the ATIS system should have the capabilities displayed in Tables 13 and 14. Table 13 displays the required subsystems, along with the associated equipment packages, for this scenario. Table 14 displays the relevant services required from the nine ATIS market packages.

Table 13. Required ATIS Subsystems for Scenario #4 from ITS System Architecture

Subsystems in National ITS System Architecture	Required Equipment Packages	Availability of Required Equipment Packages
Personal Information Access Subsystem	Traveler Requests Traveler Information Receipt	Yes Yes
Information Provider Subsystem	ISP Data Collection Basic Information Broadcast	No Yes
Traffic Management Subsystem	Traffic Surveillance Incident Detection Incident Dispatch Coordination	Yes Yes Yes
Emergency Management Subsystem	Emergency Dispatch Emergency Response Management	Yes Yes
Roadway Subsystem	Roadway Surveillance Roadway Incident Detection	Yes Yes
Remote Traveler Support Subsystem	Remote Transit Information Services Remote Interactive Information Reception	No No No
Transit Management Subsystem	Transit Center Information Services	No
Parking Management Subsystem	Parking Coordination Parking Electronic Payment Parking Management and Surveillance	No No No
Transit Vehicle Subsystem	On-board Transit Fare and Load Mgmt On-board Transit Information Services	No No

Table 14. Required ATIS Market Package Services for Scenario #4 From ITS System Architecture

ATIS Market Packages in National ITS System Architecture	Required Services From Market Packages	Availability of Required ATIS Services
Broadcast Traveler Information Interactive Traveler Information Autonomous Route Guidance Dynamic Route Guidance ISP Based Route Guidance Integrated Transportation Management/Route Guidance Yellow Pages and Reservation Dynamic Ridesharing In Vehicle Signing	Traffic Information Incident Information Broadcast Information Traveler Information Traveler Request for Traffic Information Weather Information Parking Information Transit Fare and Schedules Route Guidance Yellow Pages and Reservations	Yes Yes Yes Yes Yes No No No No No

Analysis of this scenario can begin by examining the current capabilities of New Jersey's transportation organization, and comparing them to the requirements set forth in Tables 13 and 14. In previous scenarios, it has been shown that New Jersey agencies can provide the service set forth in the Personal Information Access, ISP, Traffic Management, Emergency Management, and Roadway subsystems. The Remote Traveler Support Subsystem consists of Remote Transit Information Services and Remote Interactive Information Reception. These services consist of providing travelers with information, both transit and highway related, at remote locations, such as rest stops, transit stops, etc. Currently, TRANSCOM is deploying a series of kiosks that will allow travelers to query TRANSCOM's database for traveler information from remote locations. As of this time, kiosk locations have yet to be determined, but it is anticipated that they will be deployed soon. Unfortunately, the remaining three subsystems are not supported by New Jersey transportation agencies.

The explanation of the first five ATIS market package services have already been accounted for in previous Scenarios. The remaining five services are available in New Jersey in various degrees. Weather information is available through various media, including the Internet, television, and radio, though it is not provided directly by New Jersey transportation agencies. Transit fares and schedules are available through the NJ Transit web site, and various other sources, including TRANSCOM's kiosks. Unfortunately, route guidance and yellow pages/reservations are not available.

From this analysis, it can be seen that the current ATIS capabilities of New Jersey's transportation systems can provide some traveler information to out-of-state travelers, though not the entire repertoire of services described in the National ITS System Architecture.

NJDOT'S ROLE IN DEVELOPING A TRAVELER INFORMATION SYSTEM IN NEW JERSEY

This section is intended to satisfy the requirements of Task #4, as described in the proposal for "**MULTIPLE APPROACHES TO REAL TIME ROUTE INFORMATION**". The main objective of this section is to present a critical review of Advanced Traveler Information Systems in terms of ATIS operations and funding. The operational models and revenue models employed in the United States for ATIS purposes will be examined. Next, the value of traveler information will be discussed, in terms of its value to travelers. Other information markets will be analyzed to help determine the role of traveler information in our society. Finally, recommendations will be made to the NJDOT in its role in developing Advanced Traveler Information Systems.

Advanced Traveler Information Systems

A traveler information system (TIS) is intended to provide travelers and drivers with multi-modal trip planning, route guidance, and advisory functions. By providing these services, a TIS has the potential to alleviate driver stress, decrease travel times, and increase throughput. Theoretically, a TIS can provide a large quantity of multi-modal information to users at various times during the course of a trip through a variety of communication devices. First, information can be accessed pre-trip or en-route based upon a user's needs. Next, a TIS can provide information such as travel time, both current and predicted, incident and delay information, routing, including alternate routes to avoid recurring and non-recurring congestion, transit scheduling, and construction information. Users can access such information through roadside devices, such as VMS and HAR, by mass communication mediums, such as radio and television, pagers, regular phone and cellular phones services, and the Internet. Finally, the TIS can determine the format by which information is delivered. For example, all traveler information can be available to the general public via the Internet, or the information can be personalized based on a user's profile. Personalized traveler information can contain data concerning specific routes or the entire transportation network, and can be delivered via email, pager, or phone calls. Table 15 exhibits the characteristics of three existing TIS sites, the Georgia NAVIGATOR, Arizona's AZTech, and Traffic.com, a traveler information website.

Table 15. Characteristics of Existing Traveler Information Systems

	Georgia NAVIGATOR	**Arizona AZTech**	**Traffic.com**
Accessibility			
Pre-trip	X	X	X
En-route	X	X	X
Type of Information			
Travel Time	X	X	
Incident	X	X	X
Delay	X	X	
Routing			
Transit	X	X	X
Construction	X	X	
Communication Device			
HAR	X	X	
VMS	X	X	
Phone		X	
Pagers		X	
Radio	X	X	
Television	X	X	
Internet	X	X	X
Information Format			
Generic	X	X	X
Personalized		X	

Current Trends in the Market for Traveler Information

In the mid to late 1990s, many cities throughout the United States promoted the development of Advanced Traveler Information Systems to help reduce congestion and to make use of their existing and planned ITS architectures. These projects were publicly funded throughout the country, either through Field Operational Tests, in states such as Pennsylvania and California, or through the Model Deployment Initiative, in Phoenix, Arizona, Seattle, Washington, San Antonio, Texas, and New York/New Jersey/Connecticut region. Currently, most of these traveler information systems are still operational and providing valuable information to a wide range of consumers. For example, the AZTech traveler information system, based in Phoenix, Arizona, provides multi-modal traveler information to the public sector through road side VMS, telephone, television, kiosks, and the Internet. However, the structure of the information systems, specifically the organizational make-up and the business models, has continuously evolved. In this section, the current operational and financial framework of existing ATIS systems is examined, as well as the market for traveler information.

Operational Models

Traveler Information Systems throughout the United States use one of three models to collect and disseminate traffic data. These models can be classified as exclusively public, exclusively private, and public-private (Yim 2001b). The key difference in these models is that responsibility for data collection/dissemination varies in each model. For example, in the exclusively public model, public agencies are responsible for data collection and dissemination, whereas in the exclusively private model, the private sector has all such responsibility. Finally, in the public-private partnership, responsibility is divided between public agencies and the private sector. Each model has its advantages and disadvantages, as discussed below.

Exclusively Public Model

The exclusively public model exploits the wealth of resources available to public agencies in terms of research, development, and implementation of Traveler Information Systems. The exclusively public ATIS model has the following characteristics (Yim 2001a).

- First, ATIS is a component of a larger transportation management program.
- ATIS is a component of a broader-scoped transportation management program.

- A Department of Transportation manages and operates ATIS.
- Existing public resources are dedicated to ATIS.
- Public sector has control over the process of data collection and dissemination.
- Inter-agency, multi-jurisdictional coordination is central to ATIS operation.

The major advantage of the “public” model is that the public sector can control maintenance, operation, and development of the information system. Unfortunately, this model limits competition amongst private firms to improve data quality and the reduce operation costs.

The primary example of the exclusively public model is the Georgia NAVIGATOR. Georgia Department of Transportation operates and maintains NAVIGATOR. The TMC, centrally located in Atlanta, is the heart of the NAVIGATOR system. It serves as a center for transportation emergencies that occur anywhere in the state and is linked to central transportation centers in other cities. NAVIGATOR is designed to gather information from a variety of sources; process the information; and develop an appropriate response which is communicated to the public via the system's website, cable TV broadcast and its changeable message signs (GDOT 1998). Though by definition, the NAVIGATOR is an exclusively public traveler information system, information dissemination is done with some private sector involvement. For example, Georgia Department of Transportation is negotiating with a private firm to operate dissemination to cable TV. (Yim 2001a)

Exclusively Private Model

The exclusively private model is seen when traffic data collection and dissemination are conducted solely by the private sector without the help of the public sector. This model is currently used in the United States. Private companies have supplied traffic information to various distributors, specifically commercial radio and television stations, for a number of years. These companies, such as Metro Networks and Shadow Broadcast Services, often collect their own information using planes and helicopters, and augment the information using public sources, such as state highway patrols and ITS technologies including CCTV, probe vehicle data, and loop detector data. These traffic information providers offer their services on a barter system. For example, in the radio industry, traffic reporting services supply radio stations with traffic reports in return for inventory, i.e. airtime. The airtime is subsequently sold to advertisers for profit. Further analysis of the financial details of the exclusively private model will be discussed in the next section.

Numerous advantages exist concerning this model. First, the public sector is not directly responsible for data quality or operational efficiency. Second, through competition within the private sector, the public sector benefits through private sector enhancements of the transportation system. Disadvantages include the inconsistency of traveler information and the possibility that only travelers who are willing to pay for information will receive it.

Public-Private Model

The public-private model is the case where both public and private groups are involved in traveler information collection and dissemination. In the United States, it is common for various State DOTs to allow suppliers access to publicly acquired traffic information without a fee. Suppliers (i.e. private sector) then disseminate the information via radio, television, and telephone. The public-private model is extremely popular within the U.S. and is also used in other industries as shown later in this report.

