New Jersey ITS Architecture Program

SJTPO Regional ITS Architecture

Final Report (Draft)

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Revision History

Filename	Version	Date	Author	Comment
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1 Executive Summary

The "Development of Statewide/Regional Intelligent Transportation Systems (ITS) Architectures And Deployment Plans" project has created two regional ITS architectures (North Jersey Transportation Planning Authority (NJTPA) and South Jersey Transportation Planning Organization (SJTPO) New Jersey ITS Architectures) as well as a statewide ITS architecture (The New Jersey Statewide ITS Architecture). These two regional and one statewide ITS architectures are roadmaps for transportation systems integration in the State of New Jersey over the next 15 to 20 years. These architectures have been developed through a cooperative and consensus based effort by the region's transportation agencies, covering all modes and all roads in the region. These architectures represent a shared vision of how each agency's systems work together currently or will work together in the future, sharing information and resources to provide a safer, more efficient, and more effective transportation system for travelers in the region.

1.1 Purpose

The two Regional ITS Architectures and the Statewide ITS Architecture represent a consensus blueprint for ITS Investments in the state. Why develop these ITS architectures? First and foremost the architectures define integration opportunities between agencies within the state and identify how cooperation between the agencies in the deployment of ITS systems can be used to satisfy transportation needs. By defining what currently exists in the area of ITS deployments, the ITS architectures can be used to identify gaps in needed ITS services and can identify how these gaps might be addressed.

The architectures can be used to efficiently structure implementations of ITS technologies. By creating a long range plan for the implementation of these systems and technologies, agencies can

- Prepare for future expansion
- Leverage funding
- Identify standard interfaces

Finally, development of the three architectures allows New Jersey to comply with the FHWA Rule/FTA Policy on Architecture and Standards. The FHWA Final Rule (and corresponding FTA policy) to implement Section 5206(e) of the TEA-21 requires that Intelligent Transportation Systems (ITS) projects funded through the Highway Trust Fund conform to the National ITS Architecture and applicable standards. The Rule/Policy requires that the National ITS Architecture be used to develop a local implementation of the National ITS Architecture, which is referred to as a "Regional ITS Architecture." The federal deadline for conformance to this Final Rule/Policy is 8 April 2005. The development of the three architectures will make most of New Jersey fully compliant with this rule/ policy, which will facilitate the approval of federal funds to support ITS projects in the state. (Note that four counties which are part of the DVRPC MPO region participate directly in the DVRPC Regional ITS Architecture. While this regional ITS architecture is not currently compliant with Rule 940, the DVRPC Staff have indicated that this architecture will be updated in the near future to bring it into compliance.)

1.2 Major Findings and Highlights

The development of regional and statewide ITS architectures is being done to support transportation planning at the state and regional level. As such the architectures are ultimately an expression of ITS services that can be implemented to meet transportation needs. What makes up a regional or statewide ITS architecture? The following are the key aspects of each architecture:

- **Scope.** A definition of the geographic scope, timeframe, and range of services covered by each ITS architecture.
- **Stakeholders.** These are the agencies or organizations involved in surface transportation.
- **Inventory.** A set of “elements” that represent the systems (or parts of systems) owned, managed, or maintained by the stakeholders.
- **ITS Services.** These represent how the ITS elements will share information to provide services that satisfy transportation needs. Each architecture defines a set of customized services, referred to as “Customized Market Packages” (after the name given in the National ITS Architecture to represent how ITS provides specific surface transportation services).
- **Interfaces and Information Flows**. The interfaces and information flows between the elements are the details that make up the customized market packages.
- **Functional Requirements.** Each major element in the architectures has functional requirements that it must meet in order to provide the functionality implied by the market packages in which it participates.
- **Agreements.** The definition of interfaces between the elements of different agencies identifies the possible need for formal or informal agreements between these agencies.
- **Standards.** The definition of interfaces and information flows provides a pointer to ITS standards that may be applicable in the regional or statewide deployments.
- **Project Sequencing.** Projects are the high level definition of how one or more customized market packages defined by the architectures will be implemented.

While the architecture represents a long range vision for transportation in the state or individual region, projects will be implemented in some sequence or time order (short term to long term) depending on a variety of factors including agency priorities, funding, technical issues, and institutional issues.

- **Integration Strategy.** The definition of how the ITS architectures will be used to support both transportation planning and project development.

The architecture outputs described above were developed with extensive, consensus stakeholder review. The next section will highlight the stakeholders and their review.

1.2.1 Scope

The geographic scope of the Northern New Jersey Regional ITS Architecture, also referred to as the NJTPA Regional ITS Architecture, is the 13 counties that make up the North Jersey Transportation Planning Authority (NJTPA). These counties are shown in blue in Figure 1-1. The geographic scope of the Southern New Jersey Regional ITS Architecture, also referred to as the SJTPO Regional ITS Architecture, is the 4 counties that make up the South Jersey Transportation Planning Organization (SJTPO). These counties are shown in red in Figure 1. The counties in white in Figure 1 are covered by the Delaware Valley Regional Planning Commission, which several years ago developed a regional ITS architecture for their region (and this architecture will be updated soon according to DVRPC Staff). The Statewide ITS Architecture naturally covers the entire state. For all three architectures a timeframe of 20 years into the future was chosen for the architecture development. Regarding scope of services, the statewide ITS architecture covered those services that are statewide in nature (e.g. Commercial Vehicle Operations or Electronic Toll Payment) as well as services of statewide agencies such as New Jersey Transit. For each regional ITS architecture, services in the areas of Traffic Management, Traveler Information, Emergency Management, Transit Management, Archive Data Management, and Maintenance Management that were regional in nature were covered.

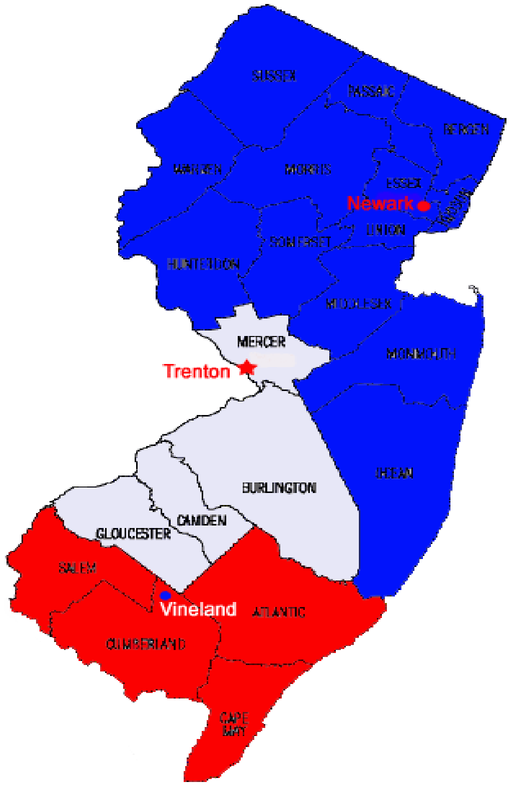


Figure 1-1. Planning Regions For New Jersey

1.2.2 Stakeholders

Stakeholder coordination and involvement is one of the keys to the development of an ITS architecture. Who are the stakeholders? Any organization or agency that has a vested interest in transportation systems with a region. Throughout the course of this project, the stakeholders of the region have been brought together to develop, review, and comment on key aspects of the architectures. These stakeholder meetings (of which there have been 42 in total), included training courses (3), functional area meetings (18 for the architecture and 18 for the deployment plan), and final integration review meetings (3). These meetings helped aid in the development of each regional architecture, helped the architecture team and other stakeholders develop an understanding of systematic problems within each region, and allowed for open discussions between stakeholders to begin the process of developing institutional agreements between agencies. A total of 165 stakeholders from 46 agencies or organizations participated in the meetings or the review of the project outputs. The stakeholders came from a wide array of state, county, and local agencies representing public safety, transportation operations, transit operations, transportation planning, as well as the private sector. Table 1-1 summarizes the organizational participation at the 36 functional area workshops.

Organization	Representation
Atlantic County	2
Bergen County	1
BISTATE	1
Cape May County	1
Cisco Systems	2
City of Atlantic City	2
City of Newark	4
City of Vineland	1
County of Essex	1
County of Salem	1
Cross County Connection TMA	1
Cumberland County	3
Delaware River Joint Toll Bridge Commission	5
Delaware River Port Authority	2
Delaware Valley Regional Planning Commission	3
Edwards & Kelcey	2
Federal Highway Administration	3
French & Parrello Associates	1
Gannett Fleming	1
HNTB Corporation	1
Hudson County	1
Hudson County TMA	3
Keep Middlesex Moving	2
Meadowlink	4
Middlesex County	1
Monmouth County	2
New Jersey Association of Counties	1
New Jersey Department of Transportation	27
New Jersey League of Municipalities	1
National Association of Industrial and Office Properties	1
New Jersey State Police	3
New Jersey Turnpike Authority - Parkway	6
New Jersey Turnpike Authority - Turnpike	14
North Jersey Transportation Planning Authority	4
Ocean City Police Dept.	1
Port Authority of NY & NJ	5
Port Authority Transportation Corporation	1
Ridewise	1
Rutgers University	3
South Jersey Transportation Authority	13
Somerset County	1
Sussex County	1
TRANSCOM	5
TransOptions	2
UMDNJ-EMS	1
Union County	2

Table 1-1. Stakeholder Participation at Functional Area Workshops

1.2.3 Inventory

Each of the three ITS architectures is defined by a set of ITS elements called the Inventory. An ITS element is defined as the name used by the stakeholder to describe an ITS system. Some examples of ITS elements (and their stakeholders) are:

- NJDOT TOC North (New Jersey DOT)
- NJT Bus Operations North (New Jersey Transit)
- NJSP Dispatch - Troop A, B, C (New Jersey State Police)

In some cases the ITS elements represent parts of a system (rather than the complete system). Some examples of this are:

- NJDOT North ITS Field Equipment (which represents field equipment such as dynamic message signs, CCTV, etc.)
- E-ZPass Tag
- In addition ITS elements may represent other non-ITS systems that interface with ITS systems. Some examples of this type of element are:
- Print and Broadcast Media
- Regional Hospitals

All told, there are 441 different ITS elements defined in the three architectures. For each ITS element the Inventory contains a definition, assignment to stakeholder, and a mapping to entity of the National ITS Architecture. This last aspect of the inventory is used to connect the regional (or statewide) ITS architecture to the National ITS Architecture so that the services, interfaces, and information flows defined in the national effort can be used for the regional (or statewide) architectures. The National ITS Architecture defines 22 subsystems (the major “players” in providing ITS services) and 73 Terminators (the “players” who are on the edge of the architecture. The subsystems exchange information with these peripheral players). The 22 subsystems of the National ITS architecture can be shown on a single diagram called the “sausage diagram” given in Figure 1-2.

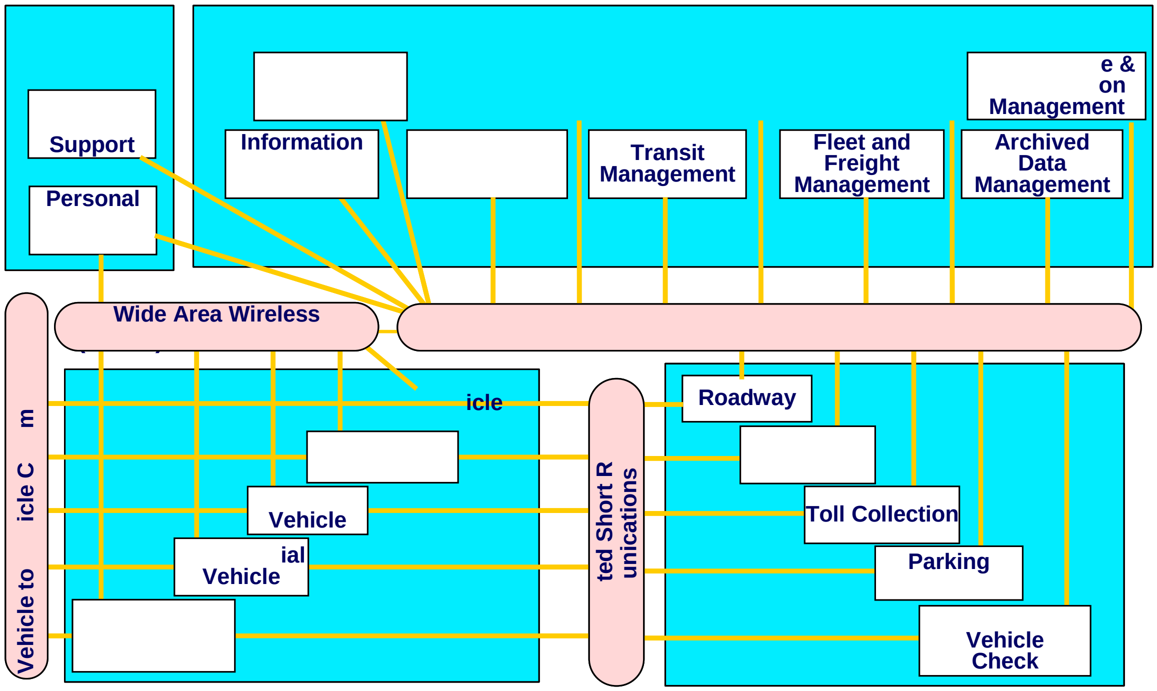


Figure 1-2. National ITS Architecture Sausage Diagram

A brief analysis of the mapping of the ITS elements to the National ITS Architecture yields the following summary statistics. These statistics are derived from the "combined" architectures database and provide an indication of the number of range of ITS elements included in the New Jersey ITS Architectures.

Subsystem	Number of Elements Mapped to Subsystem
Archived Data Management Subsystem	31
Commercial Vehicle Administration	16
Commercial Vehicle Check	1
Commercial Vehicle Subsystem	1
Emergency Management Subsystem	42
Emergency Vehicle Subsystem	5
Emissions Management	1
Fleet and Freight Management	3
Information Service Provider	30
Maintenance and Construction Management	25
Maintenance and Construction Vehicle	4
Parking Management	6

Subsystem	Number of Elements Mapped to Subsystem
Personal Information Access	1
Remote Traveler Support	13
Roadway Subsystem	10
Security Monitoring Subsystem	6
Toll Administration	3
Toll Collection	10
Traffic Management	37
Transit Management	45
Transit Vehicle Subsystem	9
Vehicle	6

Table 1-2. ITS Inventory Summary Statistics

1.2.4 Needs and Services

User needs were identified during a series of ITS functional area meetings early in the development of the New Jersey ITS Architectures. The user needs were then allocated amongst one or more of approximately 80 specific ITS service categories identified in the National ITS Architecture. These service categories are called Market Packages in the National ITS Architecture. Market packages collect together two or more system elements (from the same or multiple stakeholders) that can work together to deliver a given transportation service and the architecture flows that connect them. External systems on the boundary of ITS are also included. In other words, Market Packages identify the ITS system elements required to implement a particular transportation service. Market packages included in the New Jersey ITS Architectures were tailored to fit, separately or in combination, real-world transportation problems and needs.

Customized market packages represent the stakeholder consensus requirements for information that may be exchanged between specific ITS elements to effect specific sets of ITS services. As such, they collectively represent the *concept of operations* for a region. The customized market package for the New Jersey ITS Architectures have been organized by transportation functional area as follows:

- Archived Data Management Systems (AD)
- Advanced Public Transportation Systems (APTS)
- Advanced Traveler Information Systems (ATIS)
- Advanced Traffic Management Systems (ATMS)
- Commercial Vehicle Operations (CVO)

- Emergency Management (EM)
- Maintenance and Construction (MC)

The New Jersey ITS Architectures contain 488 separate customized market package diagrams. An analysis of the customized market packages by functional area reflects the following summary statistics.

Functional Area	Statewide	NJTPA	SJTPO	All
Advanced Traffic Management Systems	39	58	40	137
Maintenance and Construction	24	36	27	87
Advanced Public Transportation Systems	36	48	38	122
Advanced Traveler Information Systems	8	14	8	30
Commercial Vehicle Operations	10	14	6	30
Emergency Management	24	16	14	54
Archived Data	15	7	6	28
Totals	**156**	**193**	**139**	**488**

Table 1-3. Number of Customized Market Package Diagrams by Functional Area and ITS Architecture

1.2.5 Operational Concepts and Agreements

An operational concept defines the roles and responsibilities of stakeholder ITS elements in providing ITS services. For this project the roles and responsibilities have been defined at a market package level. For each customized market package that is short- term in its implementation a description of stakeholder roles and responsibilities was defined. As an example for the Northern New Jersey Architecture 37 different market packages operational concepts are described.

In addition, for each of these customized market packages that involved interfaces that crossed institutional boundaries, the potential needed agency agreements were identified.

1.2.6 Functional Requirements

An ITS Architecture is a functional architecture. The information exchanged between ITS elements in the architecture is driven by functions resident in each of the ITS elements defined in the architecture. The functions describe the tasks or activities performed by the ITS elements and "what" is done with the information received by the ITS element. To define projects that implement various portions of the ITS Architecture, functional requirements must be derived from which to translate the functional descriptions into designs (which make for example technology choices) to be built.

1.2.7 Interconnects and Interfaces

Interconnects and Interfaces define the details of how the different ITS elements in the architecture are connected. A system interconnect answers the question, “What ITS elements are connected?” A system interface answers the question, “What information and control exchanges (existing and planned) occur between ITS Elements?” Architecture flows represent these information and control exchanges between ITS elements in the architecture.

System interfaces were refined through the process of editing the customized market package diagrams. Where stakeholders defined a need for an information or control exchange, an architecture flow was placed between system elements. Where no need was identified, the architecture flows were removed. And, where new local requirements were identified, outside of the scope of the National ITS Architecture, new architecture flows were created and documented.

The New Jersey ITS Architectures contain 2346 interconnects (separate connections between systems) and 9593 architecture flows. An analysis of the architecture database reflects the following summary statistics.