Several variations of the public-private model exist, as follows (Yim 2001b):

1. Functional division of responsibilities
   Modeled after the weather information system in the United States, where the public sector collects the information and sells it to private firms.
2. Franchised operations
   There are two variations, exclusive franchise and non-exclusive. In exclusive franchise, the public collects the data and sells the information to private firms for dissemination by one firm entirely. In non-exclusive, the public sector retains some rights to the information and also sells it to numerous firms.

3. Publicly owned, privately operated system
   In this scenario, the public sector would fund and develop the ATIS system. The private contractor would provide the equipment and be responsible for operations.
4. Unified public-private partnership
   Both sectors would collect information and send it to a traveler information center for dissemination, using both public and private facilities.

In the United States, all of the above traveler information system models exist in some degree or another. Table 16 gives a generic description of the models used for traffic management and traveler information systems in the United States.

Table 16. Existing Models of Traveler Information Systems in the United States

Data Collection	Both public & private with low cost infra-structure investment
Data Dissemination	Exclusively private
Traffic Operations Center	Exclusively public
Traveler Information Center	Public-private partnership
ATIS product/service marketing	Test stage
Public CMS facilities	Test state

Revenue Models

Traveler Information Systems established through Field Operation Tests (FOT) or the Model Deployment Initiative (MDI) programs were publicly funded. However, since public funds are limited, it is evident that alternative financing schemes for TIS operations and maintenance are required. Three basic revenue-generating models are available for TIS operations: the tax based, the user fee based, and the third party sponsor based models. [19]

The tax-based model is least likely to be implemented in the United States, as opposition exists to increasing taxes to support publicly funded projects. By using this model, taxes would support a publicly owned ATIS. The advantage of this model is that publicly funded projects are not market sensitive; rather they are independent upon the economy. However, the disadvantage obviously lies in the uncertainty of maintaining public funds to continue maintenance and operation of the project.

The user fee based model is when users pay a fee for access to information. Two types of fees can be implemented, the per user transaction fee or the subscription fee. Through this model, value added resellers can acquire the information and then sell it to consumers or the information can be sold directly to consumers. Existing ATIS services in the NY/NJ/CT region employ this model. TRANSCOM's Trips123 program providers travelers with three unique services: QuickCheck, TeleWarning, and the TransitAdvisor. The first service provides travelers with real-time traffic and transit reports via telephone or the Trips123 web site, while the third service provides travelers with step-by-step instructions for travel between an origin and destination using any transit service in the region. Both of these services are provided free of charge. TeleWarning, a subscription based service, alerts subscribers to traffic and transit incidents on their most frequently used travel routes via a personalized message sent to the subscriber's preferred communication device. At this time, the subscription cost has yet to be determined. The advantage of user fee based model is that the ATIS can be self-supporting if the fees cover the maintenance and operating costs of the system. However, uncertainty exists concerning the costs that consumers would be willing to pay for ATIS services. Studies have yet to conclusively prove the value of traveler information. [27]

The third party sponsor based model assumes that commercial sponsors pay for traffic information. Private companies, such as Metro Networks and Shadow Traffic, have successfully implemented this model in the United States to provide radio and television stations with traffic broadcasts. Private-sector market studies have established that radio listeners value traffic information and prefer stations that broadcast traffic reports.

For this reason, radio broadcast traffic reports provide commercial radio stations with a competitive advantage in attracting advertising revenue. Since the first traffic reports were broadcast in major U.S. cities, the traffic information reporting business has grown into a profitable industry with companies that operate in 62 metropolitan areas across the U.S.

The current commercial traffic information market in the United States is founded on the premise that consumers' desire for traffic congestion information is similar to their desire for news, weather, and sports information. Traffic information that suggests route or time alternatives in response to an "incident" or unusual road conditions is considered useful, but the absence of travel alternatives does not necessarily diminish the value consumers place on traffic information. Rather, it appears that listeners value information, regardless of their ability to act on it. Radio listener surveys cited by marketing research firms affirm this premise. [(23)]

Traffic information providers, such as Metro Networks and Shadow Traffic, earn their revenue from selling ad slots on radio and television to third parties. In the United States, about one half of all radio and television airtime is sold to sponsors for advertisements. Several studies have shown that the demand for traffic reports has increased in recent years and that commercial networks see the traffic information services as good revenue generators. Specifically, studies conducted by numerous radio stations have shown that traffic reporting is important to listeners. Radio stations provide the information to their listeners as a type of community service and as a means to attract more listeners, or at least not to lose listeners, who are interested in road conditions [(25)].

Value of Information in Other Markets

In this section, other commercial markets, where information is valuable commodity, are examined. The purpose of this discussion is to draw some analogies from other similar markets and try to better understand the similarities between the traffic information market and other markets. More importantly, some of these other markets have been active for a relatively long time period, such as the "weather information market", while other markets, such as the "on-line information" market, are experiencing similar growing pains. An assessment of these markets can provide us with valuable insights in to the "traveler information" market, in terms of operational concepts and revenue generation.

Consumers and professionals use information to make knowledgeable decisions. It can be considered as organized data that implicitly contains meaning or as intelligence from the "assembly, analysis, or summary of data into a meaningful form". (29) The value of information is determined by its relevance to the decision at hand, its importance to the decision maker, and to the extent it affects the outcome of the decision. Research evidences that information reduces costs, saves time, improves decision-making, and yields customer satisfaction. (29) Based on these facts, information is of the utmost value to any consumer.

<u>The On-Line Information Market</u>

Current and reliable information is essential in today's high-paced digital economy. Today, the Internet provides millions of users unlimited access to information. Yet, most users do not understand that current and reliable information is not available without significant costs. For many users accustomed to unlimited and free information, it is difficult to communicate the value of current and reliable information. For example, the majority (55%) of online consumers stated that they are not willing to pay for news on the Internet. As Michael J. Stern, CEO of Information Markets Corp. notes:

> "It is no surprise that consumers have been unwilling to pay for most content online. Most content is undifferentiated, and somebody, somewhere, is giving it away for free. The typical consumer figures 'why pay for it here?' For people to

pay for information, it must be unique, not available elsewhere, and ideally highly customized."

In the United States, a 1997 survey found information to be a $623 billion dollar business made up of 114,000 companies that employ more than three million people. Publishing, including software, newspapers, periodicals, books, databases and directories, accounted for $179 billion. Most major traditional information companies have modified their businesses to reach consumers online. For example, Dow Jones launched The Wall Street Journal Interactive Edition. The McGraw-Hill Companies publish online versions of periodicals such as Business Week. Reuters provides an array of news and financial information products, while Experian creates credit reports. Forrester and Simba Information publish market research, while Thomson and Encyclopedia Britannica provide reference materials. On the other hand, new information companies have launched business models that focus solely on providing online content. Many new online content sites have been successful in on-line marketing, such as C/Net and ecommercetimes.com. Others have re-created their technology focus, originally in print, online, such as ZDNet.

For these and other on-line information providers, there are five established options for generating revenue on the Internet:

1. Advertising/sponsorship: information is provided free of charge while the site is supported by ad revenue; e.g. Yahoo! and Lycos.
2. Pay-per-service: free information is provided as a marketing tool in order to gain customers for fee-based services; e.g. Andersen Consulting.
3. Pay-per-search: value is derived from the quality and accuracy of the information found by searching; e.g. Westlaw.
4. Pay-per-use: users can view information without charge but cannot print, save, or forward the information without paying a fee; e.g. Northern Light.
5. Subscription: a subscription allows users to access information for either a fixed or per-search fee; e.g., Dow Jones' Wall Street Journal online

Several of these options are similar to the ones used by current ATIS operations. Specifically, the advertising/sponsorship and subscription options are currently in use, while the second option is being considered by the Trips123 service. The pay-per-search option is not a viable ATIS revenue model because the purpose of ATIS is to provide traveler information for multi-modal travel. Often, travelers may have multiple requests, and it is doubtful that travelers would be willing to pay for each request.

The Weather Information Market

Throughout the world, weather affects numerous commercial industries, from transportation companies to utility providers to agricultural firms. The impact of weather is seen everyday, and its social importance is evidenced by the fact that weather forecasts are continuously broadcasted via television and radio and always available on-line.   Companies spend millions of dollars in weather forecasting equipment or services in order to minimize the impact of weather on their operations. For example, the operations of airlines and utility companies are significantly influenced by the weather, as discussed below.

The impact of weather information on utility companies is substantial. Utility companies forecast their daily power generation based on the relationship of power demand, time of day, season, and weather. Weather variables have a significant affect upon the output generated due to the fact that weather influences a customer's demand for heat or air conditioning and also affects the utility companies ability to generate power in terms of the form of power generation (fossil, nuclear, or hydroelectric), and how many generators to use (startup and shutdown costs). Furthermore, severe weather causes even greater disruptions to power generation, and costs utility companies millions of dollars. For example, the Duke Power Company, based in Charlotte, NC, published the following information on the costs it incurred due to severe weather [21] (Table 17).

Table 17. Impact of Severe Weather on Duke Power Company

Storm Date	Storm Type	Total Customer Outages	Cost
May, 1989	Tornadoes	228,341	$15,189,671
September, 1989	Hurricane Hugo	568,445	$64,671,150
1990	ALL STORMS		$753,805
March, 1993	Wind, Ice, & Snow	146,436	$9,176,203
October, 1995	Hurricane Opal	116,271	$1,655,350
January, 1996	Western NC Snow	88,076	$872,585
February, 1996	Ice Storm	660,000	$22,905,627
September, 1996	Hurricane Fran	409,935	$17,471,826

The aviation industry, probably more than any other mode of transportation, is also greatly affected by weather. Weather conditions, such as thunderstorms, snow storms, wind, and fog can affect every phase of flight. Commercial aviation in the U.S., with its more than 16,000 daily flights, must deal with these adverse types of weather regularly, and the cost is a significant.