Interconnect/Interface	Statewide	NJTPA	SJTPO	All
Interconnects	1001	902	847	2346
Architecture Flows	3973	3362	2923	9593

Table 1-4. Number of Interconnects and Interfaces by ITS Architecture

The focus of the ITS Architecture is on *external* interfaces between ITS elements. (*External* in the sense that architecture flows that connect different stakeholder ITS elements are “external” to either of the stakeholders.) This focus on external interfaces acknowledges that usually the most difficult and time consuming barrier to deployment of interoperable ITS elements in a region or state is achieving the institutional agreement between stakeholders to exchange specific information between specific ITS elements. An objective of the New Jersey ITS Architectures is to specifically identify these information exchange requirements very early in the process of deployment, so that the time consuming process of achieving prerequisite institutional agreements can proceed as early as possible.

Moreover, identification of common interfaces of systems in a region provides opportunities for standardization of these interfaces resulting in improved interoperability of systems within the region.

1.2.8 Projects

The incorporation of the ITS Architecture in the planning process will ultimately yield projects that are linked to the ITS Architecture. Through the deployment of projects produced from the planning process, the ITS services supported in the ITS Architecture will be implemented and made a reality in the transportation system. Project implementation completes the evolution from transportation needs to services, to functional description in the ITS Architecture, to project identification in the planning process, to project definition and deployment. The overarching goal of the ITS Architecture development process is that this evolution take place with the maximum amount of integration that is reasonable so as to efficiently and economically implement the systems required to serve the transportation community and users.

Projects were identified for Northern New Jersey, for Southern New Jersey and for a statewide focus. The projects were identified through a review of the three architectures (to identify services that met identified needs) and through a review of the statewide and regional planning documents such as the Statewide Transportation Improvement Program (TIP) Fiscal Year 2005 – 2007. The ITS Projects identified for each region (or the state) were mapped to market packages of the three architectures. Then the projects were organized into the following functional areas (using the market package mapping):

- Commercial Vehicle Operations & Ports
- Electronic Toll/Parking Management Fare Payment
- Information Archive Management
- Public Safety/Emergency Management/Homeland Security
- Public Transportation Management
- Traveler Information/Traffic Management/Maintenance Management

The list of projects was further refined to establish which projects were allocated to the short term (5 years), medium term (5 to 10 years), and long term (over 10 years). This provided a priority for the list of projects denoting a general order for project implementation.

Finally, the team obtained stakeholder feedback on the proposed ITS projects and their prioritization. Obtaining stakeholder feedback was necessary for the following reasons:

- Ensure an ITS Project was consistent with stakeholder needs.
- Confirm estimated timeline or priority for ITS Project deployment.
- Understand the relationship and traceability between ITS projects and the Statewide New Jersey ITS Architecture.

The stakeholder feedback was accomplished through a series of stakeholder workshops where the information was presented and input from the stakeholders was incorporated into the material. The complete list of projects is presented in Section 11 of the full documentation.

A small subset of these projects, called *Regionally Significant Projects*, are highlighted below. A Regionally Significant Project is one with a short timeframe, AND affecting multiple institutions AND/OR having regional or extra-regional impact. The Regionally Significant Projects for all three architectures are shown in Table 1-5.

Project	Architecture	Description
NJDOT STOC - Statewide Transportation Operations Center	Statewide	Where multiple regions or institutional facilities are affected, the STOC coordinates: • incident/emergency planning and response; • timing of maintenance, construction and workzones • statewide early warning, disaster response and recovery, and evacuation.
Statewide Evacuation and Coordination Program	Statewide	STOC coordination with the NJ State Office of Emergency Management and major traffic Management centers; major public safety dispatch centers and major transit management centers.
Transit Smart Card	Statewide	A single payment instrument enabling payment reciprocity between the offering agencies coordinated under DVRPC, NJTPA and SJTPO Fare Reciprocity Networks which will include all transit properties operating in New Jersey.
NJDOT Statewide 511 System + Transit Expansion	Statewide	Enables the dissemination of traffic information between traffic management centers, including NJDOT TOC North/South/Central and potental travelers. Traveler information Includes roadway network conditions, roadway construction, and transit information.
NJDOT TOC Central/North/South Regional Traffic Control and Coordination	Statewide	Exchange of traffic information and control between NJDOT TOC North/South/Central. Also, information exchange between these Traffic Management centers with the I-95 Corridor Coalition Information Exchange Network and TRANSCOM.
PANYNJ Port Commerce Electronic Clearance and Processing System	NJTPA	PANYNJ Port Commerce Operations Centers coordinating electronic clearance with Private Commercial Vehicle Fleet Dispatch, Terminal Access Equipment at PANYNJ Ports (that communicate with private commercial vehicles, and PANYNJ Port Commerce Credentialing Back Office (SEALINK). Also includes NJ CVIEW and NJDOT CVO Administration coordination with the NJ CVO Electronic Permitting System and Private Commercial Vehicle and Fleet dispatch.
North Jersey County EOCs Evacuation and Re-entry Management	NJTPA	Connects NJTPA County EOCs (Emergency Operations Centers) to coordinate resources with the • NJ State Police • Transit agency dispatches • Local traffic operations centers as well as the NJTA Parkway and Turnpike TOCs • Local and statewide roadway maintenance agency dispatches
North New Jersey County EOCs Disaster and Response Management	NJTPA	Enables County EOCs to coordinate emergency management functions with NJSP, NJTPA regional public safety dispatch, traffic management centers, maintenance agency dispatches and transit agencies.

Project	Architecture	Description
NJT Rail Operations Transit Security	NJTPA	Provides security systems for Rail infrastructure, including within rail stations, rail cars and maintenance yards. Security systems include CCTV surveillance systems, access systems, threat detection sensors, and transit operator and users activated alarms.
TRANSCOM Regional Architecture Expansion	NJTPA	Expands the existing network, enabling the sharing of traffic information between the additional transportation and emergency management agencies, including status of traffic devices (e.g., messages on dynamic message signs), traffic incident reports and status, construction notices, and road network conditions.
TRANSCOM Regional Transportation Information (TRIPS123)	NJTPA	Continued support and expansion of TRIPS123 to provide tailored information in response to a traveler request. Includes a subscriber system which "pushes" traveler information to a traveler based on a submitted profile. Personal devices supported include phones, personal digital assistants (PDAs), and kiosks.
PANYNJ Airports/Port Commerce Arterial Surveillance and Traffic Monitoring System	NJTPA	Provides traffic monitoring and control capabilities on airport and port facilities. The project includes the hardware, software, field equipment such as traffic signals, lane control signals, and communications infrastructure.
NJDOT and NJT Bus Operations South Transit Information Exchange	SJTPO	Facilitates the sharing of transit information and transit service coordination between transit agencies in the region. Supports the sharing of transit information such as including real-time schedules, incident information and other transit traveler information.
South New Jersey County EOCs Disaster and Response Management	SJTPO	Enables County EOCs to coordinate emergency management functions with NJSP, SJTPO regional public safety dispatch, traffic management centers, maintenance agency dispatches and transit agencies.
NJDOT Maintenance and NJDOT TOC South Road Weather Data Collection, Management and Integration	SJTPO	Enables the collection, processing, sharing, and storage of environmental and road weather information. Information includes atmospheric information and pavement conditions. The system provides real-time and historical information to users.
NJDOT South Traveler Information System Deployment (ATIS) / 511	SJTPO	Enables the dissemination of traffic information between traffic management centers, including NJDOT TOC South/Central and potental travelers. Traveler information Includes roadway network conditions, roadway construction, and transit information.

Table 1-5. Regionally Significant Projects

1.2.9 Integration Strategy

The Integration Strategy presents the approach for integrating the ITS Architectures developed for the New Jersey statewide, the Northern Region, and the Southern Region into the transportation planning process and leveraging the ITS Architectures in project definition. The approach facilitates and provides a mechanism for the projects identified in the Implementation Plan to be planned and deployed in an orderly and integrated fashion.

One of the most important outcomes of the New Jersey Statewide, NJTPA Regional, and SJTPO Regional ITS Architectures is that they will be used to plan and deploy ITS across the state and the regions involved. To do this, the ITS Architectures must be integrated into their respective planning processes. As a result of integrating the ITS Architectures into the planning processes, the architectures will link the objectives and needs of the regions with the ITS deployments in the field.

Figure 1-3 reflects a generic planning process with which all organizations can identify and on which they can base their more detailed process modifications. The right-side of the figure (MPO Planning Process) refers to federally funded projects and the left-side (Other Agency Planning Process) refers to projects being funded through other means (e.g., local funding). All regions use both processes to fund their planning efforts. A primary goal of the planning process is to make quality, informed decisions on the investment of funds for regional transportation systems and services.

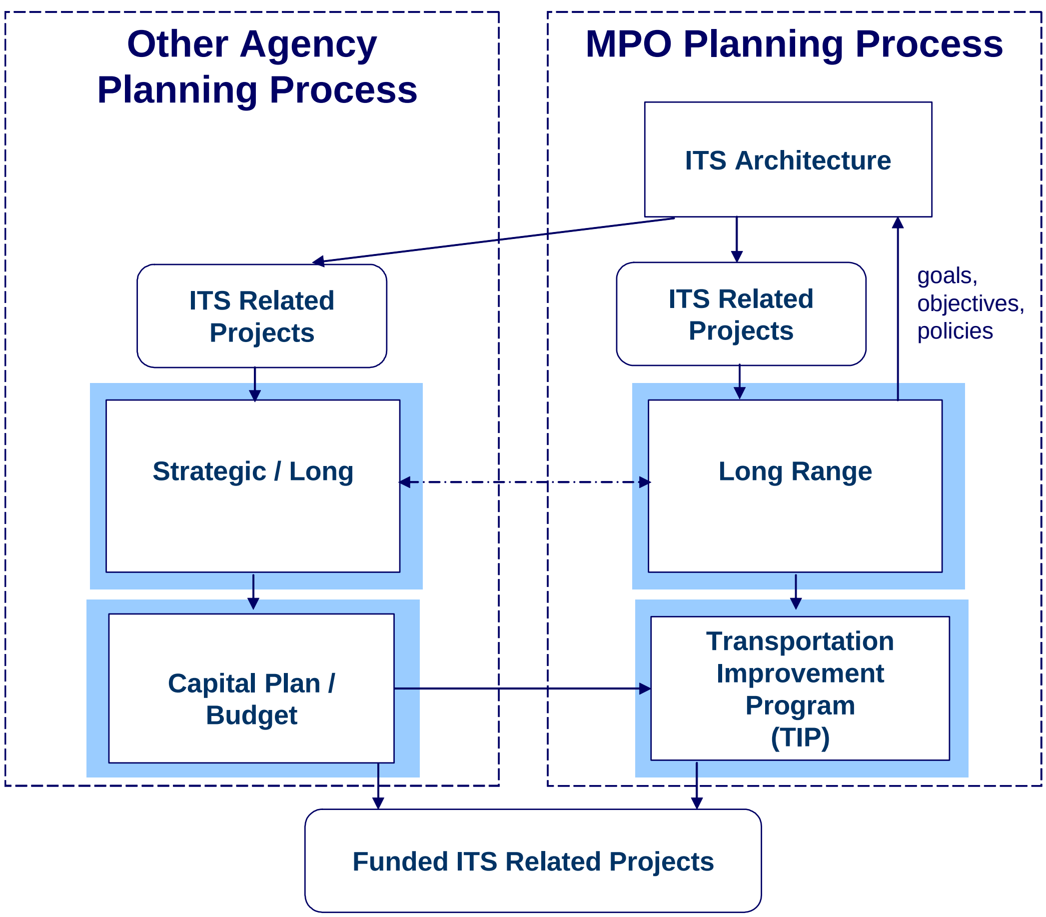


Figure 1-3. New Jersey ITS Architecture in the Transportation Planning Process

As shown in the figure, the ITS Architectures support the prioritization of ITS related projects that feeds into the respective planning documents.

Projects that emerge from the planning process can benefit from the use of the ITS Architecture in their definition and development. Project implementation should follow the systems engineering process. The ITS Architecture is most effective in the early phases of the systems engineering process. Figure 1-4 shows the project implementation process for deploying ITS projects.

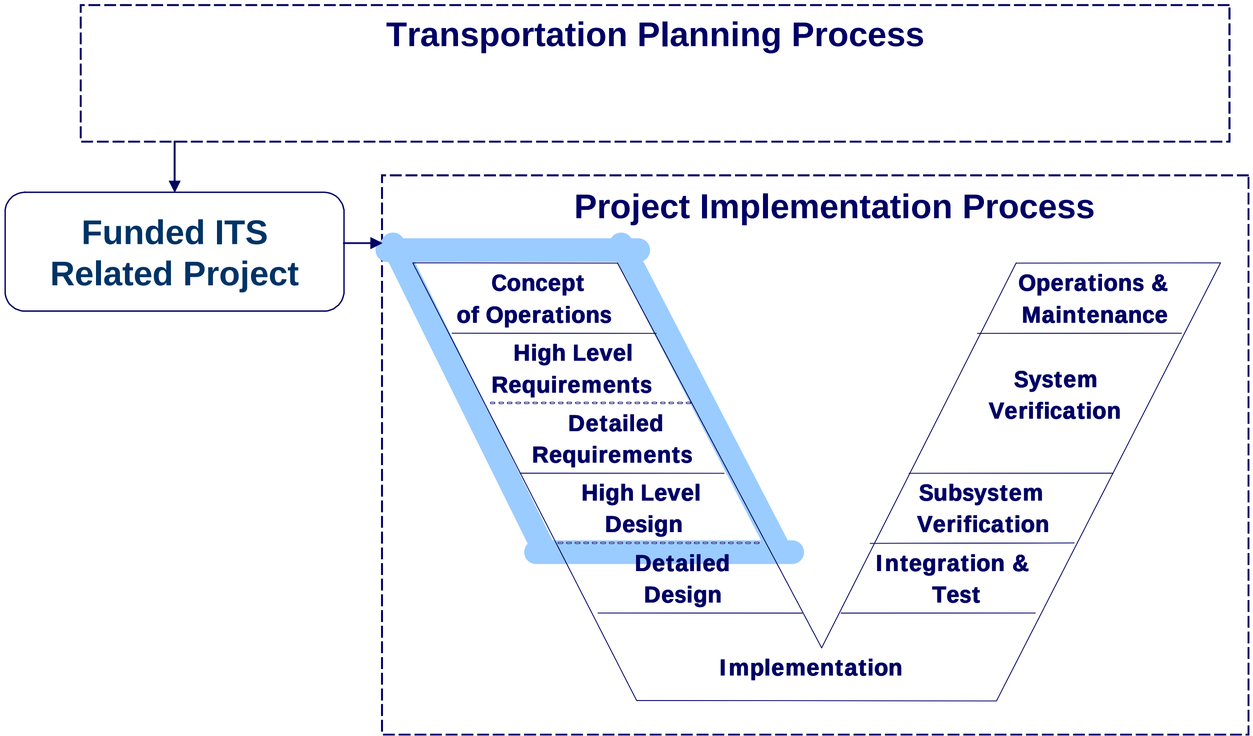


Figure 1-4. New Jersey ITS Architecture in the Project Implementation Process

The project implementation process shown in Figure 1-4 is a systems engineering process. It is a process that can be used to systematically deploy ITS that reduces risk. The Systems Engineering process is more than just steps in systems design and implementation; it is a life-cycle process. The process recognizes that many projects are deployed incrementally and expand over time. US DOT Rule 940 requires that the systems engineering process be used for ITS projects that are funded with federal funds.

1.2.10 Documentation of ITS Architectures

The ITS Architectures are documented in three forms. The first is this document, which provides an overview of the architectures and summary information about many of the aspects of the architecture. The second form of documentation is the Turbo Architecture database. This FHWA developed software tool captures the details of the architectures including definition of stakeholders, inventory, market packages, interconnects, interfaces, functional requirements, and standards. An example of the the tools capture of interconnects (for the element ACESP Dispatch- which is the dispatch function for the Atlantic City Expressway State Police) is shown in Figure 1-5.

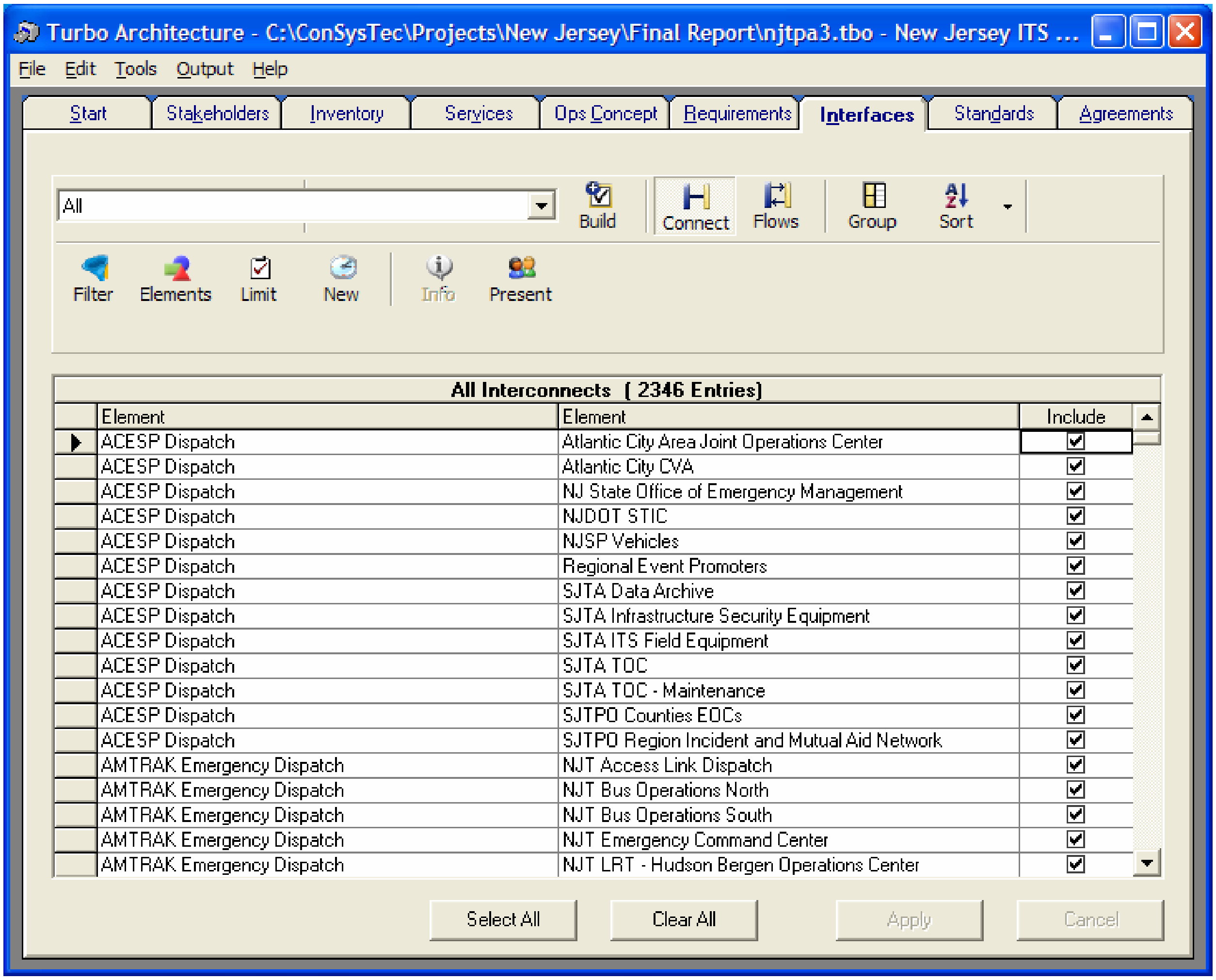


Figure 1-5. Sample Turbo Architecture Screen Capturing Interconnect Information

The third form of documentation of the architectures is the New Jersey Statewide and Regional ITS Architecture website. ConSysTec Corporation has developed, posted and hosted the temporary hyper-linked website where all project architectures, deployment plans, and relative documentation (i.e. meeting minutes, other draft architectures, stakeholder comments, etc.). The website currently resides at http://www.consystec.com/newjersey/default.htm. It is the intent of ConSysTec to host this site for at least three years after the conclusion of the project, or until NJITAC chooses an alternative site to utilize as a host for the documentation. In addition to hosting the website for NJITAC, an html image of the website (which can be used to directly load a web server with the developed website for all three ITS architectures and deployments plans) will be delivered to NJITAC on CD-ROM.

The website provides in an easy to access hyperlinked format the same detailed descriptions of stakeholders, elements, interfaces, and functional requirements found in the Turbo Architecture database. An example of the details for the element NJDOT Accident Reporting System is shown in Figure 1-6.

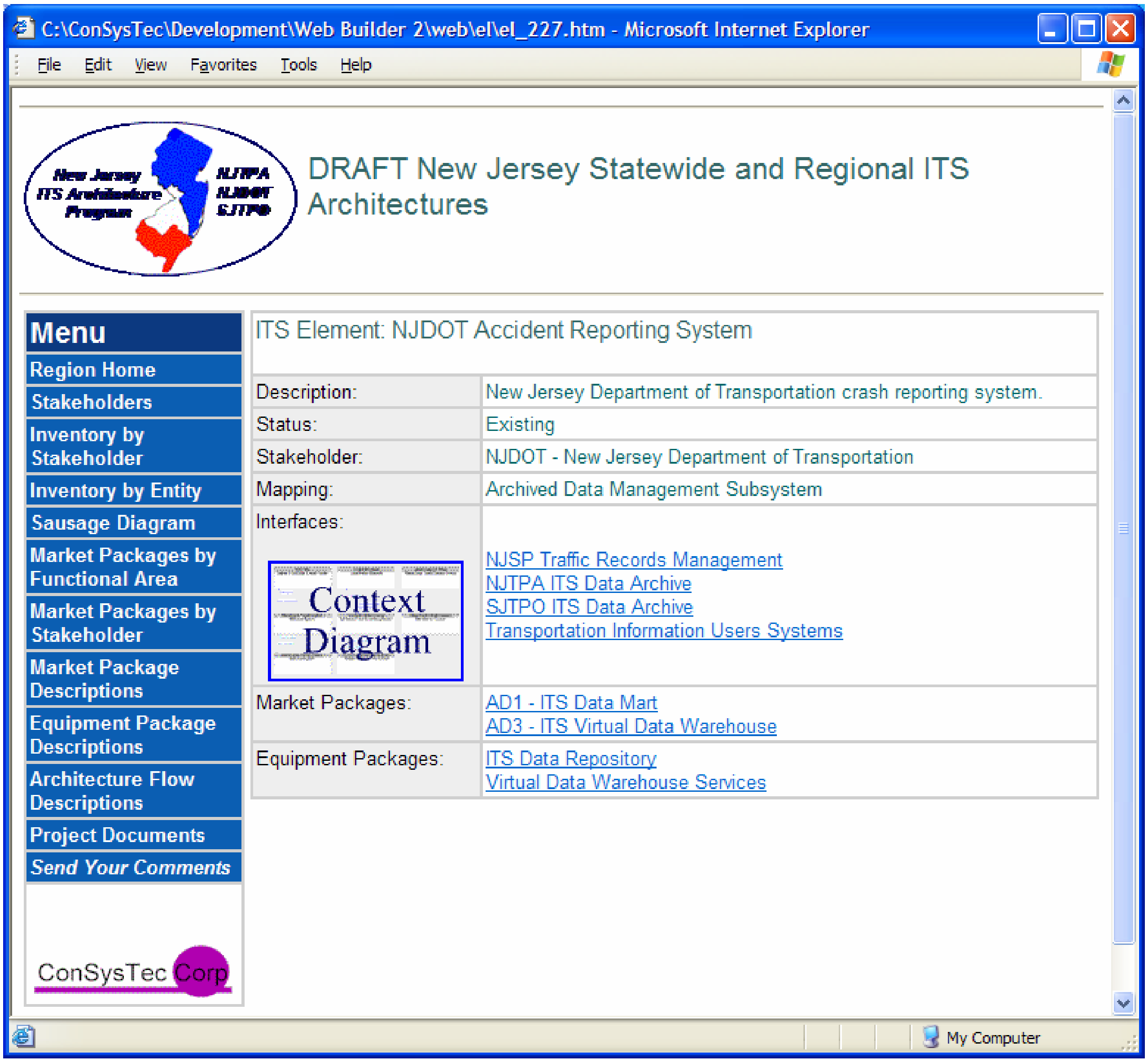


Figure 1-6. Example Element Definition on Hyperlinked Website

2 Introduction

The "Development of Statewide/Regional Intelligent Transportation Systems (ITS) Architectures And Deployment Plans" project has created two regional ITS architectures (one for the NJTPA MPO and another for the SJTPO MPO) as well as a statewide ITS architecture (The New Jersey Statewide ITS Architecture). These regional and statewide architectures are roadmaps for transportation systems integration in the State of New Jersey over the next 20 years. These architectures have been developed through a cooperative and consensus based effort by the region's transportation agencies, covering all surface transportation modes in the region. These architectures represent a shared vision of how each agency's systems work together currently or will work together in the future, sharing information and resources to provide a safer, more efficient, and more effective transportation system for travelers in the state.

The architectures have been created to meet all requirements of the Architecture and Standards FHWA Final Rule/ FTA Policy. The FHWA Final Rule (and corresponding FTA Policy) to implement Section 5206(e) of the TEA-21 requires that Intelligent Transportation Systems (ITS) projects funded through the Highway Trust Fund (and other federal funds) conform to the National ITS Architecture and applicable standards. The Rule/Policy requires that the National ITS Architecture be used to develop a local implementation of the National ITS Architecture, which is referred to as a "Regional ITS Architecture." The federal deadline for conformance to this Final Rule/Policy is 8 April 2005.

These ITS architectures are an important tool that will be used by:

- Operating Agencies to recognize and plan for transportation integration opportunities in the regions.
- Planning Agencies to better reflect integration opportunities and operational needs into the transportation planning process.
- Other organizations and individuals that use the transportation system in the region.

These ITS architectures provide an overarching framework that spans all of these organizations and individual transportation projects allowing them to maximize technical and institutional integration of ITS across the state, counties, and local jurisdictions for planning ITS. Using the ITS architectures, each transportation project can be viewed as an element of the overall transportation system, providing visibility into the relationship between individual transportation projects and ways to cost-effectively build an integrated transportation system over time.

2.1 Project Objective

The primary objective of this project is to develop the two regional ITS architectures and a statewide architecture that meet the following criteria:

- Create consensus based ITS Architectures that are consistent with one another.
- Maximize technical and institutional integration of ITS across state, county and local jurisdictions for planning ITS.
- Focus on Use of Architecture tools for Planning ITS.
- Meet the Federal deadline of 8 April 2005 for ITS projects going into final design that would use federal funds.

2.2 Architecture Development Process

In order to develop these ITS architectures, the iterative process as outlined in Figure 2-1 was used. The development process scheduled frequent releases of the draft ITS architecture, which were reviewed by the stakeholders within each region. By collecting feedback throughout the process, the design was adapted based on stakeholder feedback. This process creates a framework for the participation of the architecture users and engenders buy-in from the stakeholders within the regions throughout the design and development of the ITS architectures. Each successive iteration adds detail to the design so that the overall process results in more precise requirements that better serve the needs of the stakeholders within the region(s). The use of this iterative process throughout the development of each regional ITS architecture enabled better understanding the stakeholders within each region and the requirements each has for ITS investments.

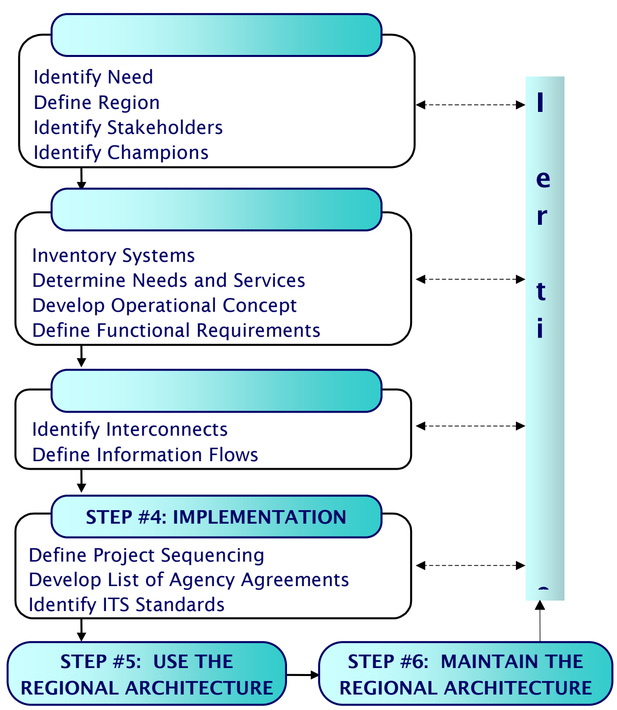


Figure 2-1. Overall Architecture Development Process

2.2.1 Program Tasks and Key Milestone

The tasks and key milestones for this project were as follows:

- **Educate Stakeholders.** It is important to ensure that each stakeholder or agency within the region be familiar with ITS, as well as the U.S. National ITS Architecture. Specifically, it is important for each stakeholder to understand their role in the architecture and how it can be used as a tool for the planning and deployment processes. To this end, stakeholder training seminars were conducted in April 2004.
- **Develop Draft ITS Architectures**. It is important to have an initial overview of the ITS applications either deployed or planned for the study region. In order to do so, the architecture team utilized existing documentation of ITS systems that exist or are planned for the region, as well as detailed knowledge members of the team may have of ITS investments in the regions.
- **Gather Information.** Detailed, accurate information is essential when developing a planning document of any type. For the purposes of developing these regional ITS architectures, regional stakeholders were gathered together for discussions about the regions goals in a series of Functional Area Workshops (where stakeholders of like systems could get together to discuss the regional plan). The first series of architecture workshops was held from May 12, 2004 through June 9, 2004. A second series of development plan workshops was held from June 15, 2004 through July 21, 2004 to discuss deployment of specific ITS projects. The final set of three integration workshops were held from August 17, 2004 through August 19, 2004. It was through these workshops, and the close interaction and discussions held by all stakeholders attending the workshops, that enabled the architecture team to capture the different regions intentions for deployment of ITS services.
- **Refine the Architecture.** The stakeholder workshops enabled the architecture team to draw together a consensus based architecture that addressed the needs of ITS within the regions. A systematic review and revision of the two regional ITS architectures and the New Jersey Statewide ITS Architecture captured comments, suggestions, and intentions of the stakeholders within the regions.
- **Develop Architecture Implementation Plans.** In addition to developing these regional and statewide ITS architectures for the state of New Jersey, the the NJTPA and SJTPO MPOs, an ITS Deployment Plan was developed for each region. These ITS Deployment Plans outline a vision for ITS deployment in each region, identifying projects that are needed to implement the ITS Architecture. The projects were allocated by stakeholders to short, medium, and long-term timeframes. The benefit of completing such a task is that it helps each region

plan and prioritize ITS deployment initiatives (and required funding) so that the ITS infrastructure can be incrementally built-out over an approximately 20 year horizon. It is these ITS Deployment Plans (and their respective Regional ITS Architecture) that provide or highlight opportunities for integration among key regional stakeholders of ITS components/systems so that as each deployment is funded it can expand on an ITS system from which stakeholders can share information.

- **Document Architecture and Implementation Plans.** This final report documents the development process, ITS architectures, and prioritized deployments within the regions. It also presents a strategy for deployment or implementation within the regions. Finally, the architecture website has a comprehensive set of underlying databases, hypertext reports, market package diagrams, and project documents (including this final report) that can be accessed through the web. Note that some appendixes to this report exist only on the project CDROM and website, but not the paper reports due to their large size and the fact that these pages, as needed, can be easily printed from their electronic formats.

2.2.2 Deliverables

The deliverables for each regional ITS architecture and for the statewide ITS architecture can be broken down into three main areas: architecture documentation, deployment plan documentation, and website.

- **Architecture documentation.** The documentation being delivered for the Statewide and two Regional ITS Architectures developed on this project consist of an architecture database and a detailed architecture report. A software tool specifically linked to the National ITS Architecture (Turbo Architecture) was utilized in each architecture developed on this project. Turbo Architecture was utilized for its ability to accurately represent the components of the architectures through its system of diagrams and reports (generated by specific requirements). The Turbo Architecture database, complete with all of the inventory items, description of services, diagrams, reports, etc., will be delivered upon project completion. ConSysTec has developed software tools to augment TurboArchitecture called Visual Analyst (VA). VA provides a graphical front-end to ease the entry of information into TurboArchitecture and assure the consistency between customized Market Packages and the Turbo Architecture database. In addition, a hypertext reporting capability is included in VA that automates much of the production of hypertext websites based on the TurboArchitecture database. TurboArchitecture and ConSysTec's Visual Analyst, along with associated ITS Architectecture maintenance training materials will be a separate deliverable.

- **Deployment Plans.** Through the architecture development process, stakeholders reached consensus on the transportation needs in the Regions that could be addressed with ITS, working with the architecture team to customize and prioritize market packages that formed the basis for projects in the deployment plan. The New Jersey Statewide, NJTPA and SJTPO deployment plans build on their respective architectures by outlining specific ITS project recommendations and strategies for the specified region, and allocate these projects to deployment timeframes and stakeholder responsibilities (for implementation and operation of each system) so that the projects and associated services can be implemented throughout the life of the Deployment Plan (approximately 20 years). A regional ITS architecture maintenance process completes the Deployment Plan.
- **Website.** Consystec has developed, posted and hosted the hyperlinked website where the regional and statewide ITS architectures, deployment plans, and related documentation (i.e. meeting minutes, other draft architectures, stakeholder comments, etc.) currently reside (www.consystec.com/newjersey). It is the intent of Consystec Corp to host this site for at least three years after the conclusion of the project, or until NJITAC determines an alternative site to host the documentation. In addition to hosting the website for NJITAC, an html image of the website (which can be used to directly load a web server with the developed website for all three ITS architectures and deployments plans) will be delivered to NJITAC.

2.2.3 Key Milestones

The activities below represent the key milestones for the development of the NJTPA, SJTPO and Statewide Regional ITS Architectures.

- **Kickoff Meeting.** The kickoff meeting was held February 18, 2004, in Newark at the offices of NJTPA. Key stakeholders and stakeholder groups were represented at this meeting to prepare for the project. Key project responsibilities for both consultant and stakeholders were discussed.
- **Stakeholder Training.** Training for all stakeholders was conducted from April 14 through April 23, 2004. During the course of training, the stakeholders were introduced to the project team and the terminology used in the development of regional or statewide architectures and deployment plans.
- **Regional ITS Architecture Workshops.** This series of interactive stakeholder workshops were conducted from May 12 through June 9, 2004. During these workshops, stakeholders had an opportunity to interact with each other and the architecture team to identify ITS services, ITS inventory and market packages

(how specific ITS inventory elements share information for one or several related ITS services) for their regions.

- **Deployment Plan Workshops.** The series of deployment plan workshops were conducted from June 12 through July 21, 2004 to review regional ITS projects and allocate them to near (0-5 year), medium (5-10 year) and long (10+ year) term timeframes.
- **Final Integration Workshops.** The series of final workshops were conducted from August 17 through August 19, 2004. These workshops reviewed the key results of the program as well as the structure to be used in the Final Report for each architecture.
- **Final Presentation.** The final presentation of the regional and statewide architectures and deployment plans, as well as an overview of the documentation and website, is scheduled for December 6, 2004.
- **Final Documents.** The final documents for this project (both electronic and paper media) will be delivered to the NJTPA, SJTPO and NJDOT on December 22, 2004.

2.2.4 Stakeholder Engagements

Throughout the course of this project, the stakeholders of the region (the agencies or organizations that have a vested interested in ITS deployment within the region) have been brought together for a variety of training and coordination activities. These activities, including training courses (3), functional area meetings (18 for the architecture and 18 for the deployment plan), and final integration review meetings (3), guided the development of each regional architecture, helped the architecture team and other stakeholders develop an understanding of systematic problems within each region, and allowed for open discussions between stakeholders to begin the process of developing institutional agreements between stakeholder agencies. In addition to the aforementioned engagements, stakeholders also have/had the responsibility to review and comment on intermediate results of the regional and statewide architecture development via the website. A comprehensive list of stakeholder activities is listed in Table 2-1 below.