The cost of acquiring weather data and forecasts for aviation is extremely expensive. Monthly fees for the communication of upper air and surface data alone, per airline, are approximately $6,000. Additional costs of acquiring graphical weather data, lightning data, and radar and satellite imagery is approximately $7,000. There are four passenger and two cargo airlines that have their own staff of meteorologists. Salaries alone range from $750,000 to more than $1 million annually. Many airlines without meteorologists contract with a weather data and forecast vendor. Costs, though lower than a paid staff, can run well over $100,000 per year. However, airlines are eager to pay these sums to avoid costs associated with flight diversion, cancellation, and delay. The cost of a diverted flight can be as high as $150,000 and a cancellation close to $40,000 [(21)].

In order to provide accurate weather information, the American Meteorological Society has recommended development of a public-private partnership between the National Oceanic and Atmospheric Administration (NOAA) and the private sector. In this relationship, it will be the responsibility of NOAA to provide weather, climate and hydrologic information and forecasts for the entire country with an emphasis on the provision of forecasts and warnings of severe weather. The private sector will provide a variety of value-added meteorological products weather and climate information services, which will enhance the basic products generated by the public sector. The partnership will be based upon the philosophy that a public-private partnership will lead to enhanced weather forecasting services and will help both public and private sector firms sensitive to weather impacts [(22)].

Comparison of Traveler Information with Other Commodities

The generally accepted purpose of traffic information is to provide travelers with information in order for them to save travel time during their trip. A traveler can access traffic information either pre-trip or en-route, and based upon this information, alter their trip characteristics, such as departure time, mode, or route. Yet, in order to charge for traveler information, it must be compared to any other commodity that is sold with the purpose of benefiting consumers. Traveler information is unique when compared to such goods, including information goods discussed above. First, the benefits of traffic information are inversely proportional to the amount of people receiving the information due to the buildup of traffic on the alternate route. Following this principle, it should also be noted that traffic information benefits drivers who are not direct customers. Indirect benefits to non-ATIS customers include reduced travel time due the diversion of vehicles from congested roads. This fact does not hold true for weather information or some types of on-line information. Specifically, weather information is for the use of the general public. In cases of severe weather, the weather agencies would want as many people as possible to have access to weather information in order to save lives and money.

Next, the cost of transporting the information to the consumer is minimal. Most fixed goods require the consumer to make a trip, such as a trip to the grocery store, but traveler information is available at one's fingertips [26]. Consumers can receive traffic information when, where, and how it is most convenient (i.e. the Internet, radio, television, cell phones, pagers, etc.). However, this ability means that consumers do not directly receive traveler information from the supplier; instead, the information is sent through another medium. In this case, traveler information is similar to weather and on-line information. Both weather and on-line information can be accessed at a user's convenience, at often, the information is distributed not from the party gathering the data, but after the data has been reviewed, edited, and deemed ready for distribution.

Finally, the difference between traveler information, and most information goods in general, and traditional goods is that the area from which the information is collected is of more importance to the consumer than the location from which it is distributed [27]. This fact is true for all information goods, in that the location of the information collection is more important than the location from which it is distributed. For example, weather and traveler information disseminated over the Internet can concern travelers in the NY/NJ area, but yet be disseminated using servers located in Virginia.

Recommendations to the NJDOT

The potential for ATIS capabilities in New Jersey is very promising. Transportation agencies within New Jersey currently have an ITS system architecture that is capable of providing traveler information to the general public, as seen in the sausage diagrams given in Figures 13 to 16. All of the transportation agencies within New Jersey have implemented ITS concepts, but all have not been successful in developing ATIS operations. For example, the New Jersey Highway Authority is not in position to implement any traveler information services, since it has not developed any of the required subsystems for ATIS. In this study, it is found that the NJHA has not developed subsystems such as the Roadway, Vehicle, Remote Traveler Support, or the Information Service Provider subsystems that are integral to ATIS functions. New Jersey transportation agencies use a variety of equipment to collect traffic data, including pavement loops, radar, video cameras, loop detectors, VIDS, and RTMS. Furthermore, agencies already generate travel advisory data, especially during incidents and special events (A more detailed review of the existing status of ATIS operations for each transportation agency can be found in Section 5.0 and in Appendix B). However, much more work needs to be accomplished before ATIS can be implemented in a statewide setting. NJDOT will undoubtedly play a large role in this implementation process, but it must be prudent in applying its resources. Based on the research conducted in this project, the following recommendations are suggested to the NJDOT.

The NJDOT should become involved in collecting traveler information by creating an infrastructure to gather and disseminate traffic information. States such as Georgia, Texas, Minnesota, California, Pennsylvania, Montana, Florida, and New Mexico have already implemented ITS architectures to gather traffic data for traveler information purposes through reliable and efficient operations. Our research results indicate that NJDOT has begun to establish a fully functional ATIS system architecture within the state, as seen in the sausage diagram in Figure 11. For example, NJDOT Traffic Operations North is capable of collecting traffic data, such as speed, volume, and occupancy, from several major highways in northern NJ. However, the operational status of the sensors are deemed “sporadic” and though traffic data is collected, it is not stored or aggregated in any format. The combination of sporadic data collection and lack of storage can be detrimental to long-term ATIS operations. Improving the data collection devices in the field will be the first step in established an infrastructure to provide ATIS capabilities. Within the next few years, the NJDOT should take steps to improve their ATIS system architecture. Based on the conducted research, the DOT should start to improve its information gathering capabilities, by installing more traffic sensors throughout the state. For example, parts of Rt. 287, which stretches from central New Jersey to the NY/NJ border in the north, do not have any traffic sensors installed, as indicated in the Traveler Information surveys. Furthermore, major state highways such as Rt. 46 and Rt. 3 do not have any sensors installed. Each of these highways experiences extreme congestion during peak hours, and installation of traffic sensors would enable the DOT to begin collect traffic information for these routes. For the locations that already have traffic sensors, NJDOT should attempt to improve the operational status of these sensors, either by implementing rigorous maintenance programs or installing higher quality traffic sensors.

A comparison of the traveler information market to the weather information market evidences the benefits to the NJDOT, and society in general, in becoming involved with the TIS market. Table 17 shows the fiscal impact of severe weather on a power company. Damages incurred by the power company are in the millions of dollars. If the company had received appropriate weather information, much of this sum could have been saved. Similarly, a recent study conducted by Ozbay *et al.* (30) reveals the congestion costs in northern New Jersey range from between $20,509,887,658 and $87,167, 022,546, or $0.47/vmt and $2.00/vmt. (30) These values reflect both the uncongested travel time and the additional time imposed on each user due to congestion. If the uncongested travel time is disregarded, and only the cost of time loss due to congestion is determined, the cost of congestion ranges from $1,869,619,345 and $7,945,882,216 for peak periods in Northern NJ. Though this cost is not directly incurred by NJDOT, the DOT can help reduce the costs associated with congestion, and thereby save the public money. The weather information market is also successfully using a public-private partnership as an infrastructure to collect and disseminate weather information. NJDOT is advised that this type partnership is theoretically and practically the most beneficial to society. In theory, the public-private partnership takes advantage of the many resources available to public agencies, and the marketing and business prowess of the private sector. Furthermore, the public-private partnership has been successfully implemented in other markets, such as the weather information market discussed earlier, and in the traveler information market, such as the TravInfo FOT in the San Francisco Bay Area.

The NJDOT is advised to sell traveler information, specifically traffic information, to VARs or other third parties. In order to ensure that the DOT benefits from developing a TIS infrastructure, the DOT should sell the collected traffic information to value-added resellers and other interested third parties instead of selling traveler information directly to the consumer. The DOT should become involved in the market for selling traveler information as it is predicted to become quite profitable, either by attempting to sell information directly to the consumer or by selling the information to VARs or ISPs, such as Metro Networks or Shadow Traffic. Table 5 shows the potential market size for long distance recreational traveler information services using various communication mediums. For the given communication mediums, the market size ranges from 2.2 to 19.8 million users. Results from the study also indicate that users were willing to pay $1 to $5 for information from each source, and $500 to $2000 for installation of an in-vehicle TV display. Furthermore, willingness to pay studies indicate that traveler information can be profitable. Polydoropoulou *et al.* (1997) conducted a willingness to pay case study of the SmarTraveler System customer market. [31] The researchers conducted a survey with 442 current users of the system, and 220 non-users. Results of the study indicate that users of the system would be willing to pay either a subscription fee or a pay-per-service fee for traveler information. When the SmarTraveler service was introduced to non-users, they also exhibited a willingness to pay for traveler information. The DOT has the option of trying to capture this market itself, or selling the information to the private sector and allowing them to capture this market. By directly selling traveler information to VARs and ISPs, the DOT is ensured of retrieving the costs of collecting traveler information. If the DOT attempted to sell information directly to the consumer, it would risk losing the capital it would have to invest in attempting to market and sell traveler information.

Another fiscal option for NJDOT would be to gather traveler information and publish it on-line through its own web site. By establishing a web site, the DOT could then emulate the revenue models used in the on-line market for information. For example, NJDOT could provide advertising space so that the website is supported by ad revenue while providing traveler information for free. This option would be most profitable if the website had numerous visitors. Another option would be the pay-per-service option, where NJDOT could provide a specific service, such as personalized traveler information, while providing basic traveler information for free. This option is already being attempted by TRANSCOM in its Trips123 program.

In order for the NJDOT to successfully sell traveler information for NJ roadways, the information must be reliable, accurate, and timely. These qualities are achieved by having quality traffic sensors and communication mediums that operate constantly. The financial benefits of selling traveler information cannot be expected immediately. Within the next five years, NJDOT has the potential to achieve financial rewards by marketing traveler information. The key behind the prospective profit in the market for traveler information is to provide the public with the information they require, dynamic and predictive traveler information that the traveler can access anytime and anywhere. The latter capability is dependent upon the popularity of in-vehicle navigation devices. The popularity of in-vehicle navigation is comparable to the current popularity of cell phones and hand-held devices. Each of the latter products followed a similar trend during their infancy, when they were projected to become integral products in the future market. Current research done by agencies such as the I-95 coalition and numerous research projects funded by the FHWA and the mindset of transportation professionals from agencies such as TRANSCOM indicate that providing traveler information through in-vehicle devices is the key to the future of traveler information systems. NJDOT should prepare itself to be able to deliver quality information when the in-vehicle products enter the mainstream market (i.e. become affordable and readily available). Within the next five years, NJDOT should focus on providing reliable traveler information to VARs and ISPs with the knowledge that this information is distributed through in-vehicle navigation and that the market size for traveler information will continue to grow as the popularity of in-vehicle devices increases.

Another area in which NJDOT can influence the development of ATIS is by fostering coordination among the state's transportation agencies. TRANSCOM and I-95 Corridor Coalition are already involved in coordinating efforts to implement ATIS strategies. However, NJDOT should take on a larger role because these particular agencies (TRANSCOM, I-95) have larger priorities than simply New Jersey. NJDOT's ample resources, both financial and operational, affect all aspects of the state's transportation network. No individual transportation agency within NJ could function without some assistance from NJDOT. Therefore, NJDOT should foster coordination among state agencies. For example, NJDOT can become more involved with NJTRANSIT for collecting and disseminating traffic and transit information using the resources available to both agencies. It can also become more involved with TRANSCOM, and help support the Trips123 program.

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APPENDIX A: CURRENT TRAVELER INFORMATION SITES ON THE INTERNET

The following tables display currently available web sites that provide traveler information throughout the country. The tables are divided into three sections: multiple city, city/region, and statewide/provincial. Each category contains the following information: site name, funding, and notes describing the information given in each site.

Multiple City

Site Name	*Funded by*	*Notes*
AccuTraffic – www.accutraffic.com	Private Sector	Links to DOT transportation sites for every state. Also give weather information.
Etak Traffic – www.etaktraffic.com	Private Sector – Etak, Inc.	Provides incident and construction info. for U.S. cities, including NYC
Real Time Traffic - traffic.maxwell.com	Private Sector – Maxwell Technologies	
SmarTraveler - www.smartraveler.com	Private Sector – SmartRoute Systems	Provides detailed traveler info. for 11 U.S. cities, including NYC
TrafficOnline - www.trafficonline.com	Private Sector – TranSmart Technologies	Provides personalized traveler info. for 5 U.S. cities; requires shareware download
Traffic Station - www.trafficstation.com	Private Sector – Extension of *Tele-Warning* system	Provides incident info. for 6 U.S. cities.
TravTips - www.travtips.net	Private Sector – I-95 Corridor Coalition	Travel and trip planning info. for Boston/New York trip.

City/Region

City & Site	Funded by	Notes
Albany - http://www.troopers.state.ny.us/TMC/TMCINDEX.html	NY State Police	Provides text messages regarding traffic conditions; links to construction info.
Atlanta - www.georgianavigator.com/traffic www.trafficstation.com	Georgia NAVIGATOR & Tele-Warning System	NAVIGATOR capabilities discussed in report; other site provides congestion details, along w/ incident and construction info.
Boston – www.smartraveler.com www.travtips.net	Smart Route Systems & ARCINC	Detailed traveler info. (including real-time video); traffic maps, incident/construction info.,

		weather info.
Branson, Mo. – branson.tripusa.com	Missouri DOT, FHWA, and private companies	Traffic and travel resource for Branson area
Chicago – www.trafficonline.com www.trafficstation.com www.travelinfo.org	TranSmart; Tele-Warning System; IDOT, INDOT, WisDOT (ITS Corridor)	Detailed traveler information including travel times, real-time video, and incident/construction info.
Cincinnati – www.smartraveler.com	Smart Route Systems	Traffic maps, travel times, incident/construction info.
Dallas – www.etaktraffic.com	Etak, Inc.	Traffic maps, and incident/construction info. including location, type, impact, cessation time
Denver - www.etaktraffic.com	Etak, Inc.	Traffic maps, and incident/construction info. including location, type, impact, cessation time
Detroit - campus.merit.net/mdot www.etaktraffic.com	MDOT & Merit Network, Inc.; Etak, Inc.	Traffic maps along w/ relevant weather info.; Traffic maps, and incident/construction info. including location, type, impact, cessation time
Grand Rapids, MI – www.skyview.iserv.net	Grand Rapids Skyview Traffic	Incident/construction info. updated 3 times/rush hour, weather info.
Hampton Roads, VA – www.vdot.state.va.us/traf/traf.html	VADOT	Tracks speeds for Hampton Road's tunnels, traffic cameras, weather info., and commuting info.
Hartford – www.travtips.net	ARCINC	Traffic maps, incident/construction info., weather
Honolulu – www.eng.hawaii.edu/~csp/Trafficam	U. of Hawaii and Honolulu's TCC	Traffic cameras, construction info
Houston - www.accutraffic.com traffic.tamu.edu www.trafficonline.com www.trafficstation.com	Accutraffic; TranStar, TranSmart Technology; Tele-Warning System	Provides detailed traveler information including real-time video, incident/construction info., congestion levels, speed; TranStar project discussed within report
Indianapolis – www.etaktraffic.com	Etak, Inc.	Traffic maps, and incident/construction info. including location, type, impact, cessation time
Lehigh Valley – www.22renew.com/traffic/h	Pennsylvania DOT	Traveler info. for Rt. 22 reconstruction project; single

ome.html		graphic color-coded to show delay
Lexington, KY - www.lfucg.com/trafficw/trafinfo.htm	Lexington-Fayette Urban County Gov't Traffic Info. Network	Construction info., audio functionality, weather and multi-modal info.
Las Vegas - www.etaktraffic.com	Etak, Inc.	Traffic maps, and incident/construction info. including location, type, impact, cessation time
Los Angeles – traffic.maxwell.com/la www.etaktraffic.com www.trafficstation.com	Maxwell Technology, Etak, Inc., Tele-Warning System;	Provides detailed traveler information; includes traffic maps, congestion levels, incident/construction info, weather info.
Milwaukee – traffic.maxwell.com/mil travelinfo.org/milwaukee.html www.dot.state.wi.us/dtd/hdist2/monitor.html www.trafficonline.com	Maxwell Technology; IDOT, INDOT, WisDOT (ITS Corridor), WisDOT MONITOR; TranSmart Technology	Detailed traveler information for Milwaukee area
Minneapolis/St. Paul - talk.startribune.com/stonline/traffic trafficview.twincities.sidewalk3.com www.etaktraffic.com www.smartraveler.com www.twincitiesexpress.com	MnDOT; Microsoft Sidewalk; Etak, Inc.; Smart Route Systems; Streamline Data Solutions & MnDOT	Detailed traveler information for Twin Cities area
Montgomery County, MD - www.dpwt.com/TraffPkgDiv/index.html	Montgomery County Dept. of Public Works and Transportation	Traffic cameras, incident/construction info., audio functionality, weather and multi-modal info.
New York Metro - www.smartraveler.com metrocommute.com www.travtips.net	Smart Route Systems; MetroCommute; ARCINC	Detailed traveler information for
Oakland County, MI - www.rcocweb.org	Road Commission for Oakland County	Traffic maps, traffic cameras, traffic speeds, construction info., weather info.
Philadelphia - www.smartraveler.com	Smart Route Systems	Traffic maps, travel times, incident/construction information,

		multi-modal information
Phoenix - www.azfms.com www.etaktraffic.com	AZTech; Etak, Inc.	Traffic maps w/ congestion levels, traffic cameras, incident/construction info., weather and multi-modal info.
Sacramento - www.transierra.com/sacto.htm	Etak, Inc.	Sacramento to Lake Tahoe Corridor Traffic maps with incident/construction information.
Salt Lake City - www.utahcommuterlink.com	Commuter Link	Traffic maps with real-time cameras; incident/construction information
San Antonio - www.transguide.dot.state.tx.us/map/	TransGuide	Traffic maps with congestion levels, speeds, incident/construction info., weather & multi-modal information
San Diego - traffic.maxwell.com/sd www.trafficstation.com	Maxwell Technology; Tele-Warning System	Traffic maps with congestion levels, incident/construction information, weather and multi-modal information
San Francisco - traffic.maxwell.com/sf web2.kpix.com/traffic www.etaktraffic.com www.trafficonline.com www.trafficstation.com	Maxwell Technology; KPIX television; Etak, Inc.; TranSmart Technology; Tele-Warning System	Traffic maps with congestion levels, incident/construction info., speeds, weather and multi-modal information, real-time cameras
San Jose - www.ci.san-jose.ca.us/traffic	Streets and Traffic Department	Traffic maps with congestion levels, speed, incident/construction information, multi-modal information
Seattle - trafficview.seattle.sidewalk1.com www.ivhs.washington.edu/trafnet www.trafficonline.com	Microsoft Sidewalk; Univ. of Washington; TranSmart Technology	Traffic maps with congestion levels, travel times, incident/construction info., weather and multi-modal information
Toronto - www.mto.gov.on.ca/english/traveller/compass	Ontario Ministry of Transportation	Traffic cameras, multi-modal information
Washington, DC - www.etaktraffic.com www.smartraveler.com	Etak, Inc.; Smart Route Systems	Traffic maps, travel times, incident/construction info. and impacts, multi-modal information

Statewide/Provincial

State & Site	Funded by	Notes
Arizona - http://www.azfms.com/HCRS/hcrs.html	Arizona DOT	Incident/construction information, weather info.
British Columbia - http://www.th.gov.bc.ca/bchighways/jump3.htm	British Columbia Ministry of Transportation and Highways	Traffic cameras, incident/construction information, weather information.
California - cad.chp.ca.gov http://www.dot.ca.gov/hq/roadinfo	California Highway Patrol's Computer Aided Dispatch Media Information Center; Caltrans	Incident/construction information, weather information.
Connecticut - http://www.state.ct.us/dot	CTDOT	Active incidents and maintenance or construction activities and live camera shots.
Delaware - http://www.state.de.us/deldot/cam/delaware.html	DelDOT	Incident, event, construction information.
Manitoba - umtig.mgmt.umanitoba.ca	The University of Manitoba's Highway Traffic Information System	Traffic maps with traffic data/statistics.
Maryland - http://www.chart.state.md.us/	MADOT CHART program	Traffic maps with congestion levels, traffic cameras.
Oregon - http://www.odot.state.or.us/roads	ODOT	Traffic maps, traffic cameras, weather and multi-modal info.
Quebec - http://www.mtq.gouv.qc.ca/etat_routes_java		Road conditions.
Texas - http://www.dot.state.tx.us/hcr/main.htm	TxDOT	Construction Information.
Washington State - traffic.wsdot.wa.gov	WsDOT	Traffic maps with congestion levels, traffic cameras, incident/construction info, weather and multi-modal info.