Development of Statewide/Regional Intelligent Transportation Systems Architectures and Deployment Plans

Attendance at each workshop is shown in parenthesis.	**Statewide**		**Southern**		**Northern**	
	ITS Architecture	Deployment Plan	ITS Architecture	Deployment Plan	ITS Architecture	Deployment Plan
Travel & Traffic Management; Maintenance Management	1 Day 5/12/04 (32)	1 Day 6/15/04(24)	1 Day 5/13/04 (27)	1 Day 6/16/04(16)	1 Day 5/14/04 (16)	1 Day 6/17/04(11)
Parking Management			1/2 Day 5/19/04 (9)	1/2 Day 6/23/04 (6)	1/2 Day 5/20/04 (15)	1/2 Day 6/24/04 (10)
Public Transportation Management	1/2 Day 5/18/04 (11)	1/2 Day 6/22/04 (9)	1/2 Day 5/19/04 (9)	1/2 Day 6/23/04 (8)	1/2 Day 5/20/04 (18)	1/2 Day 6/24/04 (10)
Inter-regional Electronic Toll/Parking/Fare Payment	1/2 Day 5/18/04 (17)	1/2 Day 6/22/04 (13)				
Information Archive Management	1/2 Day 5/25/04 (15)	1/2 Day 7/13/04 (12)	1/2 Day 5/26/04 (8)	1/2 Day 7/14/04 (7)	1/2 Day 5/27/04 (9)	1/2 Day 7/15/04 (15)
Ports					1/2 Day 5/27/04 (23)	1/2 Day 7/15/04 (14)
CVO & Ports	1/2 Day 5/25/04 (11)	1/2 Day 7/13/04 (13)				
Public Safety/Emergency Management/Homeland Security	1 Day 6/8/04(27)	1 Day 7/20/04 (19)	1/2 Day 5/26/04 (14)	1/2 Day 7/14/04 (13)	1 Day 6/9/04(19)	1 Day 7/21/04 (9)
Maintenance Model	1/2 Day 6/10/04(11)	1/2 Day 7/22/04				
Final Integration Review	1 Day 8/17/04		1 Day 8/18/04		1 Day 8/19/04	

Table 2-1. Stakeholder Engagements

2.2.5 Project Architecture Team

Figure 2-2 represents the project design team organization chart. Each team member is listed with their respective company name, title, and role with regards to the development of the regional and statewide architectures and deployment plans.

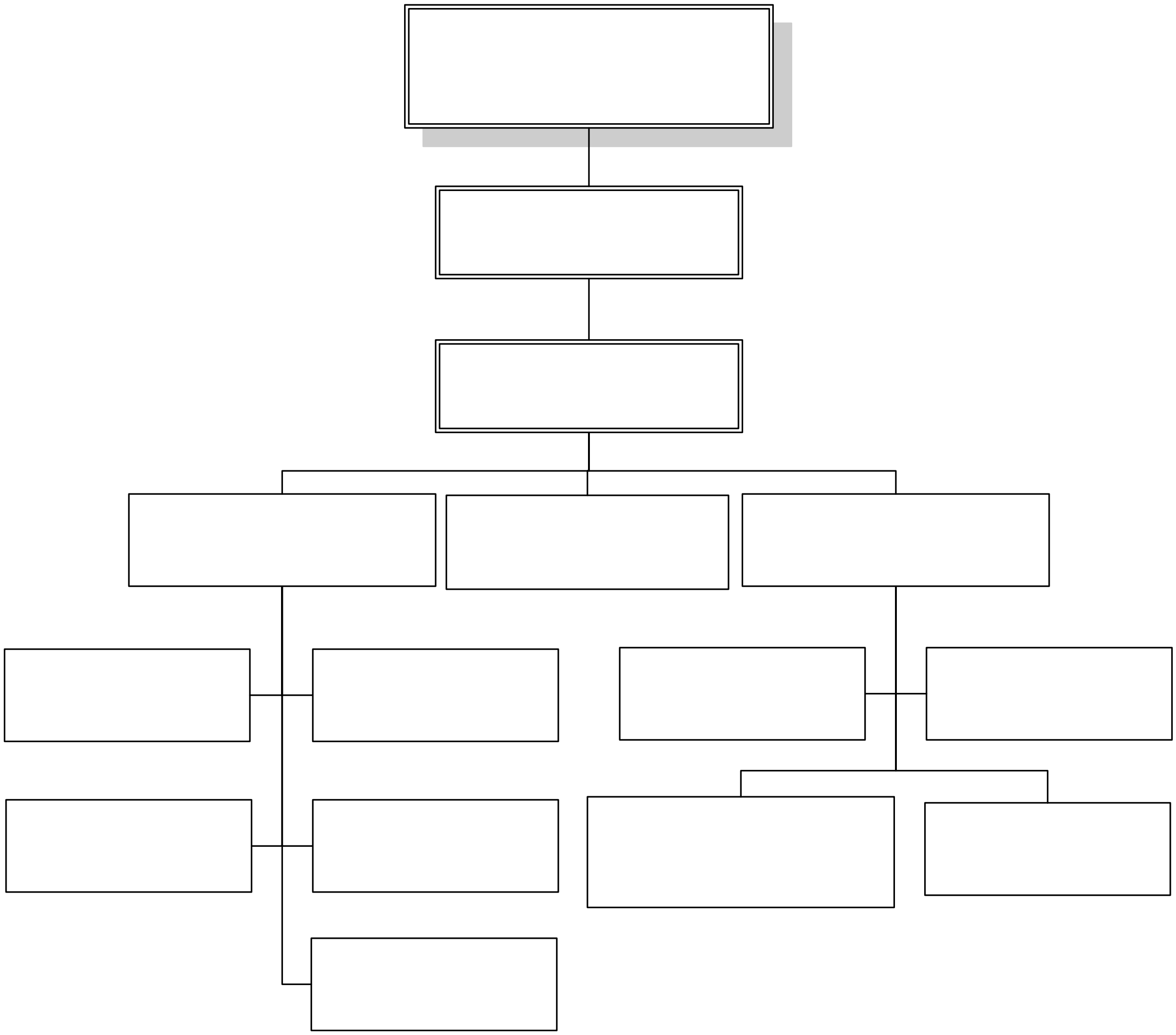


Figure 2-2. Team Organization Chart

2.2.6 Hierarchy of Information

For the purposes of developing the two regional ITS architectures and the statewide ITS architecture, a hierarchy of information has been established. For each of the three architectures a set of information has been developed as shown in Table 2-2. The information for each architecture, described from the bottom to the top of the table is:

- **ITS Inventory.** The ITS inventory is a list of all ITS elements within the region or regions. This list consists of the element, the stakeholder responsible for the element, the element definition, and how the element is mapped in the regional or statewide ITS architecture. An ITS element is a specific instance of an ITS entity (subsystem or terminator) derived from the National ITS Architecture.

- **Customized Market Package Diagrams.** For each ITS architecture there is a set of customized market package diagrams. Each market package describes how one or more closely related ITS services are implemented using ITS elements and showing information exchanged between the ITS elements ("architecture flows"). The market packages represent how the architecture will implement a user service, and in so doing form the basis for specific projects.
- **Projects.** The ITS related projects for a region. A project is based on one or several related market packages. Architecture flows that connect ITS elements owned or operated by different stakeholders represent information that crosses across agency boundaries, and thus are the technical basis for institutional agreements between these different ITS stakeholders.
- **Project Sequence.** The rough sequencing of projects within the region.
- **Implementation Plan.** Information required to program projects in their region, including estimated capital and recurring costs, benefits, and staffing requirements.
- **ITS Architecture.** The regional or statewide ITS architecture is composed of the previous elements of the hierarchy.

<table>
<tr><th colspan="2">ITS Architecture</th></tr>
<tr><td>Project Sequence
(Priority, Project Description)</td><td>Implementation Plan
(Cost, Benefits, Staffing)</td></tr>
<tr><td colspan="2">Projects (made up of one or more Customized MP Diagram)</td></tr>
<tr><td colspan="2">Customized Market Package Diagrams
(ITS Services, Interfaces and Interconnects)</td></tr>
<tr><td colspan="2">ITS Inventory</td></tr>
</table>

Table 2-2. Hierarchy of Information in the NJ ITS Architectures

2.3 Requirements of the Final FHWA Rule and FTA Policy on Architecture and Standards

The FHWA Final Rule (23CFR 940) and identical FTA Policy on Intelligent Transportation System Architecture and Standards, which took effect on April 8, 2001 defines a set of requirements that regional ITS architectures shall meet starting 8 April 2005. Table 2-3 shows how the Regional ITS architecture requirements of the rule are met by the outputs developed for the two regional and statewide architectures.

Re	**Where Requirements Documented**
Description of region	Geographic definition, as well as timeframe and scope of services are given in Chapter 3 of this document.
Identification of participating agencies and other stakeholders	Listing of stakeholders and their definitions is given in Chapter **Error! Reference source not found.** of this document. An inventory of the elements operated by the stakeholders is contained in Chapter **Error! Reference source not found.** of this document. The same information is also available in the hyperlinked web site and in the Turbo Architecture database.
An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders	The operational concept is defined in Chapter **Error! Reference source not found.** of this document.
A list of any agreements (existing or new) required for operations	A discussion of existing and needed new agreements is given in Chapter **Error! Reference source not found.** of this document
System functional requirements;	The functional requirements of the ITS systems are described in an overview in Chapter **Error! Reference source not found.** of this document, and are provided in detail in the hyperlinked web site.
Interface requirements and information exchanges with planned and existing systems and subsystems	The Interfaces and information flows are described in an overview in Chapter **Error! Reference source not found.** of the document, and are described in detail in the hyperlinked web site and in the Turbo Architecture database.
Identification of ITS standards supporting regional and national interoperability	An overview of the ITS standards is given in Chapter **Error! Reference source not found.** of the document. The detailed listing of ITS standards applicable to each interface in the architecture is described in the hyperlinked web site and in the Turbo Architecture database.
The sequence of projects required for implementation	Projects and their sequencing are covered in Chapter 9 of this document.

Table 2-3. Mapping of Requirements to Architecture Outputs

3 Description of the Region (Scope)

For the purposes of defining a regional scope for the three ITS architectures, three aspects of the scope were considered: Geographic and Institutional scope, Range of Services, and Timeframe.

3.1 Geographic and Institutional Scope

From a transportation planning perspective, the State of New Jersey is broken into three MPO planning regions: a Northern region (the NJTPA MPO), a Central region (the DVRPC MPO, also including parts of Pennsylvania) and a Southern region (the SJTPO MPO). In addition, transportation planning is carried out at a statewide level, led by NJDOT. The geographic and institutional scope of the two regional ITS architectures being developed by this project follow the geographic (and institutional) boundaries of NJTPA MPO and the SJTPO MPO.

Figure 3-1 shows the geographic scope of the three New Jersey transportation planning regions.

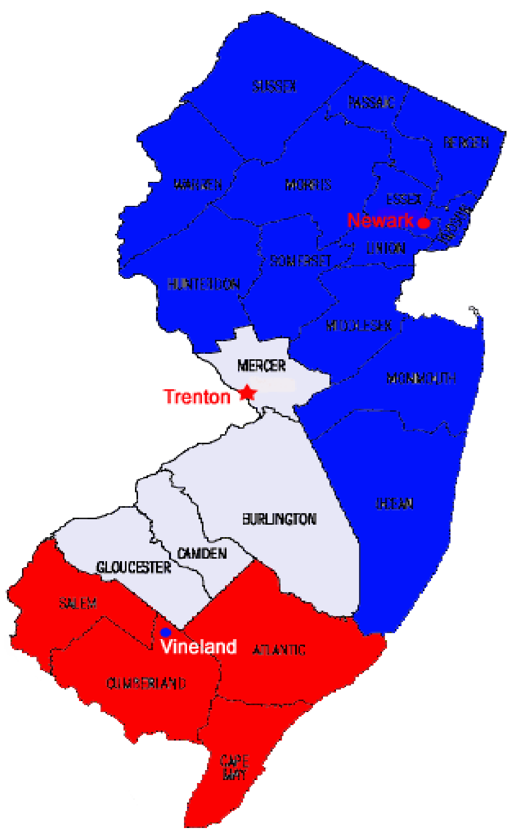


Figure 3-1. Planning Regions for New Jersey

- **NJTPA Regional ITS Architecture.** The NJTPA Regional ITS Architecture for the State of New Jersey consists of the following counties: Sussex, Warren, Morris, Passaic, Bergen, Essex, Hunterdon, Somerset, Union, Hudson, Middlesex, Monmouth, and Ocean. Institutionally, this is the jurisdiction of the North Jersey Transportation Planning Authority (NJTPA). In addition, the geographic region for Northern New Jersey also covers projects allocated by the NJTPA Transportation Improvement Plan (TIP).

- **SJTPO Regional ITS Architecture.** The SJTPO Region ITS Architecture for the State of New Jersey consists of the following counties: Salem, Cumberland, Atlantic, and Cape May. Institutionally, this is the jurisdiction of the South Jersey Transportation Planning Organization (SJTPO) counties. In addition, the geographic region for Southern New Jersey also covers projects allocated by the SJTPO TIP.
- **The Statewide ITS Architecture** for the State of New Jersey covers the entire state of New Jersey. In addition, the geographic scope also covers and projects that were allocated by the State of New Jersey STIP.

There is a third transportation planning region in the state that includes the following counties: Mercer, Burlington, Camden, and Gloucester. This is the Delaware Valley Regional Planning Commission (DVRPC). The Regional ITS Architecture for this region was developed several years ago and the DVRPC staff have indicated an intention to update it in the near future, consistent with the architectural decisions made in this effort. DVRPC staff have been active participants in the development of the three regional ITS architectures in this study, identifying and confirming interfaces between DVRPC ITS elements and elements in the three study regions.

In addition to these four clearly defined “regions”, we also have taken into consideration that each ITS architecture and deployment plan may interact with ITS elements in adjoining ITS architecture region(s). For the purposes of this project, it will be common to see an adjacent region’s (or adjacent state’s) elements within another region – because these ITS elements share information for specific services in the study region. To this end, these adjacent regions will be considered the boundary of these three ITS architectures and deployment plans. The additional states that have been considered as part of the Architecture or Deployment Plan process are: New York, Pennsylvania, Maryland, and Delaware.

3.2 Range of Services

The NJTPA and SJTPO regional ITS architectures and deployment plans cover services local to the regions that cut across a broad range of ITS, including traffic management, transit management, traveler information, emergency services, archived data management, and maintenance and construction operations. These regional ITS services are provided in both rural and urban settings as part of the individual regional ITS architectures. The statewide ITS Architecture and Deployment Plan focuses mainly on transportation/incident operations coordination across regions, statewide information sharing and reporting, and commercial vehicle credentialing and safety inspection services. I.e., the Statewide ITS Architecture services represent services that are uniformly administered across the entire state, and that often involve leadership by NJDOT.

3.3 Timeframe

The Regional and Statewide ITS Architectures and Deployment Plans for the State of New Jersey provide an approximately 20 year outlook for ITS activities and deployments in the region. Specifically, the ITS architectures address existing ITS systems as well as those planned for development over the next 20 years. They represent a snapshot of the currently anticipated projects based on information from stakeholders, and they put together a plan of attack for deployment initiatives in each specific region, and for the State. The ITS architecture planning process leads directly into the deployment plan process. As part of the deployment plans, ITS projects are classified as having a short, medium, or long range timeframe for implementation. The for purposes of this project, short range is considered 0-5 years, medium range is considered 5-10 years, and long range is considered more than 10 years until full deployment. As such, each ITS architecture and associated deployment plan will require regular updates to ensure that they maintain accurate representations of each region and each regions deployment agenda.

4 The Stakeholders

A major factor in developing a consensus architecture is the involvement of the agencies and organizations who are associated with the ITS elements described in this report. As stated in the *Request for Proposals* for this project: “Identifying these organizations is the first step in defining the regional architectures.”

A Stakeholder is defined as any government agency or private organization involved with providing transportation services in the region or state. In the context of these ITS architectures, a Stakeholder, owns, operates, and/or maintains at least one ITS element in the ITS Architecture. A preliminary list of Stakeholders was identified at the project kickoff meeting, with the assistance of the NJITAC.

Invitations were sent by both e-mail and U.S. Mail to agencies throughout New Jersey and also New York City and eastern Pennsylvania for the training sessions that were held to introduce the project to the stakeholders. As mentioned in the *Request for Proposals:* “The process should identify relevant agency systems, and include key transportation agencies and stakeholders…” Approximately 288 invitations were sent.

As the project progressed, a database was created to document and track stakeholder involvement in the project. As of the last workshop, there were approximately 165 stakeholders included in the database.

The following tables present a snapshot of the stakeholder involvement in the project.

Table 4-1 presents the project workshop schedule; including the initial training sessions and the final integration review meetings. There were a total of 42 meetings.

Table 4-2 shows stakeholder participation at each meeting. The attendance figures shown do not include the ConSysTec architecture team.

Table 4-3 presents the agency participation in the project. Approximately 46 agencies and consulting firms (excluding the ConSysTec architecture team) participated in the project.

The tables in Appendix 4.A show stakeholder attendance at each of the workshops. The lists present the stakeholders invited, those that attended the workshop (noted with a check), and those stakeholders that participated in special meetings outside the workshop.