APPENDIX B: ATIS INFORMATION SURVEY AND RESULTS

This is a survey that will provide information on the availability of ITS data in New Jersey. The survey is being conducted under the direction of Professor Kaan Ozbay. These questions are intended to identify traffic data available in New Jersey.

General Information

Name:
Title:
Agency Name:
Agency Location:
Phone:
Fax:
Email:

Agency Information

1. Does your agency operate a "Traffic Control Center (TOC)"? Yes No
2. Please give brief description of Geographical Scope of TOC "Traffic Operations Center (TOC)"

3. How many miles of roadways / railway are under surveillance of the TOC?

4. How many miles of other roadways / railways that are not under surveillance?

5. What kind of traffic sensing equipment are employed by your agency and at what extent operational currently? Please list these according to the table shown below. (NOTE: If additional space is needed for any table in this survey, please use back of page or attach additional pages.)

Type of Sensor	Number	Location	Operational Status

6. If you have traffic sensors, how is the data transmitted to your TOC?
7. What types of sensors, such as loop detectors, RTMS, acoustic sensors, etc. does your agency operate and what type of data does each sensor collect?

Sensor Type	Type of Data Collected

8. What is the rate at which traffic data is collected by each type of sensor?

Sensor Type	Data Type (speed, volume, etc.)	Collection Rate

9. Do you store the data collected? YES NO

10. If yes, what is the aggregation level you use for the stored data?

11. Do you have any Video Cameras operated by your agency? YES NO

If yes, please fill out the following table.

Type	Location	Quantity	Spacing	Viewing Capability (Pan, Zoom, Tilt)

12. Where and in what data format is the imagery/map stored?

13. Do you have any weather sensors installed in the jurisdiction of your agency? YES NO

If so, please fill out the following table.

Type	Location	Quantity	Sensor Capabilities (surface and ambient temperature, ice, fog, rain detection, other)

14. Does your agency operate Electronic Toll Collection System (ETC) in its jurisdiction? YES NO

15. Do you use ETC to collect traffic information, such as exit-entry times, vehicle classification, and travel time between two tollbooths? YES NO

If so, please fill in the following table.

Type of Data Collected	Location & Format of Collected Data	Availability of Data to Other Organizations

16. Does your agency operate weigh stations in its jurisdiction? YES NO

17. Can truck volumes and truck weights be accessed automatically (via internet or modem) from these stations? YES NO

If so, please fill out the following table.

Location	Type of Scale Used	Format Data Stored	Other Data Collected

18. Does your agency collect or distribute transit system data (trains, buses) in New jersey? YES NO

If yes, please fill in the following table.

Transit System	Data Collected	Data Distributed	Distribution Medium

Specific Data Requirements

1. Does your agency collect incident data? YES NO

   If so, does the incident data contain the following information:

   Source of incident YES NO

   Type of incident YES NO

   Location - cross street, address, city, zip code, milepost, latitude/longitude, direction (please circle appropriate data) YES NO

   Start Time YES NO

   End Time or Expected Duration YES NO

   Severity YES NO

   Number of Lanes Blocked YES NO

   Personal Comments of Data Collector YES NO

2. Does your agency collect traffic congestion data? YES NO

   If so, does the traffic congestion data contain the following information: YES NO

   Source of congestion (construction, accident, etc.) YES NO

   Location of congestion – freeway or arterial YES NO

   Congestion Levels – light, medium, heavy YES NO

   Volume, Occupancy, Speed YES NO

3. Does your agency collect special event data? YES NO

   If so, does the special event data contain the following information:

   Source of special event data YES NO

   Type of special event YES NO

   Location – street, address, city, zip, latitude/longitude, direction YES NO

   Start time YES NO

   End time or expected duration YES NO

   Description of special event YES NO

4. Does your agency generate/disseminate traffic advisory data? YES NO

If so, does the traffic advisory data contain the following information:

Source of advisory data	YES	NO
Type of advisory	YES	NO
Location – street, address, city, zip, latitude/longitude, direction	YES	NO
Start time	YES	NO
End time or expected duration	YES	NO
Description	YES	NO

5. Does your agency collect transportation mode data (air, rail, subway, etc.) YES NO

If so, does this data contain the following information:

Transportation mode identification	YES	NO
Schedule adherence	YES	NO
Transit or railroad route	YES	NO
Waypoint – Transit Checkpoint, Train Station, or Airport Identification	YES	NO
Expected time of arrival at waypoint	YES	NO

6. Does you agency provide public/private companies or agencies with incident, congestion, special event, or other data? YES NO

If yes, list the public/private companies with type of information provided.

7. Do you store previously collected traffic data? YES NO

Is it available to the public or other agencies?	YES	NO
Do you conduct analysis of traffic trends?	YES	NO

8. What other types of data collected by your agency would be useful for planned Traveler Information System services?

New Jersey ITS Information

1. Please refer to the attached user services list and identify the operational and planned user services concerning ATIS by your agency. Also, please rate each user service (high, medium, or low priority) concerning its importance regarding ATIS.

2. Do you use the collected traffic data for any of the operational ATIS packages? YES NO
If so, please state which ATIS packages the data is used for.

3. Does your agency gather probe vehicle information? YES NO
If so, please list the information contained in the probe vehicle data, and in the format it is stored.

4. Many accidents occur in New Jersey due to various reasons. Is your agency involved in the management of these accidents? If yes, explain how.

5. How does your agency detect accidents?

7. Does your agency have a "standard" incident report form? YES NO

8. Does your agency use an automatic incident detection algorithm? YES NO
If yes, identify the type of incident detection algorithm.

9. Do you disseminate traveler information in case of accidents? YES NO
If yes, please circle the medium via which information is disseminated:

CMS VMSD Radio Media Kiosk WWW Other______________

10. What type of traveler information do you disseminate during traffic accidents or other incidents such as construction, maintenance, etc. (congestion, accident location, length of delay, other)?

11. Do you post congestion and/or weather advisories? YES NO

12. Do you recommend alternate routes during incidents? YES NO

If yes, how?

12. ATIS in New Jersey would encompass most, if not all, of the counties in the state. Should each county be responsible for their TIS data, or should the state be responsible for all of the data? County State

General ITS/TIS Questions

1. Please identify the needs/problems that can be solved with a Traveler Information System (TIS) in New Jersey for areas your agency is in charge.
2. Please identify the services that you believe a TIS should cover. Use the ATIS user services list attached to this survey.
3. Are there any specific goals or objectives you feel that a TIS system in New Jersey should accomplish? Be specific in terms of the role of you agency.
4. Among the roads that are not currently covered by your agency for ATIS services, what types of roads [highways (e.g. Rt. 18), residential roads, interstates (e.g. Rt. 287), Turnpike, Parkway] should be covered?
5. What specific areas in New Jersey do you feel should be covered by the TIS? For example, NJ beaches, Newark, Trenton, etc.
6. What agencies do you feel can help develop a TIS system in New Jersey?
7. Do you know of any companies or organizations that would be interested in developing or purchasing value added traveler information?
8. Does your agency have Geographic Information Systems (GIS) capabilities? If so, for what purposes does your agency use GIS and what software is used?
9. Private and public sector partnerships are integral in developing a successful TIS system. If such partnerships were developed in New Jersey, then what do you feel would be the expectations of each sector? Responsibilities? Compensation?
10. Do you provide raw or processed traveler information to any public or private institutions? If yes, what kind of information do you provide, and please list the name of these institutions.
11. If you provide travel information directly or through other institutions, do you charge for this information? If yes, please explain.

12. Even if you are not charging for the traveler information today, do you believe that your agency could charge for the information the future? If yes, give a list of the type of traveler information that can be sold for a charge.
13. Are you aware of any studies or reports that your agency conducted to assess its current and future ATIS capabilities? If yes, please list them.
14. Please make a list of short-term and long-term plan of your agency for ATIS services.
15. Does your agency provide routing information to Hazardous Material (HAZMAT) carriers?
16. Does your agency provide freight carriers with traffic/incident information? If yes, please list the freight carriers, and the type of information provided.
17. Does your agency have any relations with emergency management units? If so, please describe the agreement between your agency and any EM units.
18. Does your agency have any existing relations with local law enforcement agencies? If so, please list the law enforcement agency and the type of agreement.
19. Does your agency have any relations concerning Traveler Information System functions with other government transportation agencies? If so, please list the agency and the type of agreement.

ATIS Survey Summary for State Agencies and Transportation Management Associations (TMAs)

General Information

Contact Person	*Agency*	*Operational TOC*	*Geographic Scope of TOC*
Patricia Ott	NJDOT North	Yes	Middlesex, Somerset, Hunterdon Warren Sussex Morris, Essex, Hudson, Union, Passaic, Bergen Counties (state roadways only)
Tom Batz	TRANSCOM	Yes	Central Connecticut (Hartford), New York, New Jersey (Trenton) -- 28 Counties
Robert Dale	NJTPA	Yes	Entire NJ Turnpike. Have surveillance information from Interchange 8A to the northern terminus
Mark Muriello Ira Huttner	NYNJPA (Tunnels & Bridges)	Yes	All tunnels and bridges under our operations have their own facility.
Rich Rash	NJHA	No	TRANSMIT program covers part of Parkway. CCTV cameras isolated locations.
Ted Dahlburg Chris King	DVRPC	No	Primary role of agency is traffic modeling and forecasting with a focus on the national highway system using various tools such as the 4-step transportation model, TRANPLAN, and GIS
Jim Hogan	NJDOT South	Yes	Mercer, Monmouth and Rest of South Jersey

Agency Information

	Road Sensors					
Agency	*Available Sensors*	*Location*	*Operational Status*	*Data Collected*	*Collection Rate*	*Store Data*
NJDOT North	Pavement Loops	Rts. 1, 19, 9, 1&9, 24/202	Sporadic	Speed, Volume, Occupancy	Not Available	No
	Radar	Rt. 80 Corridor	Under Construction	Speed		No
TRANSCOM	Inductive Loops					Yes
	Radar					Yes
	Sonic Detectors					Yes
	Transponders					Yes

NJTPA	Loops	Int. 8A to Northern Terminus	861	Not Available	1 minute	Not Available
	VIDS		92		1 minute	
	RTMS		12		1 minute	
NYNJPA (Tunnels & Bridges)	Loop Detectors					Centrally Stored
	Video	Airports				
	Microwave Radar	GW Bridge				
	Probe Vehicles					
NJHA	None					
DVRPC	None					
NJDOT South	Loop Detectors	Various Locations in Conjunction with Video Cameras	Operational	Incident Mgmt.	N/A	N/A
	VID	Route 1	Under Construction	N/A	N/A	N/A
	Service Patrol	Multiple Locations	Operational	Incident Mgmt.	N/A	N/A

Video Cameras

Agency	*Video Cameras*	*Location*	*Quantity*	*Viewing Capabilities*	*Store Data*
NJDOT North	Yes	Rt. 18	4	PTZ	No
		Rt. 80 Corridor	37	PTZ	No
		Rt. 1 &9		PTZ	No
		Rt. 1	14	PTZ	No
		Rt. 24/202	2	PTZ	No
TRANSCOM	Yes	TRANSMIT			
NJTPA	Yes (Cohu)	MP 100.0	1	PTZ	No
		MP 101.1	1	PTZ	No
		MP 105.8	1	PTZ	No
		MP 106.4	1	PTZ	No

NYNJPA	Yes	Airports			
		All Tunnels/Bridges		PTZ/Color	No
NJHA	Yes	Int. 163	2		No
		Driscoll Bridge	1		No
		Int. 82	2		No
		Int. 37	2		No
DVRPC	None				
NJDOT South	Yes	Various Locations	Multiple	PTZ/Color	Yes

	Other Equipment			
Agency	*Weather Sensors*	*Operate ETC*	*Operate Weigh Stations*	*Collect or Distribute Transit Data*
NJDOT North	No	No	No	No
TRANSCOM	No	Yes - used for travel time calculations as well	No	Yes
NJTPA	No	No	No	No
NYNJPA	Yes	Yes	No	No
NJHA	Yes (Driscoll Bridge)	Yes	No	Yes (buses)
DVRPC	No	No	No	No
NJDOT South	Yes (12 total)	No	No	No

Specific Data Requirements

Agency	*Incident Data Collection*	*Information Contained in Data*
NJDOT North	Yes	Source of Incident, Type of Incident, Location, Start Time, End Time, Expected Duration, Severity, Lanes Blocked, Personal Comments
TRANSCOM	Yes	Source of Incident, Type of Incident, Location, Start Time, End Time, Expected Duration, Severity, Lanes Blocked, Personal Comments
NJTPA	Yes	We collect this information, but do not put it in a data format, therefore it is very difficult to extract.
NYNJPA	Yes	Source of Incident, Type of Incident, Location, Start Time, End Time, Expected Duration, Severity, Lanes Blocked, Personal Comments
NJHA	Yes	Source of Incident, Location, Start Time, End Time, Severity, Number of Lanes Blocked
DVRPC	No	Data is not currently collected, but plans do exist. DOT's want incident data collection process for planning purposes, such as determining trouble spots and producing quantifiable statistics.
NJDOT South	Yes	Source of Incident, Type of Incident, Location, Start Time, End Time, Severity, Number of Lanes Blocked, Personal Comments

Agency	*Traffic Congestion Data Collection*	*Information Contained in Data*
NJDOT North	Yes	Source of Congestion, Location of Congestion, Congestion Levels, Volume, Occupancy, Speed
TRANSCOM	Yes	Non-Recurring Congestion only -- Source of Congestion, Travel Times
NJTPA	Yes	We collect this information, but do not put it in a data format, therefore it is very difficult to extract.
NYNJPA	Not Specifically	Volume, Occupancy, Speed
NJHA	No	N/A
DVRPC	Yes	Volume, Occupancy, Speed (not on a continuous basis but project by project), congestion location such as freeway or arterial by working with groups like traffic monitoring and truckers groups, and also focus on various corridors, and congestion levels
NJDOT South	No	Use SmartRoute ISP

Agency	*Special Event Data Collection*	*Information Contained in Data*
NJDOT North	Yes	Source of Special Event, Type of Special Event, Location, Start Time, End Time, Expected Duration, Description of Special Event
TRANSCOM	Yes	Type Special Event, Location, Start Time, End Time, Expected Duration, Description Special Event
NJTPA	Yes	We collect this information, but do not put it in a data format, therefore it is very difficult to extract.
NYNJPA	Yes	Source of Special Event, Type of Special Event, Location

NJHA	Yes	Source of Special Event, Type of Special Event, Location, Start Time, End Time, Expected Duration, Description of Special Event
DVRPC	Yes	Source of Special Event, Location, Start Time
NJDOT South	Yes	Source of Special Event, Type of Special Event, Location, Start Time, End Time, Expected Duration, Description of Special Event

Agency	*Generate or Disseminate Traffic Advisory Data*	*Information Contained in Data*
NJDOT North	Yes	Source of Advisory Data, Type of Advisory, Location, Start Time, End Time, Expected Duration, Description
TRANSCOM	No	Not Applicable
NJTPA	Yes	Source of Advisory Data, Location, Start Time, End Time, Expected Duration, Description
NYNJPA	Yes	Source of Advisory Data, Type of Advisory, Location, Start Time, End Time, Expected Duration, Description
NJHA	Yes	Type of Advisory, Location, Start Time, End Time, Expected Duration, Description
DVRPC	Yes	Source of Advisory Data, Location, End Time, Expected Duration, Description
NJDOT South	Yes	In sense that we generate data, and SmartRoute disseminates the details

Agency	*Collect Transportation Mode Data*	*Information Contained in Data*
NJDOT North	No	Not Applicable
TRANSCOM	Yes	Transportation Mode Identification, Schedule Adherence, Transit or Railroad Route, Waypoint (Airport Identification), Delay of Arrival at Waypoint
NJTPA	No	Not Applicable
NYNJPA	Yes	N/A
NJHA	Yes	Truck and Bus Counts from Toll Collection
DVRPC	Yes	Transportation Mode Identification, Schedule Adherence (project by project basis)
NJDOT South	No	Not Applicable

Agency	*Provide Public or Private Agencies with Previously Mentioned Data*	*List of Companies*
NJDOT North	Yes	TRANSCOM, I-95 Corridor through IEN, Media, Toll Agencies, NJSP, Local Police, TMAs
TRANSCOM	Yes	All Member Agencies
NJTPA	Yes	None Given
NYNJPA	Yes	TRANSCOM, I-95 Corridor

NJHA	Yes	Traffic Services
DVRPC	Yes	Motor Truck Associations, AAA, Newspapers, any private company that requests data
NJDOT South	Yes	I-95 Corridor, Smart Route, TMAs, M PO, Police, NJ Transit, TRANSCOM, ISPs

Agency	*Store Previously Collected Traffic Data*	*Available to Public or Other Agencies*
NJDOT North	Yes	Yes
TRANSCOM	Yes	Yes
NJTPA	Yes	Yes
NYNJPA	Yes	Yes
NJHA	Yes	Yes
DVRPC	Yes	Yes
NJDOT South	Yes	Yes

New Jersey ITS Information

Agency	*Does your agency gather probe vehicle information?*
NJDOT North	No. Future - TRANSMIT Program through TRANSCOM
TRANSCOM	TRANSMIT Program
NJTPA	No. Future - TRANSMIT Program through TRANSCOM
NYNJPA	Yes. Collect O-D data, Travel Time. Use EZ Pass Tags for queue time, travel time across facility.
NJHA	No. However, similar analysis is done using SKYCOM
DVRPC	No.
NJDOT South	No.

Agency	*Is your agency involved in accident management?*
NJDOT North	We have Incident Management Response Teams (IMRT) which respond to major incidents along state highways. A dedicated NJSP Sgt. is located in our office to assist. County diversion routes are being developed with preplanned routes.
TRANSCOM	No.
NJTPA	Yes.
NYNJPA	Not specifically.
NJHA	No.
DVRPC	No.
NJDOT South	Yes.

Agency	*How does your agency detect accidents?*
NJDOT North	Cameras, Emergency Service Patrol, Police, TRANSCOM
TRANSCOM	Through member agencies and ATMS programs
NJTPA	Accidents are detected by passing motorists who report them to toll collectors or by personnel in the Toll Collection Department, some of whom travel the roadway. State Police, Maintenance and Operations personnel among others may detect accidents and report them via radio. Passing motorists can use 911 or #95 cellular
NYNJPA	Facility staff, incident detection, CCTV observations, call-in's.
NJHA	Toll Collectors, Travelers, in future will use TRANSMIT.
DVRPC	No.
NJDOT South	Service Patrol, Sensors, etc. (more details to come)

Agency	*Does your agency have a "standard" incident report form?*
NJDOT North	Yes.
TRANSCOM	Yes.
NJTPA	No.
NYNJPA	Yes.
NJHA	No.
DVRPC	No.
NJDOT South	Yes.

Agency	*Does your agency use an automatic incident detection algorithm?*
NJDOT North	Future.
TRANSCOM	No.
NJTPA	Yes.
NYNJPA	Future.
NJHA	No.
DVRPC	No.
NJDOT South	In some locations, such as the traffic signal system on Route 1/73 and on Route 90 near the Taconi Palmira Bridge

Agency	*Do you disseminate traveler information in case of accidents?*
NJDOT North	Yes, via CMS, VMSD, Radio, and Media.
TRANSCOM	Not always, via CMS, Radio, Media, Kiosk
NJTPA	Yes, via CMS, VMSD, Radio, Media, HAR, HAT
NYNJPA	Yes, via CMS, VMSD. Future includes WWW. Also through TRANSCOM.
NJHA	Yes, via Media, WWW, and in future, kiosks (TRANSMIT).