Table 1
New Jersey ITS Architectures
and Deployment Plans
Workshop Dates and Locations

Date	Workshop	Region	Location
4/14/2004	Training Workshop	North	NJTPA, Newark, NJ
4/15/2004	Training Workshop	South	SJTPO, Vineland, NJ
4/23/2004	Training Workshop	Statewide	NJDOT, Ewing, NJ
5/12/2004	Travel and Traffic Maintenance; Maintenance Management	Statewide	NJDOT, Trenton, NJ
5/13/2004	Travel and Traffic Maintenance; Maintenance Management	South	SJTA, Hammonton, NJ
5/14/2004	Travel and Traffic Maintenance; Maintenance Management	North	NJ TRANSIT, Newark, NJ
5/18/2004	Public Transportation Management	Statewide	NJDOT, Trenton, NJ
5/18/2004	Inter-regional Electronic Toll/Parking/Toll Payment	Statewide	NJDOT, Trenton, NJ
5/19/2004	Parking Management	South	SJTPO, Vineland, NJ
5/19/2004	Public Transportation Management	South	SJTPO, Vineland, NJ
5/20/2004	Parking Management	North	NJTPA, Newark, NJ
5/20/2004	Public Transportation Management	North	NJTPA, Newark, NJ
5/25/2004	Information Archive Management	Statewide	GSP Executive Office, Woodbridge, NJ
5/25/2004	CVO and Ports	Statewide	GSP Executive Office, Woodbridge, NJ
5/26/2004	Information Archive Management	South	SJTA, Hammonton, NJ
5/26/2004	Public Safety/Emergency Management/Homeland Security	South	SJTA, Hammonton, NJ
5/27/2004	Information Archive Management	North	NJTPA, Newark, NJ
5/27/2004	Ports	North	NJTPA, Newark, NJ
6/8/2004	Public Safety/Emergency Management/Homeland Security	Statewide	GSP Executive Office, Woodbridge, NJ
6/9/2004	Public Safety/Emergency Management/Homeland Security	North	NJIT, Newark, NJ
6/10/2004	Maintenance Model	Statewide	GSP Executive Office, Woodbridge, NJ
6/15/2004	Travel and Traffic Maintenance; Maintenance Management	Statewide	NJDOT, Ewing, NJ
6/16/2004	Travel and Traffic Maintenance; Maintenance Management	South	SJTA, Hammonton, NJ
6/17/2004	Travel and Traffic Maintenance; Maintenance Management	North	NJIT, Newark, NJ
6/22/2004	Public Transportation Management	Statewide	GSP Executive Office, Woodbridge, NJ
6/22/2004	Inter-regional Electronic Toll/Parking/Toll Payment	Statewide	GSP Executive Office, Woodbridge, NJ
6/23/2004	Parking Management	South	SJTA, Hammonton, NJ
6/23/2004	Public Transportation Management	South	SJTA, Hammonton, NJ
6/24/2004	Parking Management	North	NJ TRANSIT, Newark, NJ
6/24/2004	Public Transportation Management	North	NJ TRANSIT, Newark, NJ
7/13/2004	Information Archive Management	Statewide	GSP Executive Office, Woodbridge, NJ
7/13/2004	CVO and Ports	Statewide	GSP Executive Office, Woodbridge, NJ
7/14/2004	Information Archive Management	South	SJTA, Hammonton, NJ
7/14/2004	Public Safety/Emergency Management/Homeland Security	South	SJTA, Hammonton, NJ
7/15/2004	Information Archive Management	North	NJTPA, Newark, NJ
7/15/2004	Ports	North	NJTPA, Newark, NJ
7/20/2004	Public Safety/Emergency Management/Homeland Security	Statewide	GSP Executive Office, Woodbridge, NJ
7/21/2004	Public Safety/Emergency Management/Homeland Security	North	NJIT, Newark, NJ
8/17/2004	Final Integration Review	Statewide	GSP Executive Office, Woodbridge, NJ
8/18/2004	Final Integration Review	South	SJTA, Hammonton, NJ
8/19/2004	Final Integration Review	North	NJ TRANSIT, Newark, NJ
8/25/2004	Maintenance Model	Statewide	NJDOT, Ewing, NJ

Table 4-1. Workshop Dates and Locations

Table 2
New Jersey ITS Architectures
and Deployment Plans
Stakeholder Participation by Functional Area Workshops

	Statewide		South		North	
Functional Area Workshops	**Architecture**	**Deployment**	**Architecture**	**Deployment**	**Architecture**	**Deployment**
Travel & Traffic Management; Maintenance Management	27	20	23	12	12	7
Parking Management			6	4	12	6
Public Transportation Management	8	5	6	4	15	6
Inter-regional Electronic Toll/Parking/Fare Payment	14	9				
Information Archive Management	12	8	5	3	6	11
Ports					18	10
CVO & Ports	10	9				
Public Safety/Emergency Management/Homeland Security	22	15	11	9	15	5
Maintenance Model	8	9				
Total	***101***	***75***	***51***	***32***	***78***	***45***

	Statewide	South	North
Training Workshop	47	14	23
Final Integration Review	19	10	7

Note: The above indicated numbers are excluding the consultant team.

Table 4-2. Stakeholder Participation by Function Area Workshops

Table 3
Deployment of Statewide/Regional Intelligent Transportation Systems Architectures and Deployment Plans
Stakeholder Participation by Functional Area Workshops

Organization	Representation
Atlantic County	2
Bergen County	1
BISTATE	1
Cape May County	1
Cisco Systems	2
City of Atlantic City	2
City of Newark	4
City of Vineland	1
County of Essex	1
County of Salem	1
Cross County Connection TMA	1
Cumberland County	3
Delaware River Joint Toll Bridge Commission	5
Delaware River Port Authority	2
Delaware Valley Regional Planning Commission	3
Edwards & Kelcey	2
Federal Highway Administration	3
French & Parrello Associates	1
Gannett Fleming	1
HNTB Corporation	1
Hudson County	1
Hudson County TMA	3
Keep Middlesex Moving	2
Meadowlink	4
Middlesex County	1
Monmouth County	2
New Jersey Association of Counties	1
New Jersey Department of Transportation	27
New Jersey League of Municipalities	1
National Association of Industrial and Office Properties	1
New Jersey State Police	3
New Jersey Turnpike Authority - Parkway	6
New Jersey Turnpike Authority - Turnpike	14
North Jersey Transportation Planning Authority	4
Ocean City Police Dept.	1
Port Authority of NY & NJ	5
Port Authority Transportation Corporation	1
Ridewise	1
Rutgers University	3
South Jersey Transportation Authority	13
Somerset County	1
Sussex County	1
TRANSCOM	5
TransOptions	2
UMDNJ-EMS	1
Union County	2

Table 4-3. Stakeholder Participation

5 ITS Inventory

5.1 Introduction

The New Jersey ITS Architectures identifies the existing and best consensus stakeholder estimates of existing and future ITS elements, and identifies the information exchange requirements between these elements, including options for open ITS standards to facilitate the exchange of information between the ITS elements.

This chapter focuses on the ITS inventory, a collection of all ITS elements in a regional and a statewide ITS architecture. The chapter is organized as follows:

- **Description.** Provides introductory and background information about this section, a definition of an ITS Inventory and ITS Elements.
- **Importance.** Provides an brief explanation of the purpose of the ITS Inventory and why it is needed.
- **Documentation**. Provides a description of how the ITS Inventory is documented within the ITS Architecture and how to access, interpret, and use the information contained in the ITS inventory.
- **Appendix 5.A.** Shows the "Sausage Diagram" for the architecture. [NOTE: The sausage diagram in this appendix is a placeholders while the architecture is finalized.]
- **Appendix 5.B.** Provides a listing of the ITS Inventory sorted by Stakeholder. The information is shown in tabular format.
- **Appendix 5.C.** Provide a listing of the ITS Inventory sorted by National ITS Architecture entity. The information is shown in tabular format.

Summary statistics are also provided to provide a reader with a sense of the breadth of the ITS architecture.

5.2 Description

5.2.1 ITS Element Attributes

The ITS Inventory is one of the cornerstones of the ITS architecture. Each ITS element contains a number of important attributes, including:

- An assignment of the ITS element to one or more stakeholders.
- A description of the ITS element. This description is one that is a stakeholder-based definition of the ITS element.
- A mapping of the ITS element to one of more of the National ITS Architecture entities

In addition to these ITS element attributes, the ITS architecture correlates each ITS element with the following:

- The customized market package the ITS element supports to provide transportation services
- The interfaces the ITS element must support to enable information and control exchanges with other ITS elements
- System functional requirements the ITS element must support to fulfill a role within a customized market package

5.2.1.1 Mapping to National ITS Architecture Entities

An objective of the New Jersey ITS Architectures is that each ITS element in New Jersey is mapped to one or more National ITS Architecture entities (e.g. subsystems or terminators). The US National ITS Architecture was used as a starting framework, but was augmented and adapted to enable solutions to physical and high-level functional requirements unique to New Jersey or New Jersey regions. The resulting customized National ITS Architecture became the New Jersey ITS Architectures.

5.2.1.2 Market Packages

Market packages are a collection of ITS elements and architecture flows between elements that support an ITS service. Chapter 6 provides an in-depth discussion related to the market packages, as these fulfill the transportation user needs identified as a starting point in developing the New Jersey ITS Architectures.

5.2.1.3 System Functional Requirements

Equipment packages are the building blocks of the subsystems in the National ITS Architecture. Equipment packages group processes from a particular subsystem together into a set of high level functional requirements that can be implemented as a package. Each ITS element (ITS system in the inventory) contains a set of equipment packages, that when taken together, constitute the system functional requirements for that system. Section 8 provides a more in-depth discussion about equipment packages and system functional requirements.

5.2.1.4 System Interfaces

One of the objectives of an ITS architecture is to document the current and future information sharing relationships between existing and planned ITS elements. These elements and their information sharing relationships must reflect the current and expected institutional stakeholder relationships in New Jersey. Section 9 presents information related to ITS system interfaces and interconnects.

5.2.2 Technical Approach

The ConSysTec architecture team first systematically identified the existing and future inventory of stakeholder elements at the subsystem level (as defined in the National ITS Architecture) based on existing regional and corridor deployments, existing ITS architectural and planning documentation, and articulation of stakeholder needs in the workshops.

With the assistance of moderators experienced in the development of ITS architectures, the stakeholders identified local ITS elements (systems), and classified these elements to subsystems and/or terminators of the National ITS Architecture (e.g., traffic management systems, traveler information systems, public transportation systems, etc.). Furthermore, the ITS systems in the inventory were classified as to whether they were either:

- Existing – the entity already exists or,
- Future – the entity may be deployed in the future.

The attributes of each ITS element in the inventory was then entered into the Turbo Architecture database.

5.2.3 Summary Statistics

The New Jersey ITS Architectures contain 441 separate ITS elements. A brief analysis of the mapping of the ITS elements to the National ITS Architecture yields the following summary statistics. These statistics are derived from the "combined" architectures database and provide an indication of the number of range of ITS elements included in the New Jersey ITS Architectures.

Subsystem	Number of Elements Mapped to Subsystem
Archived Data Management Subsystem	31
Commercial Vehicle Administration	16
Commercial Vehicle Check	1
Commercial Vehicle Subsystem	1
Emergency Management Subsystem	42
Emergency Vehicle Subsystem	5
Emissions Management	1
Fleet and Freight Management	3
Information Service Provider	30
Maintenance and Construction Management	25
Maintenance and Construction Vehicle	4
Parking Management	6
Personal Information Access	1

Subsystem	Number of Elements Mapped to Subsystem
Remote Traveler Support	13
Roadway Subsystem	10
Security Monitoring Subsystem	6
Toll Administration	3
Toll Collection	10
Traffic Management	37
Transit Management	45
Transit Vehicle Subsystem	9
Vehicle	6

Table 5-1. ITS Inventory Summary Statistics

5.2.4 Top Level Interconnect - "Sausage Diagram"

A top level interconnect diagram, or "Sausage Diagram," has been developed for each of the New Jersey ITS Architectures. The sausage diagram shows the systems and primary types of interconnections in the region. This diagram depicts all the subsystems in the National ITS Architecture and the basic communication channels between these subsystems. The New Jersey ITS Architectures interconnect diagram has been customized based on the information gathered from the stakeholders and the system inventory. The sausage diagram summarizes the existing and planned ITS elements for the region in the context of their physical interconnects. ITS elements identified for New Jersey ITS deployments (and their primary associated architecture entity) are called out in the boxes surrounding the central interconnect diagram.

In the center of the figure the rectangles represent the subsystems of the New Jersey ITS Architectures. The New Jersey ITS Architectures has elements that map to all 22 subsystems defined. In addition, the architecture has elements that map to the terminators of the National ITS Architecture. These terminators are represented by the rightmost column of boxes (shown in yellow) on the diagram.

The diagram also identifies the three basic types of communications used to interconnect the elements of the ITS architecture. These communications types are defined as:

- Fixed-Point To Fixed-Point Communications - A communications link serving stationary sources. It may be implemented using a variety of public or private communications networks that may physically include wireless (e.g., microwave) as well as wireline infrastructure. Both dedicated and shared communications resources may be used.
- Wide Area Wireless Communications - A communications link that provides communications via a wireless device between a user and an infrastructure-

based system. Both broadcast (one-way) and interactive (two-way) communications services are grouped into wide-area wireless communications. These links support a range of services including real-time traveler information and various forms of fleet communications.

- Dedicated Short Range Communications - A wireless communications channel used for close-proximity communications between vehicles and the immediate infrastructure. It supports location-specific communications for ITS capabilities such as toll collection, transit vehicle management, driver information, and automated commercial vehicle operations.

The sausage diagram for the NJTPA ITS Architecture is included in Appendix 5.A.

5.3 Importance

ITS elements are the basis for understanding which stakeholder systems (whether existing or future) may potentially connect and share information. From the stakeholder perspective, an understanding of both internal stakeholder interfaces (those that exist between ITS elements of the same stakeholder) and external system interfaces, interfaces with other stakeholders, are important. The stakeholder consensus inventory presents a middle-tier level of information from which analysts and other interested parties can define projects and transportation services (a more abstract tier of information), or drill down to explore the functional requirements of a system, or the interfaces between systems, which represent a finer detailed tier of information.

5.4 Documentation

5.4.1 Turbo Architecture Documentation

The ITS Inventory was managed using Turbo Architecture Version 3. Version 3 of the Turbo Architecture tool is compatible with Version 5 of the National ITS Architecture. The Turbo Architecture tool facilitates maintenance of Microsoft Access database tables, which are a basis for all the reports (including web pages) showing information about the ITS inventory. The figure below shows a sample ITS element as depicted by the Turbo Architecture tool.

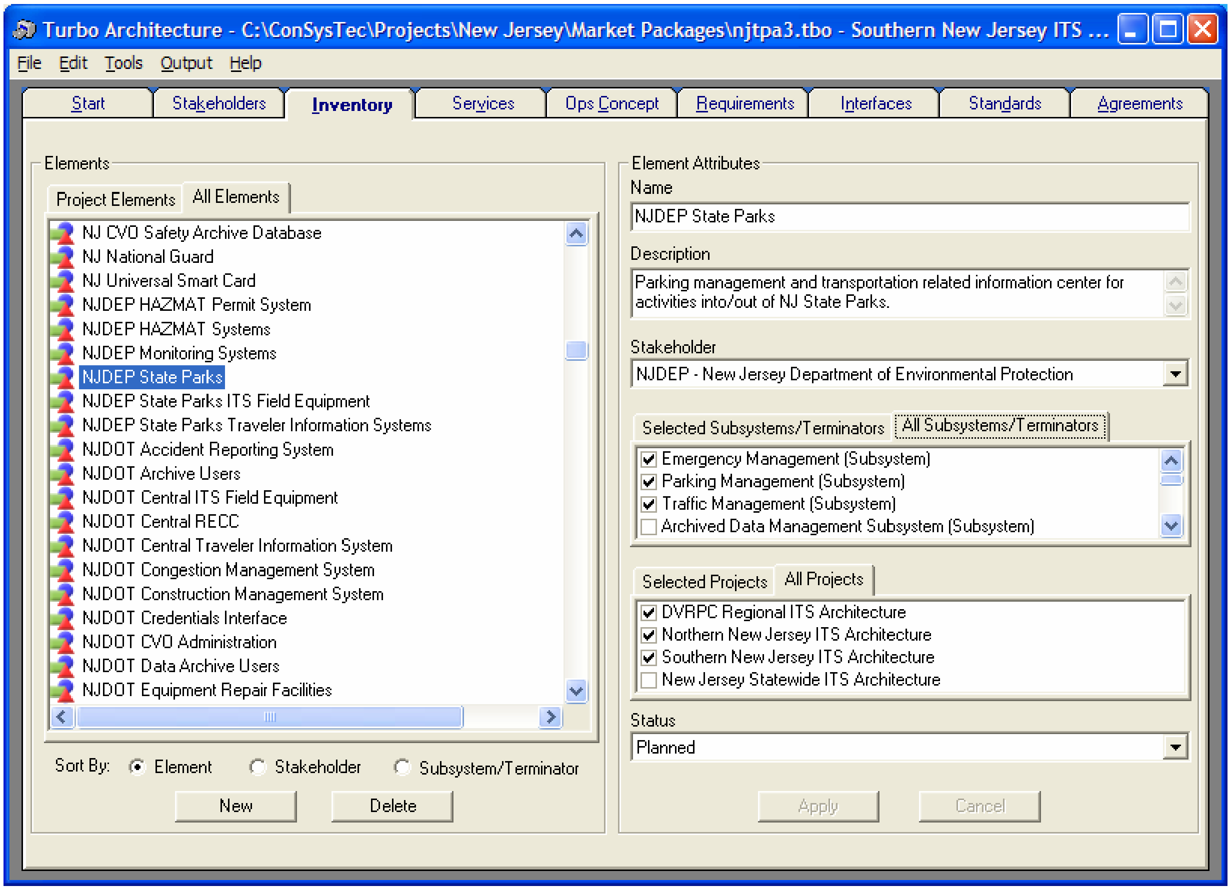


Figure 5-1. Sample ITS Element in Turbo Architecture

The ITS inventory can be organized by stakeholders (so that a stakeholder can easily see each of their assets in the architecture) or by architecture entity (i.e., subsystem or terminator) so that an analyst or other interested person can see all the stakeholder elements in a region of the same type.

5.4.2 Web Site Documentation

This New Jersey ITS Architectures website documents in tabular format the name and description of each ITS element contained in each ITS architecture. The inventory may be sorted by stakeholder or by National ITS Architecture entity. The resulting entries in the ITS inventory tables are hyperlinked to an individual ITS element page which contains the following:

- Description
- Status (Existing or Planned)
- Stakeholder
- Mapping to National ITS Architecture Entity
- List of Interfaces with Other ITS Elements

- List of Customized Market Packages that include the ITS Element

The figure below shows a sample ITS element as depicted on the New Jersey ITS Architectures website.