DVRPC	No.
NJDOT South	Yes. All of the given means but through SmartRoute

Agency	*What type of traveler information do you disseminate during traffic accidents or other incidents?*
NJDOT North	Location, Duration, Time, Date, Condition. Weekly construction report via email to TRANSCOM and TMAs.
TRANSCOM	Location, Duration, Time, Date, Condition. Distribute Weekly Traffic & Transit Advisory containing construction & special event info.
NJTPA	We advise motorists of the location and extent of congestion and length of delay if available.
NYNJPA	Length of Delay, Travel Time, Location
NJHA	Details not given.
DVRPC	Not Applicable.
NJDOT South	See above.

Agency	*Do you cost congestion and or weather advisories?*
NJDOT North	Yes.
TRANSCOM	No.
NJTPA	Yes.
NYNJPA	Yes.
NJHA	Yes, weather advisories include notices for fog, snow, and slippery surfaces.
DVRPC	No.
NJDOT South	Yes.

Agency	*Do you recommend alternate routes during incidents?*
NJDOT North	Yes. Will post detours in the event of a long term closure.
TRANSCOM	No.
NJTPA	Yes, through HAR, HAT, VMS, and the media.
NYNJPA	We recommend alternate routes, rather than specifying them.
NJHA	No.
DVRPC	No.
NJDOT South	Yes, using diversion plans that are pre-developed

Agency	*Should each county be responsible for TIS data, or should the state be responsible for all of the data?*
NJDOT North	State

TRANSCOM	N/A
NJTPA	State
NYNJPA	State, and maybe TRANSCOM
NJHA	State because it can act as a centralized depository.
DVRPC	Initially, the state should be because of its major facilities. Afterwards, responsibility should be delegated.
NJDOT South	State

General ITS/TIS Questions

Agency	*Please identify the needs/problems that can be solved with a TIS for areas your agency is in charge.*
NJDOT North	Should the DOT be in this business? Other groups can do it better than us, namely TRANSCOM and this is fast becoming a business, private groups are now getting into this business as a for fee personalized traveler information service.
TRANSCOM	Predictive models…What can we expect? In-vehicle navigation is the future, and we must get there.
NJTPA	Reduce congestion, improve safety, reduce emissions, reduce driver stress.
NYNJPA	Reduce overall congestion, route planning, diversion strategies.
NJHA	Alleviate congestion, Pre-trip traveler information in order to adjust travel times.
DVRPC	Congestion attributable to incidents, and growth in traffic, information to transmit to travelers.
NJDOT South	What we did with ESP was very good, appreciated by Mercer County. In the sense that TIS will help resolve congestion.

Agency	*Are there any specific goals/objectives you feel a TIS in New Jersey should accomplish?*
NJDOT North	Should be free to all users, should be timely, accurate and reliable. Should be consistent between agencies.
TRANSCOM	N/A
NJTPA	N/A
NYNJPA	N/A
NJHA	N/A
DVRPC	Goals consistent with your organization. Would help efficient mobility and flow of goods and people.
NJDOT South	N/A

Agency	*What specific areas in New Jersey do you feel should be covered by a TIS?*
NJDOT North	Major urban areas (Newark, Jersey City, Camden, Trenton), Recreational areas (shore, Water Gap), Major commuting corridors
TRANSCOM	Areas that are most congested and heavily traveled.
NJTPA	Cover all interstate and toll roads as well as urban arterials.
NYNJPA	N/A
NJHA	Congested Corridors, such as beyond Toms River Commuter Corridor, and before Bergen Toll Plaza.

DVRPC	Most of the major highways: Princeton-Trenton, Hopewell-Trenton, Trenton-Philly, Hightstown-Bordenton, Rte. 31
NJDOT South	Better coverage on beaches/coast, all interstates should be ITS ready using cameras for detection; plus the new tunnel near Trenton

Agency	*What agencies do you feel can help develop a TIS in New Jersey?*
NJDOT North	DOT, Toll Agencies, TRANSCOM, Media
TRANSCOM	All
NJTPA	NJTPA, NJDOT, NJHA, SJTA, PANY & NJ, NJSP
NYNJPA	N/A
NJHA	All transportation agencies.
DVRPC	Aside from transportation agencies, media, calbe companies.
NJDOT South	MPOs, Police Agencies, all transportation agencies.

Agency	*Do you know of any companies/organizations that would be interested in purchasing/developing value added information?*
NJDOT North	Currently ongoing with TRANSCOM MDI, I-95 Field Operational Test
TRANSCOM	Market research has been conducted…large companies, commercial fleets…must be packaged with other information
NJTPA	No.
NYNJPA	TRANSCOM. Forums of discussion must be opened.
NJHA	No.
DVRPC	Defer to the TMAs. Companies are interested but need to talk to someone else.
NJDOT South	SmartRoute and other ISPs

Agency	*Does your agency have GIS capabilities?*
NJDOT North	Yes, UNIX platform.
TRANSCOM	Entirely GIS based. ESRI (ArcInfo)
NJTPA	No.
NYNJPA	Yes, Esri (ArcInfo). Not used much.
NJHA	Not Yet. Will be using ESRI (ArcInfo)
DVRPC	Yes, used for analysis, portrayal and synthesis of information
NJDOT South	Yes.

Agency	*If private/public partnerships were developed in NJ, what do you feel would be the responsibilities of each sector?*
NJDOT North	TRANSCOM MDI, I-95 FOT will show results of private/public partnerships
TRANSCOM	Private partnerships already exist with P.B. Faradein, NEC, NAVTEC, TSI, SATIN
NJTPA	N/A
NYNJPA	We have a partnership with TRANSCOM.
NJHA	Through TRANSCOM.

DVRPC	Pbulic sector should be responsible for operations.
NJDOT South	N/A

Agency	*Do you provide raw or processed traveler information to any public or private institutions?*
NJDOT North	Incident and construction information to internal DOT, TRANSCOM, Media, TMAs….Video in the future to Cable TV Co.
TRANSCOM	Yes
NJTPA	No.
NYNJPA	N/A
NJHA	N/A
DVRPC	N/A
NJDOT South	Yes

Agency	*If you provide travel information directly or through other institutions, do you charge for the information?*
NJDOT North	No, but hope to in future to cover maintenance expenses.
TRANSCOM	Yes
NJTPA	Not applicable.
NYNJPA	N/A
NJHA	No, but if we did, agency should be compensated.
DVRPC	No.
NJDOT South	No. Contract with Smart Route

Agency	*Even if you are not charging for traveler information, do you believe that your agency could charge for information in the future?*
NJDOT North	Yes. We can charge for video feeds.
TRANSCOM	N/A
NJTPA	Subject to further discussion.
NYNJPA	N/A
NJHA	N/A
DVRPC	No
NJDOT South	No, not good for the state.

Agency	*Does your agency provide routing for HAZMAT carriers?*
NJDOT North	No.
TRANSCOM	No.
NJTPA	No.
NYNJPA	No.
NJHA	No.
DVRPC	No.

NJDOT South	No.

Agency	*Does your agency provide freight carriers with traffic/incident information?*
NJDOT North	No, this is provided by TRANSCOM.
TRANSCOM	Yes. (more detailed info. not available due to contract restrictions)
NJTPA	Through TRANSCOM.
NYNJPA	No.
NJHA	No.
DVRPC	Trough Travel Smart, doesn't include routing information.
NJDOT South	Through TMAs.

Agency	*Does your agency have any relations with emergency management units?*
NJDOT North	Most of the County OEMs, Traffic Officers Association, and NJSP OEM
TRANSCOM	No.
NJTPA	Yes, we have agreements with emergency management units.
NYNJPA	We do not have direct agreements, rather the Port Authority Police handle the situation.
NJHA	State Police Troop E handles all emergencies and has appropriate contacts.
DVRPC	For our ITS projects, Philly police, state police (PA & NJ)
NJDOT South	Yes, state and county police.

Agency	*Does your agency have any existing relations with law enforcement agencies?*
NJDOT North	Most local agencies through our State Police liaison
TRANSCOM	No.
NJTPA	No.
NYNJPA	Port Authority Police.
NJHA	State Police Troop E handles all emergencies and has appropriate contacts.
DVRPC	Yes.
NJDOT South	State and county police.

Agency	*Does your agency have any relations concerning Traveler Information System functions with other gov't agencies?*
NJDOT North	Future agreement with NJ Turnpike; Agreement with TRANSCOM - HAR
TRANSCOM	Yes.
NJTPA	No.
NYNJPA	N/A
NJHA	TRANSCOM.
DVRPC	We provide coordination, so everyone comes to us for information.
NJDOT South	Yes.

General Information for Transportation Management Associations

TMA	*Contact*	*Location*	*Website*	*Geographic Scope*
Cross County Connection (CCTMA)	William Ragozine	Marlton, NJ	www.ridesharenj.com	Burlington & Camden Counties (primary scope), Gloucester, Salem, Cumberland, Atlantic, Cape May
Greater Mercer (GMTMA)	Sandra Brillhart	Princeton, NJ	www.gmtma.org	Mercer County, Parts of Middlesex and Somerset Counties

TMA	*Funding*
CCTMA	Funded by NJDOT, NJTRANSIT, and dues of our membership organization
GMTMA	Funded by NJDOT and NJTRANSIT, but independent non-profit organization, and membership dues

TMA	*Mission Statement/Goals*
CCTMA	…To improve the quality of life in southern NJ through transportation solutions -- working towards recognition of organization for making a visible calculatable change in traffic congestion in southern NJ. Want to promote use of alternatives to single occupancy vehicle
GMTMA	…To work with employers, both public and private, to improve mobility and reduce traffic congestion in Mercer County area by developing options to single occupancy vehicle

TMA	*What transportation agencies do you contact to gather your data?*
CCTMA	NJ Traffic Operations South, NJTRANSIT
GMTMA	NJDOT, NJ Traffic Operations North, NJTPK, County, Municipalities

TMA	*What types of data does your TMA gather?*
CCTMA	Information on construction projects, incidents/accidents (non-recurring type), occasional special event data & traffic advisory data
GMTMA	Incident data, traffic congestion data, special event data, construction information

TMA	*Does your TMA collect/distribute transit system data?*
CCTMA	Supply all transit schedules for every form of transit. Information and all brochures derived from NJTRANSIT
GMTMA	Yes, from NJTRANSIT. Typically sent to all work locations along transit route.