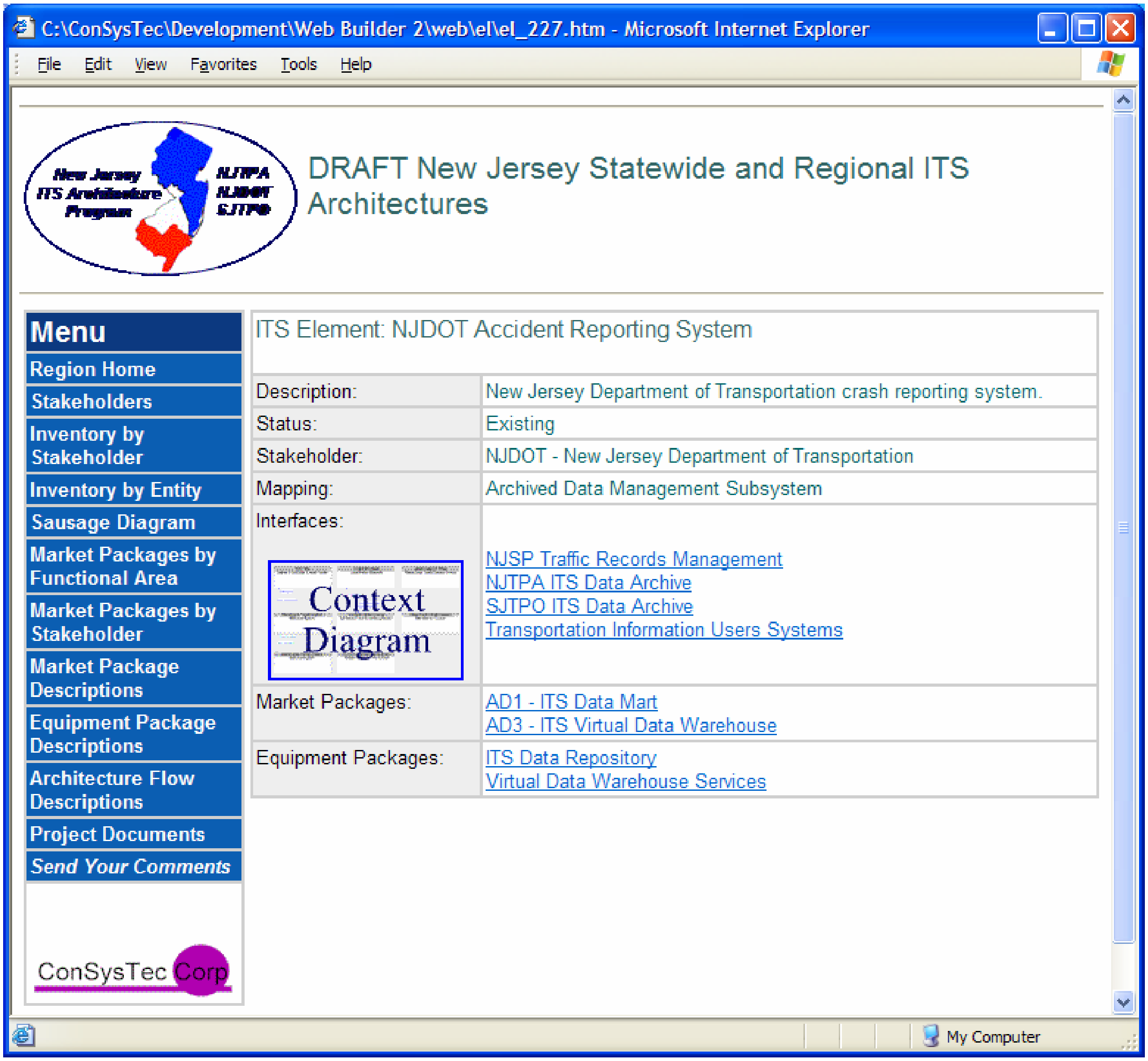


Figure 5-2. Sample ITS Element from the New Jersey ITS Architectures Website

5.4.2.1 "Sausage Diagram"

The web site for each of the New Jersey ITS Architectures contains an individual sausage diagram, accessible by clicking on the "Sausage Diagram" link on the individual ITS architectures home page. From the sausage diagram page one can download and view a PDF (portable document format) document in the web browser. The PDF of the Sausage Diagram is readily printed from the web browser in this format.

6 User Needs And Services

6.1 Introduction

This chapter focuses on user needs, ITS services, and market packages. Market packages document the set of ITS elements that together provide an ITS service. The market packages also document each stakeholder's current and future roles and responsibilities in the operation of regional or statewide ITS systems.

The chapter is organized as follows:

- **Description.** Provides introductory and background information about this section, a definition for ITS services and a discussion about Market Packages.
- **Importance.** Provides a brief explanation of the purpose of customized market packages and why they are needed.
- **Documentation.** Provides a description of how customized market packages are documented within the ITS Architecture and how to access, interpret, and use the information.
- **Appendix 6.A.** Provides a listing of customized market packages by stakeholder. The information is shown in tabular format.

6.2 Description

6.2.1 User Needs, ITS Services, and Market Packages

User needs were identified during a series of ITS functional area meetings early in the development of the New Jersey ITS Architectures. The user needs were then allocated amongst one or more of approximately 80 specific ITS service categories identified in the National ITS Architecture. Each ITS service -- and its description - maps to a generic market package diagram, and example of which is shown in the figure below. Descriptions for each of the ITS Services (Market Packages) are included in Appendix .

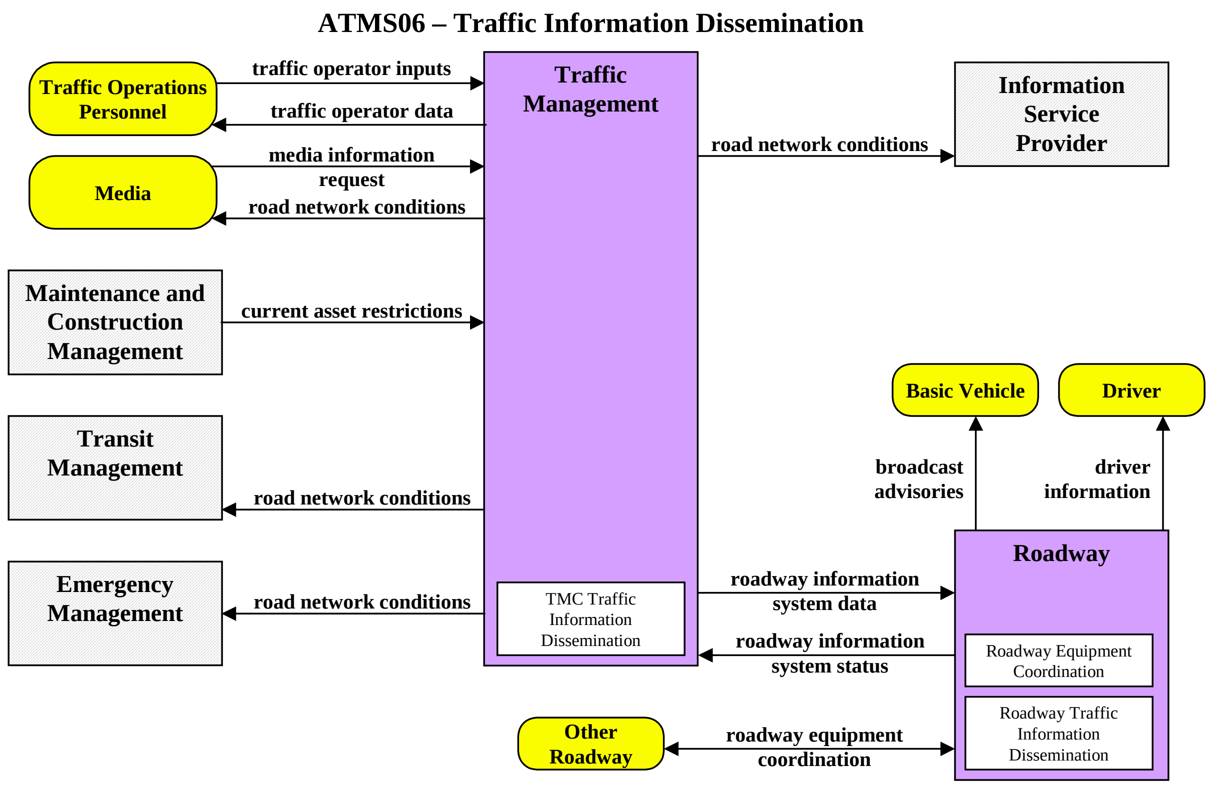


Figure 6-1. Example Generic National ITS Architecture Market Package Diagram

Market packages collect together two or more system elements (from the same or multiple stakeholders) that must work together to deliver a given transportation service and the architecture flows that connect them and other important external systems on the boundary of ITS. In other words, they identify the ITS system elements required to implement a particular transportation service. Market packages included in the New Jersey ITS Architectures were tailored to fit, separately or in combination, real-world transportation problems and needs.

6.2.2 Customized Market Packages

Customized market packages represent the consensus requirements for information that may be exchanged between specific ITS elements to effect specific sets of ITS services. As such, they collectively represent the concept of operations for a region.

The customized market package for the New Jersey ITS Architectures have been organized by transportation functional area as follows:

- **Archived Data Management Systems (AD).** These are systems used to collect transportation data for use in non-operational purposes (e.g. planning and research).
- **Advanced Public Transportation Systems (APTS).** These are systems used to more efficiently manage fleets of transit vehicles or transit rail. Includes systems to provide transit traveler information both pre-trip and during the trip.
- **Advanced Traveler Information Systems (ATIS).** These are systems used to provide static and real time transportation information to travelers.
- **Advanced Traffic Management Systems (ATMS).** These are traffic signal control systems that react to changing traffic conditions and provide coordinated intersection timing over a corridor, an area, or multiple jurisdictions. This functional area also included systems used to monitor freeway (or tollway) traffic flow and roadway conditions, and provide strategies such as ramp metering or lane access control to improve the flow of traffic on the freeway. These systems may also provide information to motorists on the roadway.
- **Commercial Vehicle Operations (CVO).** These are system used to more efficiently manage commercial fleets, monitor freight movements, hazardous materials movement, safety inspections, and electronic clearance (both domestic and international).
- **Emergency Management (EM).** These are systems that provide emergency call taking, public safety dispatch, and support emergency operations center operations.
- **Maintenance and Construction (MC).** These are systems used to manage the maintenance of roadways in the region, including winter snow and ice clearance, and construction operations.

Customized market packages diagrams represent collections of ITS elements that exchange information (illustrated with architecture flows in the market package diagram) to do a specific service. The market packages are customized to represent the operational concept for service delivery specific to the region.

An example customized market package diagram is show in the figure below.

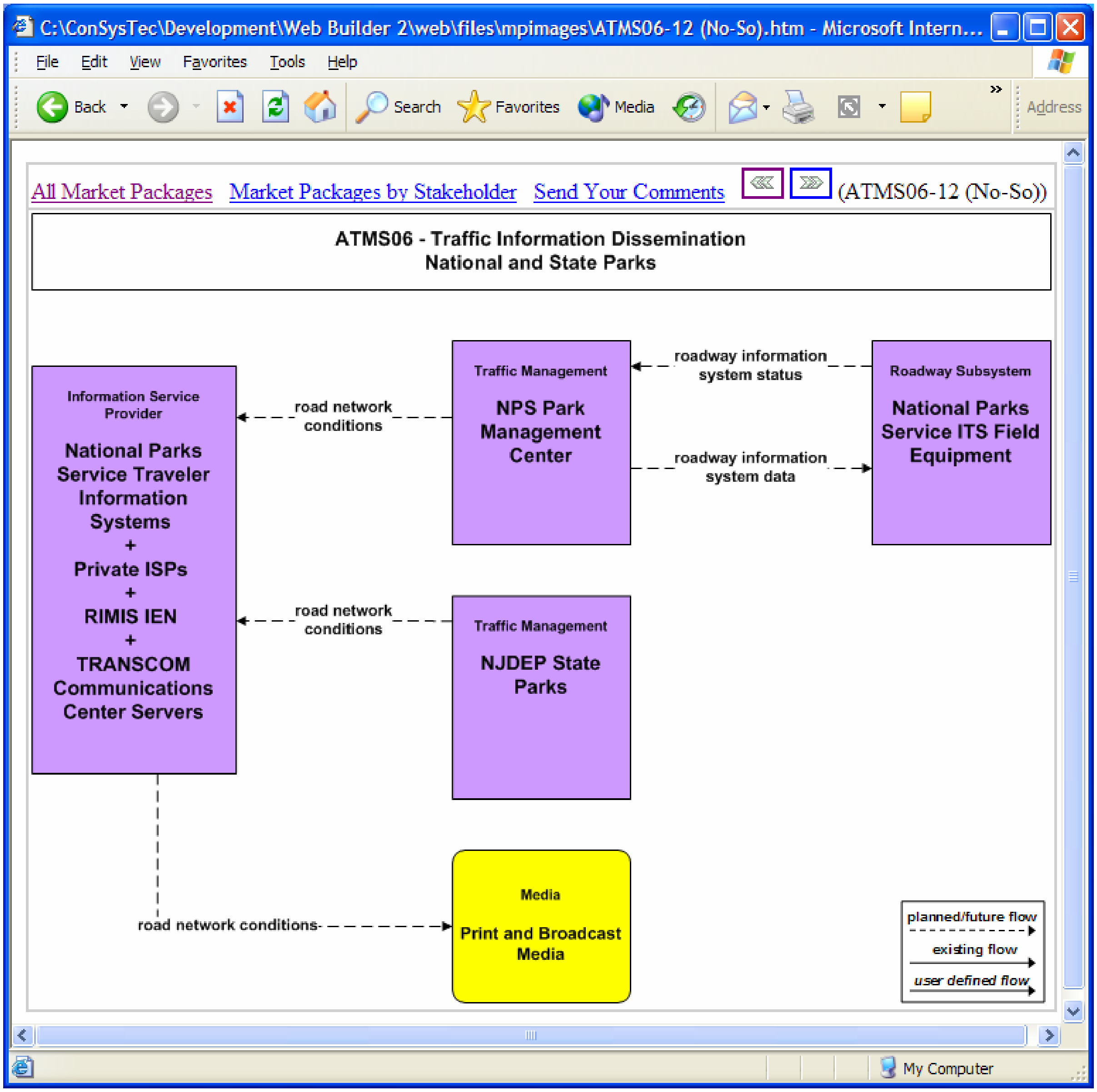


Figure 6-2. Example Customized Market Package Diagram

Each ITS element is labeled with both the generic National ITS Architecture name and the name of the local stakeholder instance that participates in the customized market package. ITS elements mapped to a National ITS Architecture subsystem are shown as purple boxes and those mapped to a terminator are shown as yellow rounded rectangles. Each customized market package diagram contains a legend that shows the three different graphical representation used to show an ITS architecture flows state: future or planned flows are shown as dashed lines, and existing flows are shown as a solid line. User-defined architecture flows, ones that do not exist in the National ITS Architecture, are shown in italics.

6.2.3 Technical Approach

The ConSysTec architecture team first systematically identified the existing and future inventory of stakeholder elements. Next, the consultants identified generic services through National ITS Architecture market packages, and where stakeholders indicated a need, the consultants customized those market packages for specific applications (existing or future) identified by the stakeholders. This customization identified information exchange at the architecture flow level. Finally, a roll-up of all information exchange requirements at the architecture flow level for each subsystem level entity was reviewed with stakeholders. The customized market package diagrams were updated in real-time with stakeholders using the Microsoft Visio diagramming software tailored by ConSysTec for use in development of regional ITS architectures. The graphical output of the Visio was output in the GIF and PDF format and made accessible to users through the project website. Information from the customized market package diagrams was also entered into the Turbo Architecture database including:

- Market Package Used. Identifies whether the ITS service exists in the architecture.
- Customized Market Package Instance. Catalogs the specific diagram created.
- Associated ITS Elements per Customized Market Package Instance
- Architecture Flows between ITS Elements

6.2.4 Summary Statistics

The New Jersey ITS Architectures contain 488 separate customized market package diagrams. An analysis of the customized market packages by functional area reflects the following summary statistics.

Functional Area	Statewide	NJTPA	SJTPO	All
Traffic Management	39	58	40	137
Maintenance and Construction	24	36	27	87
Public Transportation	36	48	38	122
Traveler Information Systems	8	14	8	30
Commercial Vehicle Operations	10	14	6	30
Emergency Management	24	16	14	54
Archived Data	15	7	6	28
Totals	**156**	**193**	**139**	**488**

Table 6-1. Number of Customized Market Package Diagrams by Functional Area and ITS Architecture

The following tables indicate whether the ITS Service (Market Package) exists in the ITS Architecture. There is one table for each ITS functional area.

Market Package	Market Package Name	Statewide	NJTPA	SJTPO
ATMS01	Network Surveillance	X	X	X
ATMS02	Probe Surveillance	X	X	
ATMS03	Surface Street Control	X	X	X
ATMS04	Freeway Control	X	X	
ATMS05	HOV Lane Management	X	X	X
ATMS06	Traffic Information Dissemination	X	X	X
ATMS07	Regional Traffic Control	X	X	X
ATMS08	Traffic Incident Management System	X	X	X
ATMS10	Electronic Toll Collection	X		
ATMS11	Emissions Monitoring and Management	X		
ATMS13	Standard Railroad Grade Crossing		X	X
ATMS14	Advanced Railroad Grade Crossing		X	X
ATMS15	Railroad Operations Coordination	X	X	X
ATMS16	Parking Facility Management	X	X	X
ATMS18	Reversible Lane Management		X	X
ATMS19	Speed Monitoring		X	
ATMS20	Drawbridge Management	X	X	X
ATMS21	Roadway Closure Management		X	X

Table 6-2. Advanced Traffic Management System Market Packages by ITS Architecture

Market Package	Market Packag	S	N	SJTPO
APTS1	Transit Vehicle Tracking	X	X	X
APTS2	Transit Fixed-Route Operations	X	X	X
APTS3	Demand Response Transit Operations	X	X	X
APTS4	Transit Passenger and Fare Management	X	X	X
APTS5	Transit Security	X	X	X
APTS7	Multi-modal Coordination	X	X	X
APTS8	Transit Traveler Information	X	X	X

Table 6-3. Advanced Public Transportation System Market Packages by ITS Architecture

Market Package	Market Package Name	Statewide	NJTPA	SJTPO

Market Package	Market Package Name	Statewide	NJTPA	SJTPO
ATIS1	Broadcast Traveler Information		X	X
ATIS2	Interactive Traveler Information	X	X	X
APTS5	ISP Based Route Guidance	X	X	
ATIS9	In-Vehicle Signing			X

Table 6-4. Advanced Traveler Information System Market Packages by ITS Architecture

Market Package	Market Package Name	Statewide	NJTPA	SJTPO
EM01	Emergency Call-Taking and Dispatch	X	X	X
EM02	Emergency Routing	X	X	X
EM04	Roadway Service Patrols	X		
EM05	Transportation Infrastructure Protection	X	X	
EM06	Wide-Area Alert	X	X	X
EM07	Early Warning System	X	X	X
EM08	Disaster Response and Recovery	X	X	X
EM09	Evacuation and Reentry Management	X	X	X

Table 6-5. Emergency Management System Market Packages by ITS Architecture

Market Package		Statewide	NJTPA	SJTPO
MC01	Maintenance and Construction Vehicle and Equipment Tracking	X	X	X
MC02	Maintenance and Construction Vehicle Maintenance	X	X	X
MC03	Road Weather Data Collection	X	X	X
MC04	Weather Information Processing and Distribution	X	X	X
MC05	Roadway Automated Treatment	X	X	
MC06	Winter Maintenance	X	X	X
MC07	Roadway Maintenance and Construction	X	X	X
MC08	Work Zone Management	X	X	
MC09	Work Zone Safety Monitoring	X		X
MC10	Maint. and Const. Activity Coordination	X	X	X

Table 6-6. Maintenance and Construction Operations System Market Packages by ITS Architecture

Market Package	Market Package Name	Statewide	NJTPA	SJTPO
AD1	ITS Data Mart	X	X	X
AD3	ITS Data Warehouse	X	X	X

Table 6-7. Archived Data System Market Packages by ITS Architecture

Market Package		Statewide	NJTPA	SJTPO
CVO01	Fleet Administration	X	X	X
CVO03	Electronic Clearance	X	X	X
CVO04	CV Administrative Processes	X		
CVO06	Weigh-In-Motion		X	X
CVO10	HAZMAT Management	X	X	X
CVO12	CV Driver Security Authentication	X	X	X

Table 6-8. Commercial Vehicle Operations System Market Packages by ITS Architecture

6.3 Importance

In the context of an operational concept, the customized market packages document the roles of stakeholders in providing ITS services in the region. From a technical perspective, the customized market packages graphically portray a mapping of the needs and services to configurations of ITS elements and their interfaces that stakeholders may include in future projects.

The market packages also represent a jumping off point from which stakeholders may define an operational concept and potential ITS projects, which may be linked to one of more of the customized market package diagrams. System analysts may also use the customized market packages to drill down to explore the specific interfaces and information exchange requirements of specific ITS elements.

6.4 Documentation

6.4.1 Microsoft Visio and Turbo Architecture Documentation

The customized market package diagrams are managed using Microsoft Visio 2003. Using extension of Visio developed by ConSysTec, the information contained in graphical form is entered into Turbo Architecture Version 3. The figure below shows an example of market package instances (derived from the individual diagrams) in Turbo Architecture.

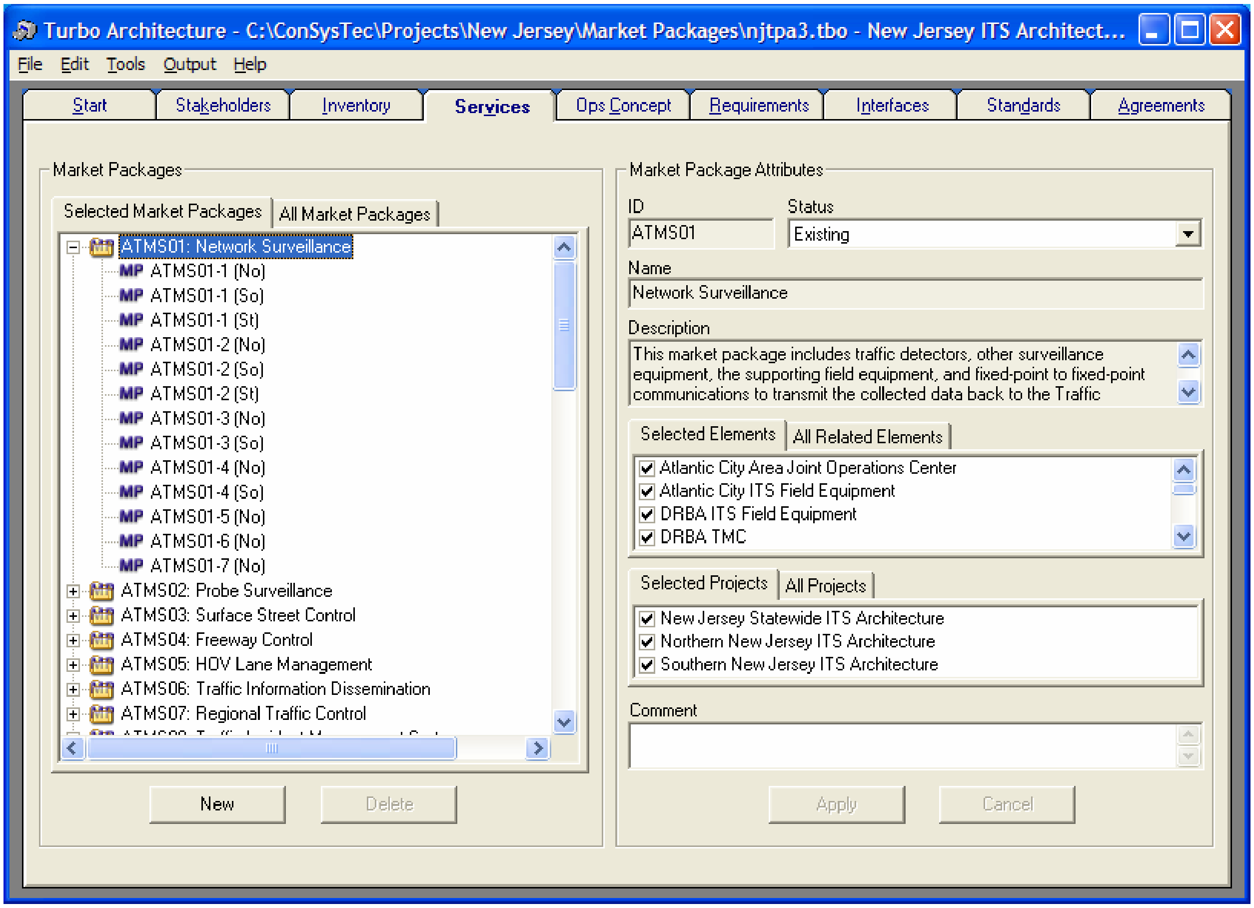


Figure 6-3. Sample Market Package Instances in Turbo Architecture

The market package screen shows the following information:

- Market package instances developed. These map one-for-one to a diagram maintained in the Visio software.
- List of associated ITS elements
- Which ITS architecture(s) the market package instance was allocated to

6.4.2 Website Documentation

Customized Market Package Diagrams are shown on the New Jersey ITS Architectures website, organized by transportation functional area and also by stakeholder, from the main menu. The market packages are accessible (viewable) by clicking on the graphic beside each of the ITS functional areas or stakeholders listed. The result is a PDF file which contains the market package diagrams for a particular functional area or stakeholder.

The figure below shows a sample page from the New Jersey ITS Architectures website which lists market packages by functional area.

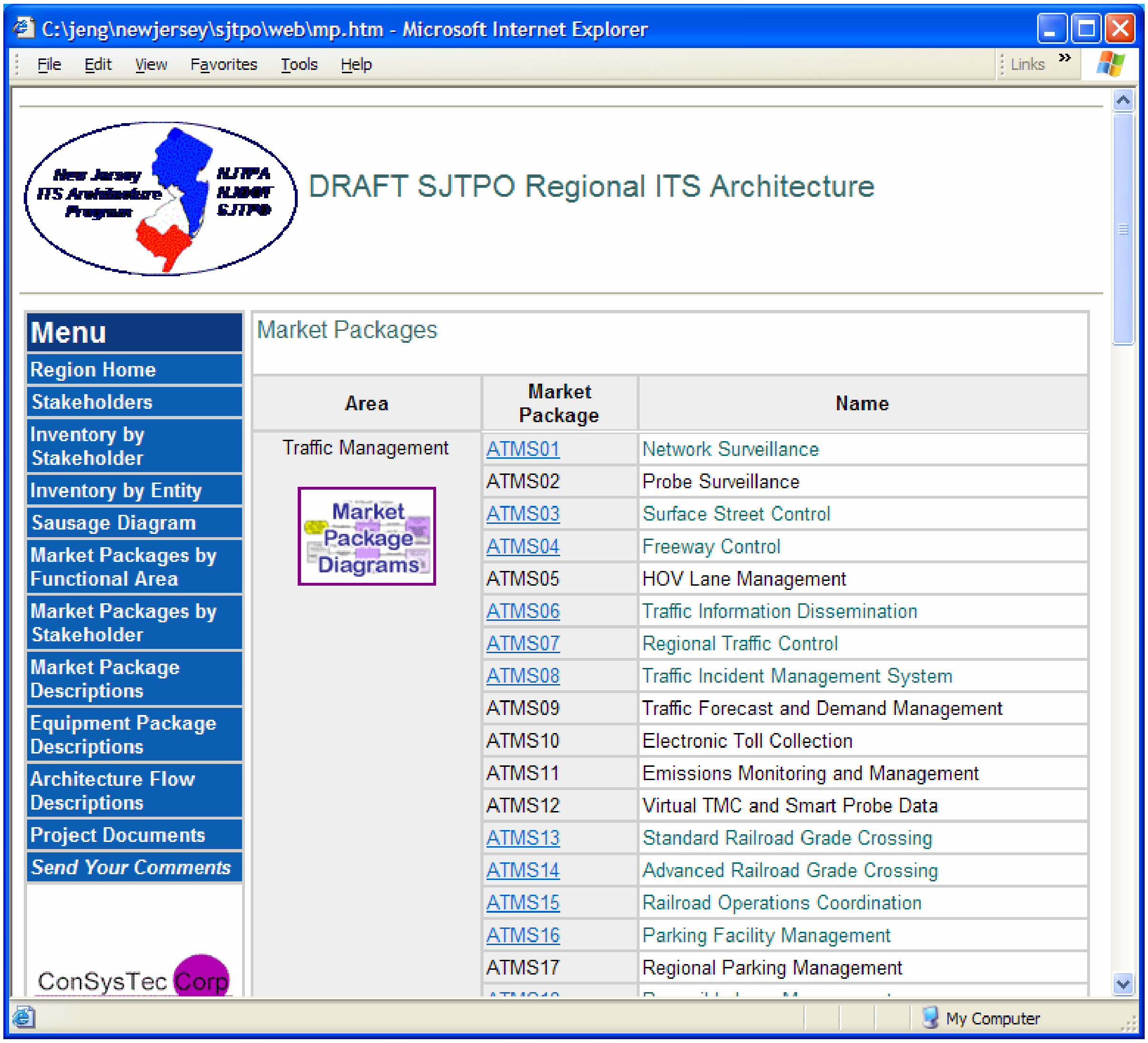


Figure 6-4. Sample List of Market Packages by Functional Area

The figure below shows a sample page from the New Jersey ITS Architectures website which identifies market packages by stakeholder.

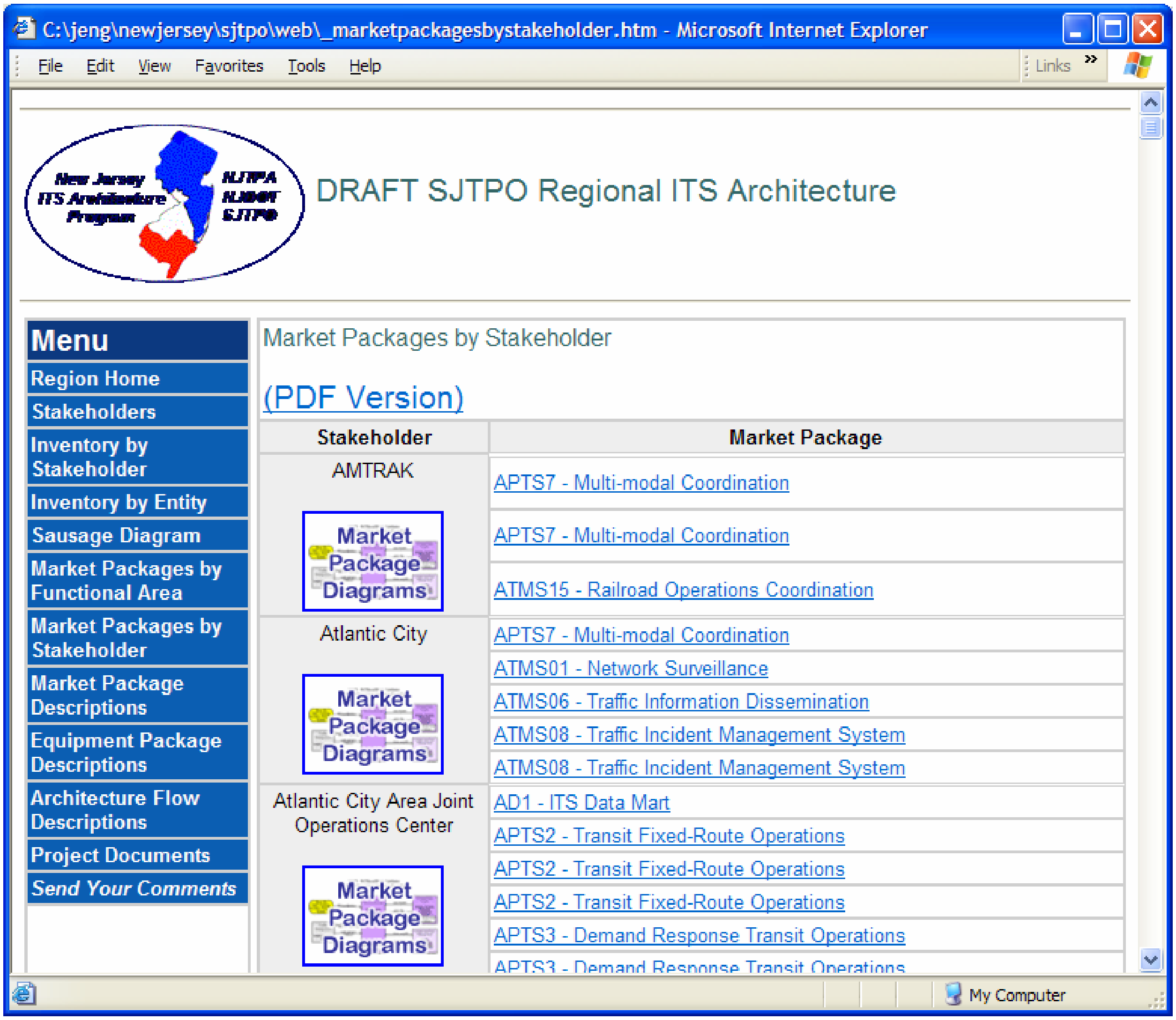


Figure 6-5. Sample List of Market Packages by Stakeholder

7 Operational Concepts and Agreements

7.1 Introduction

The identification of operational concepts and institutional agreements required are crucial to the development of a consensus architecture. As is stated in the *Request for Proposals:*

"Agreements must be identified and documented between all agencies that are expected to provide resources. The stakeholders should establish and formally agree to the expectations for cooperation."

The following pages document the operational concepts and agreements associated with the ITS architectures developed for this project.

For each short-term market package developed, a market-package diagram is shown, along with the operational concepts and agreements required. Agreements are shown where information is shared across institutional boundaries. Market packages that involve the sharing of information wholly within one institution do not require an agreement.Description

7.2 Example 1 – Transit Vehicle Tracking

The following is an example of the operational concept for Market Package APTS1 - Transit Vehicle Tracking.

Figure 7-1 illustrates transit vehicle tracking for the DRBA Cape May-Lewes Ferry System.

Operational Concept
DRBA Cape May – Lewes ferries are tracked by the DRBA Cape May - Lewes Ferry System management center. Tracking involves tracking the vehicle location and the schedule adherence of the vehicles.

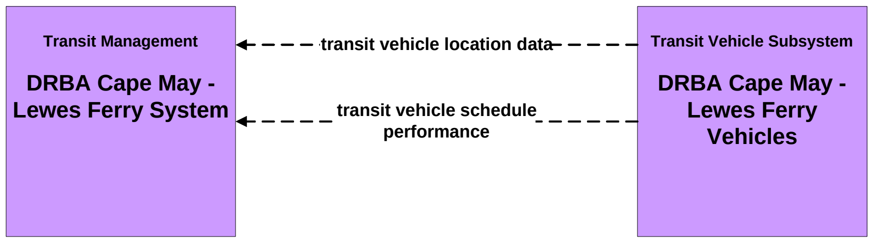
Institutional Agreements
None required. All ITS elements are under the same institutional entity.

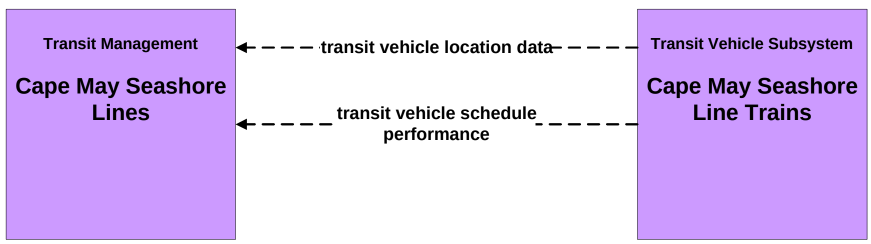
Figure 7-1 also illustrates transit vehicle tracking for the DRBA Cape May Seashore Line trains.

Operational Concept
DRBA Cape May Seashore Line trains are tracked by the DRBA Cape May Seashore Lines management center. Tracking involves tracking the vehicle location and the schedule adherence of the vehicles.

Institutional Agreements
None required. All ITS elements are under the same institutional entity.