TMA	*Does your TMA distribute collected data in "raw" form, or are their modifications made?*
CCTMA	Depends on the type of data. In general, email is translated into quick sentence or too. Not much information appended, occasionally may add information such as duration

GMTMA	Minor modifications. DOT data contains mileposts, change that to street locations, etc. However, major data that is appended is alternate route data. Mercer county has established incident management plan. If certain roadway closed, pre-determined detours are used. Only for state highways. Less focus on local roads.

TMA	*Do you disseminate traveler information, and if so, through what medium?*
CCTMA	Yes, through email, website, faxes…usually everything is through website.
GMTMA	Yes, through faxes, email, and website. Sent to either individual employees or to a company coordinator.

TMA	*How frequently do you update your traveler information?*
CCTMA	Updated twice a day on website…incidents, repair, maintenance, and construction activity.
GMTMA	As needed, at least every week. If long-term construction project, posted on website. Serious non-recurring congestion, posted immediately.

TMA	*Has your TMA conducted any studies concerning usage of the information provided?*
CCTMA	Have not conducted study yet, but will by the end of fiscal year (end of June)
GMTMA	On going in conjunction with DOT. Have previously conducted surveys. In general, have found that people find information valuable and give positive feedback. The biggest negative feedback is that information isn't applicable to customer's location.

Specific Data Requirements

Agency	*Incident Data Collection*	*Information Contained in Data*
CCTMA	Yes	Source of Incident, Type of Incident, Location, Start Time, End Time, Expected Duration, Severity, Lanes Blocked
GMTMA	Yes	Source of Incident, Type of Incident, Location, Start Time, End Time, Expected Duration, Severity, Lanes Blocked

Agency	*Traffic Congestion Data Collection*	*Information Contained in Data*
CCTMA	Yes	Source of Congestion, Location of Congestion
GMTMA	Yes, Only non-recurring congestion	Source of Congestion, Location of Congestion

Agency	*Special Event Data Collection*	*Information Contained in Data*
CCTMA	Yes Infrequently	Type of Special Event, Location, Start Time, End Time, Expected Duration, Description of Special Event
GMTMA	Yes Infrequently	Type of Special Event, Location, Start Time, End Time, Expected Duration, Description of Special Event

Agency	*Generate or Disseminate Traffic Advisory Data*	*Information Contained in Data*
CCTMA	Yes, only long term incidents and to members only	Type of Advisory, Location, Description
GMTMA	Yes, only for major accidents	Source of advisory data, type of advisory, Location, Start & End time, Description

Agency	*Collect Transportation Mode Data*	*Information Contained in Data*
CCTMA	No	Not Applicable
GMTMA	No	Not Applicable

Agency	*Provide Public or Private Agencies with Previously Mentioned Data*	*List of Companies*
CCTMA	Yes	See Website
GMTMA	Yes	See Website

Agency	*Store Previously Collected Traffic Data*	*Available to Public or Other Agencies*	*Analyze Traffic Trends*
CCTMA	No	N/A	N/A
GMTMA	Yes	Yes	No

New Jersey ITS Information

TMA	*What other types of data collected by your TMA would be useful for TIS?*
CCTMA	Have all routes and schedules for all modes of mass transit in southern NJ
GMTMA	None. Covered everything.

TMA	*Do you disseminate traveler information in case of accidents?*
CCTMA	Yes, all relevant information.
GMTMA	Yes, location, cause, duration, and if available alternate routes.

TMA	*Do you post daily congestion/weather advisories?*
CCTMA	No.
GMTMA	No.

TMA	*Do you recommend alternate routes during incidents?*
CCTMA	No.
GMTMA	Yes. Incident management plan developed between state, county and municipalities.

TMA	*Should each county be responsible for TIS data, or should the state?*
CCTMA	State. Counties should have input and should be involved, but do not have the work force or funding to do this amount of work.
GMTMA	State. To ensure consistency, all should be managed centrally.

General ITS/TIS Questions

TMA	*Please identify specific needs/problems that a TIS can help your TMA solve.*
CCTMA	Gets information out to public much more quickly and efficiently. Less manual work, more automated.
GMTMA	Can provide greater publicity of alternate modes of transportation.

TMA	*Are there any specific goals/objectives that you feel a TIS in New Jersey should accomplish?*
CCTMA	Should make people understand alternatives and value of alternate transportation modes.
GMTMA	None.

Agency	*What specific areas in New Jersey do you feel should be covered by a TIS?*
CCTMA	Atlantic City, beaches, major traffic hotspots in South Jersey region that can be prioritized.
GMTMA	Heavy commuter corridors, and recreational areas.

Agency	*What agencies do you feel can help develop a TIS in New Jersey?*
CCTMA	TRANSCOM, MPOs, AC Expressway Authority, L3 Communications, CSC
GMTMA	NJDOT, TRANSCOM, counties, NJTPK, all toll roads & bridges organizations, NJTRANSIT

Agency	*Do you know of any companies/organizations that would be interested in purchasing/developing value added information?*
CCTMA	L3 & TPA/TPO/Del. Regional Valley in developing, none in purchasing
GMTMA	Large commercial fleet carriers.

Agency	*Does your agency have GIS capabilities?*
CCTMA	Yes, ArcView, ArcInfo. For presentations, grant applications, grant submittal, support of our members that require GIS, also to defined member locations and access information. Part of ridesharing system.
GMTMA	Yes, ArcView, used for developing incident management program, ridesharing matching system, transit routing

Agency	*If private/public partnerships were developed in NJ, what do you feel would be the responsibilities of each sector?*
CCTMA	In general, TIS is state or federal responsibility, keeping that in mind, involvement of private/public would be successful. If compensation available, both should be compensated, private first.
GMTMA	Public should provide information and data, private should develop technologies to acquire customers

Agency	*If you provide travel information directly or through other institutions, do you charge for the information?*
CCTMA	No, we do not. If customer request were great enough, then would consider.
GMTMA	Yes

Agency	*Does your agency provide routing for HAZMAT carriers?*
CCTMA	No.
GMTMA	No.

Agency	*Does your agency provide freight carriers with traffic/incident information?*
CCTMA	Yes, at times.
GMTMA	Yes, at times.

Agency	*Does your agency have any relations with emergency management units?*
CCTMA	No.
GMTMA	No.

Agency	*Does your agency have any existing relations with law enforcement agencies?*
CCTMA	No.
GMTMA	No.

Agency	*Please make a list of short term and long term plans for your TMA.*
CCTMA	Very involved in creating viable membership that is interested in public/private partnership. Pager Project ongoing with NJDOT South and L3 Communications.
GMTMA	Started working with Greater Princeton Security Association to provide main large companies with better communications process for roadway conditions, prompted by Hurricane Floyd. See if we can coordinate stagger release time of employees.

Agency	*Does your TMA have any existing relations concerning Traveler Information System functions with other government agencies?*
CCTMA	Indirectly with FHWA. To small degree with DVRPC. Lack of being asked.
GMTMA	No.

Agency	*Do you get any feedback from your customers about the quality and effect of the information you provide?*
CCTMA	Have not yet, but will by the end of June 2000.
GMTMA	Will have customer feedback through survey. This year, DOT is trying to do an overall evaluation of TMAs role in traffic mitigation

Agency	*Do you cooperate with other TMAs in NJ to fulfill your objectives?*
CCTMA	Yes.
GMTMA	We all cooperate, most closely with Middlesex and Somerset Counties. We also are starting to work with Bucks County, PA.

User Service Rankings

User Services	Priority							
	TRANSCOM	NJDOT North	NJTPK	NJPKWY	NJNYPA	DVRPC	CCTMA	GMTMA
Pre-Trip Information	H	L	H	M	H	H	H	H
En-Route Trip Information	H	L	H	H	H	H	H	H
Route Guidance	M	M	M	M	H	M	H	H
Ride Matching & Reservation	L	L	M	L	N/A	M	H	M
Traveler Services Information	H	M	H	M	N/A	M	H	H
Traffic Control	L	H	H	H	H	H	H	H
Incident Management	H	H	H	H	H	H	H	H
Travel Demand Management	M	M	M	H	H	L	M	M
Emissions Testing & Mitigation	L	L	L	L	N/A	L	L	M
Highway-Rail Intersection	L	L	L	L	N/A	H	M	M
Public Transportation Management	L	L	L	M	H	H	H	M
En-Route Transit Information	H	L	L	L	H	H	L	L
Personalized Public Transit	L	L	L	M	N/A	L	M	L
Public Travel Security	L	L	L	H	N/A	H	M	M
Electronic Payment Services	H	L	H	H	H	H	H	H
Comm Veh Electronic Clear	M	L	L	M	N/A	H	L	?
Automated Roadside Safety Inspection	L	L	L	H	N/A	H	M	M
On-board Safety Monitoring	L	L	L	L	N/A	M	L	M
Comm Veh Admin Processes	M	L	M	M	H	M	L	?

Haz Mat Incident Response	L	H	H	H	N/A	H	H	H
Commercial Fleet Management	H	L	L	L	H	M	H	M
Emergency Notif. & Personal Sec	H	M	H	L	N/A	H	M	M
Emergency Veh Management	M	M	L	L	H	H	H	L
Longitudinal Collision Avoidance	L	L	L	L	N/A	L	L	M
Lateral Collision Avoidance	L	L	L	L	N/A	L	L	M
Intersection Collision Avoidance	L	L	L	L	N/A	L	M	M
Vision Enhancement for Crash Avoidance	L	L	L	L	N/A	L	L	M
Safety Readiness	L	M	L	L	N/A	L	M	L
Pre-crash Restraint Deployment	L	L	L	L	N/A	L	M	M
Automated Veh Operation	L	L	L	L	N/A	L	L	L