APTS1 - Transit Vehicle Tracking
DRBA Cape May-Lewes Ferry System / Cape May Seashore Lines





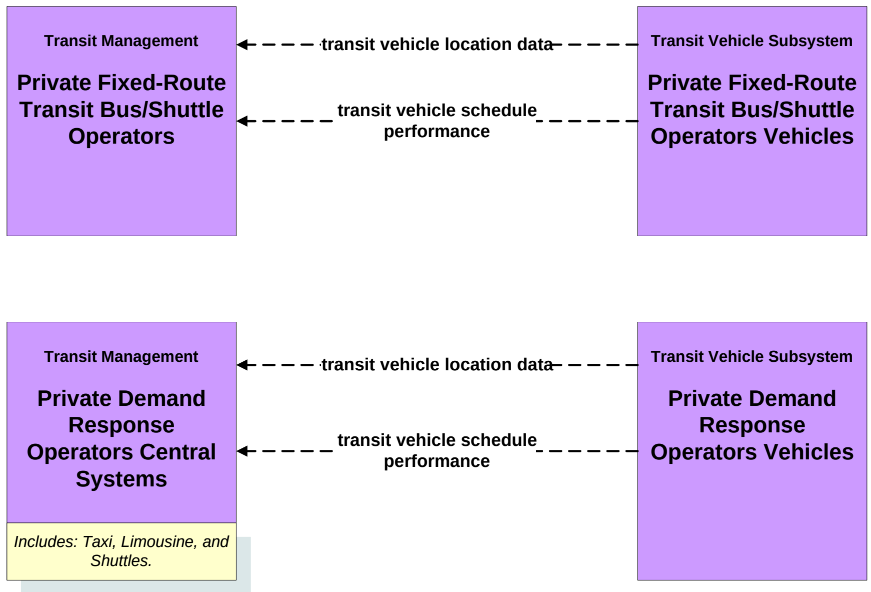
Operational Concept

DRBA Cape May – Lewes ferries are tracked by the DRBA Cape May - Lewes Ferry System management center. Tracking involves tracking the vehicle location and the schedule adherence of the vehicles.

Institutional Agreements

None required. All ITS elements are under the same institutional entity.

APTS1 - Transit Vehicle Tracking
Private Demand Response and Fixed-Route Transit Operators

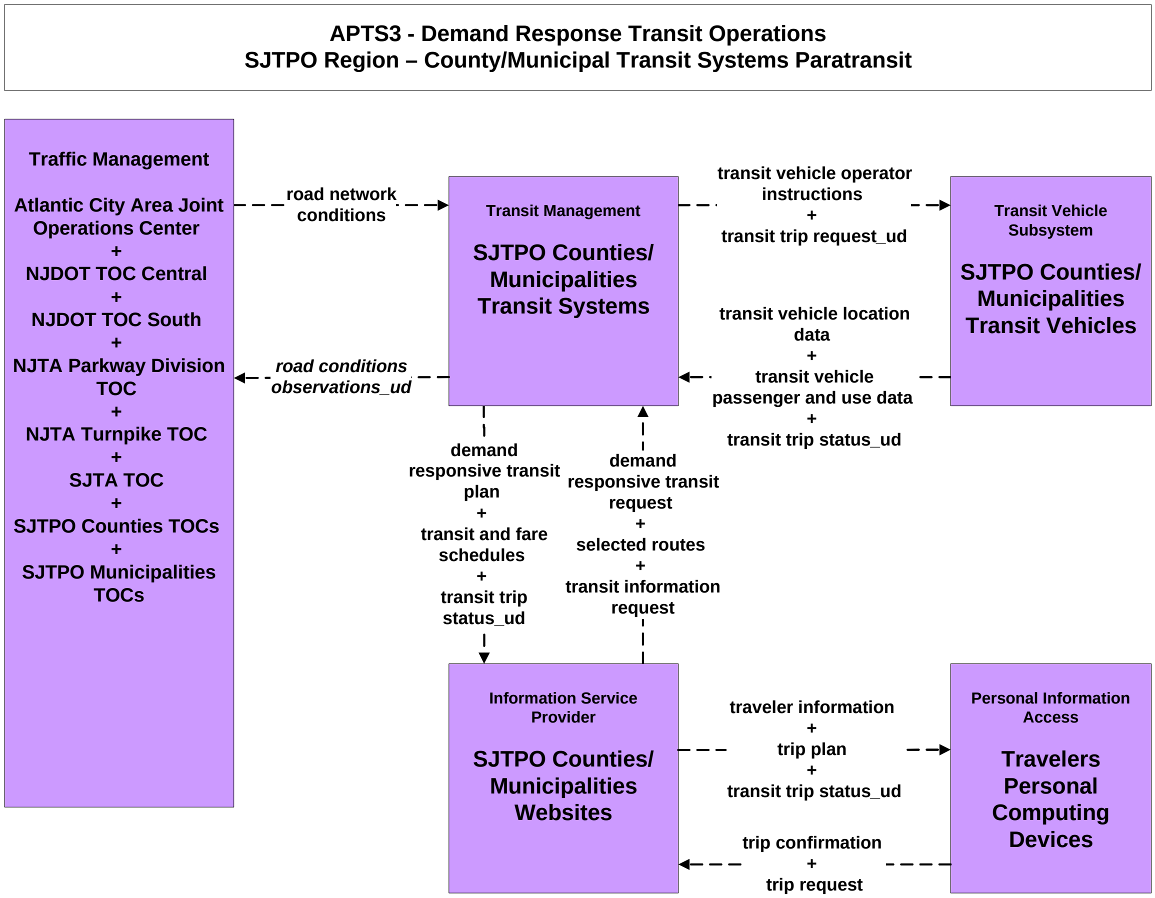


Operational Concept

Private fixed-route transit and demand-responsive operators track their vehicles. Tracking involves tracking the vehicle location and the schedule adherence of the vehicles.

Institutional Agreements

None required. All ITS elements are under the same institutional entity.



Operational Concept

Transit vehicle location and roadway network conditions are transmitted between transit vehicles, transit systems, and TOCs. Additionally, traveler information and requests are coordinated.

Institutional Agreements

The following agencies agree to share data:

Atlantic City Area Joint Operations Center

NJDOT

NJTA – Parkway

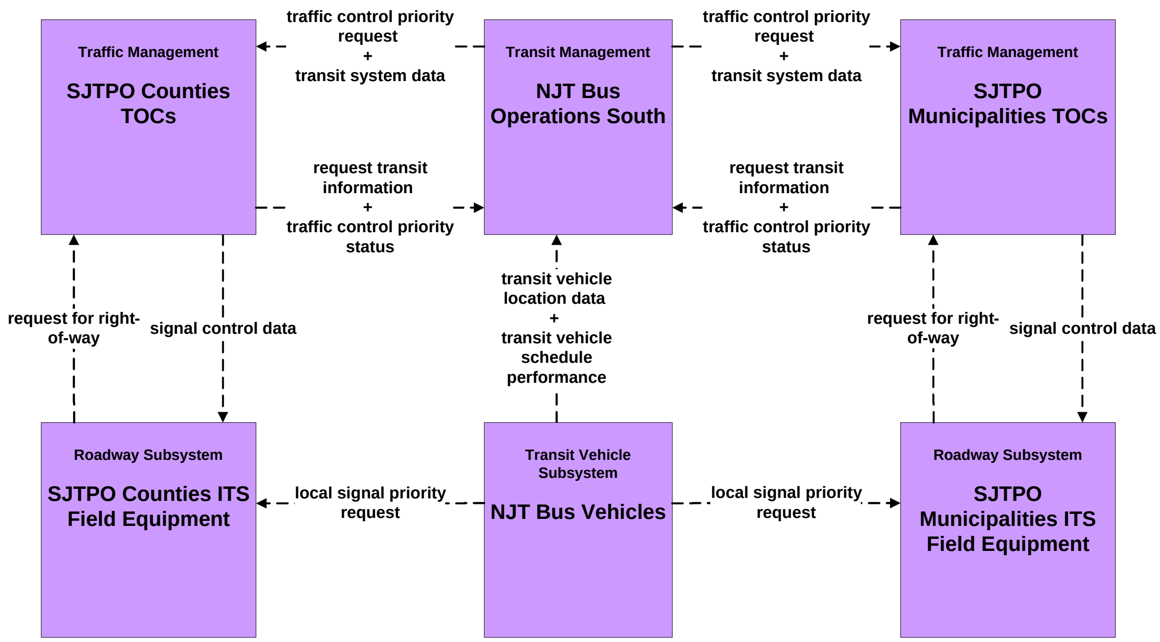
NJTA – Turnpike

SJTA

SJTPO Counties/Municipalities TOCs

SJTPO Counties/Municipalities Transit Systems

APTS7 - Multimodal Coordination
NJ TRANSIT - Bus Operations South



Operational Concept
This system facilitates signal prioritization and the transmittal of transit data.

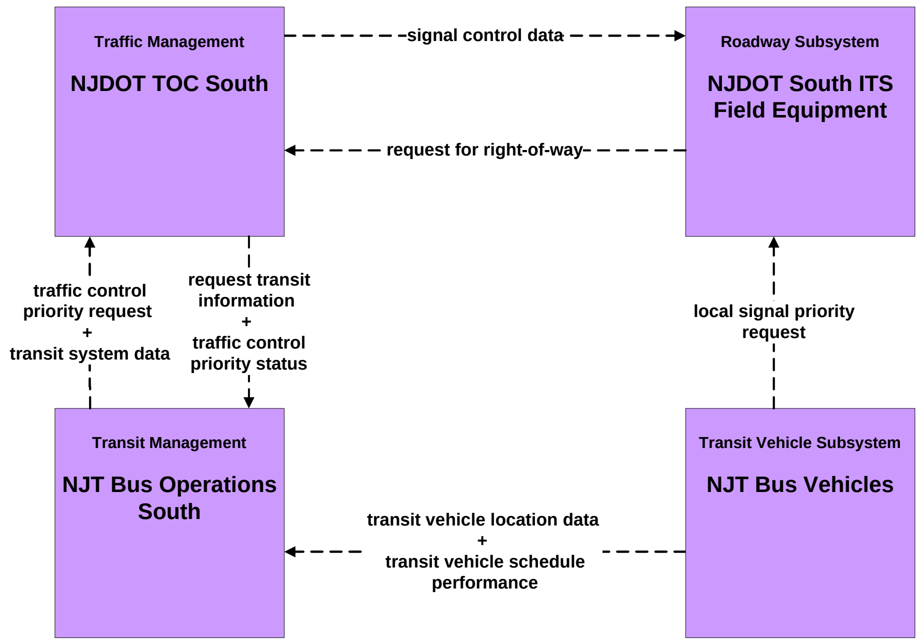
Institutional Agreements
The following agencies agree to share information:

SJTPO Counties/Municipalities TOCs

SJTPO Counties/Municipalities Transit Systems

NJ TRANSIT

APTS7 - Multimodal Coordination
NJDOT TOC South & NJ TRANSIT Bus Operations (South)



Operational Concept

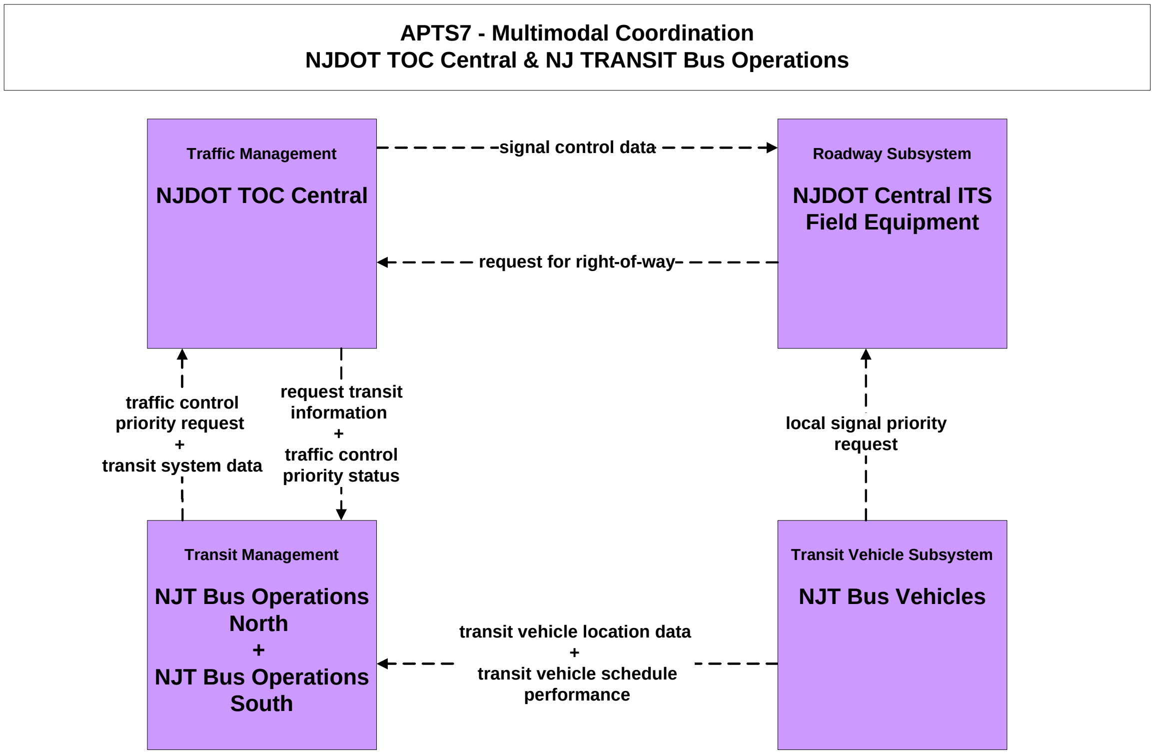
This system facilitates transit vehicle tracking, the transmittal of transit information, and signal prioritization.

Institutional Agreements

The following agencies agree to share information:

NJ TRANSIT

NJDOT



Operational Concept

This system facilitates signal prioritization and the transmittal of transit data.

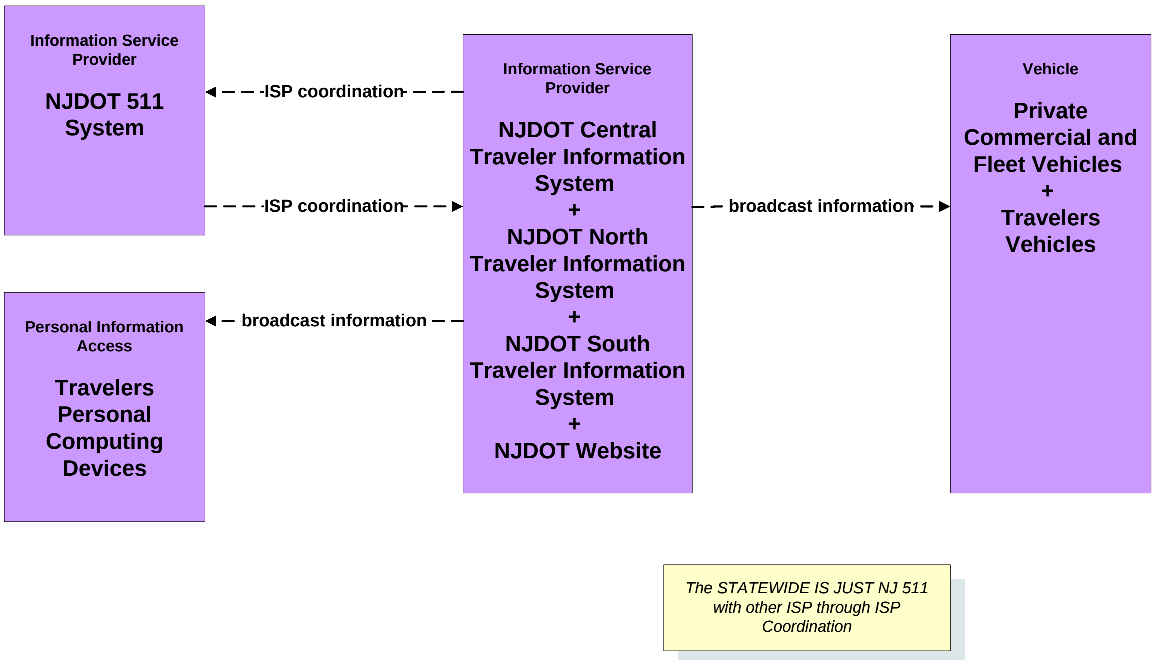
Institutional Agreements

The following agencies agree to share information:

NJ TRANSIT

NJDOT

ATIS1 - Broadcast Traveler Information
NJDOT



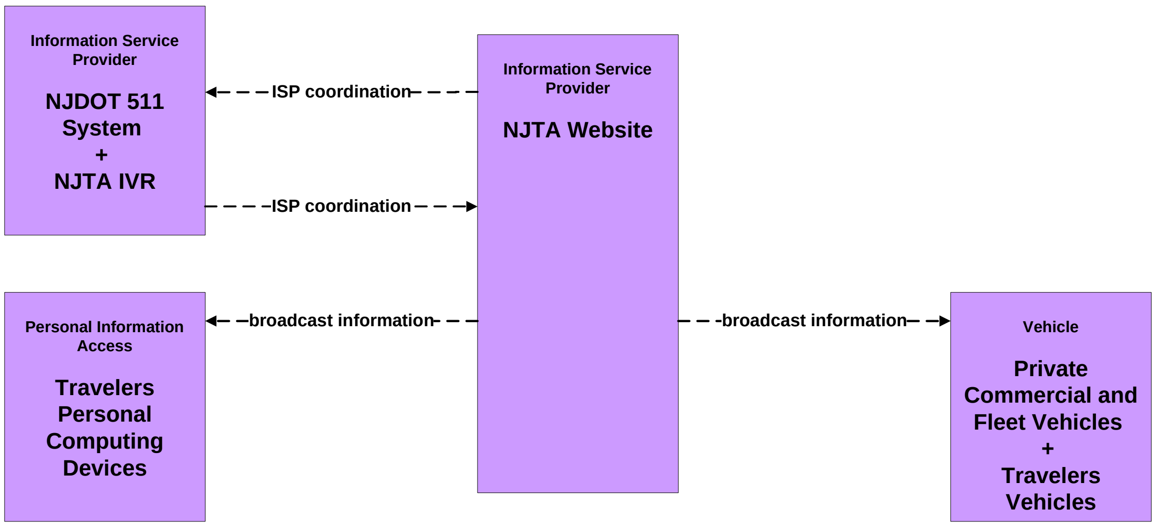
Operational Concept

This system facilitates the transmittal of broadcast information to traveler's vehicles.

Institutional Agreements

None required. All ITS elements are under the same institutional entity.

ATIS1 - Broadcast Traveler Information
NJTA (including Parkway Division)



Operational Concept

This system facilitates the transmittal of broadcast information to traveler's vehicles.

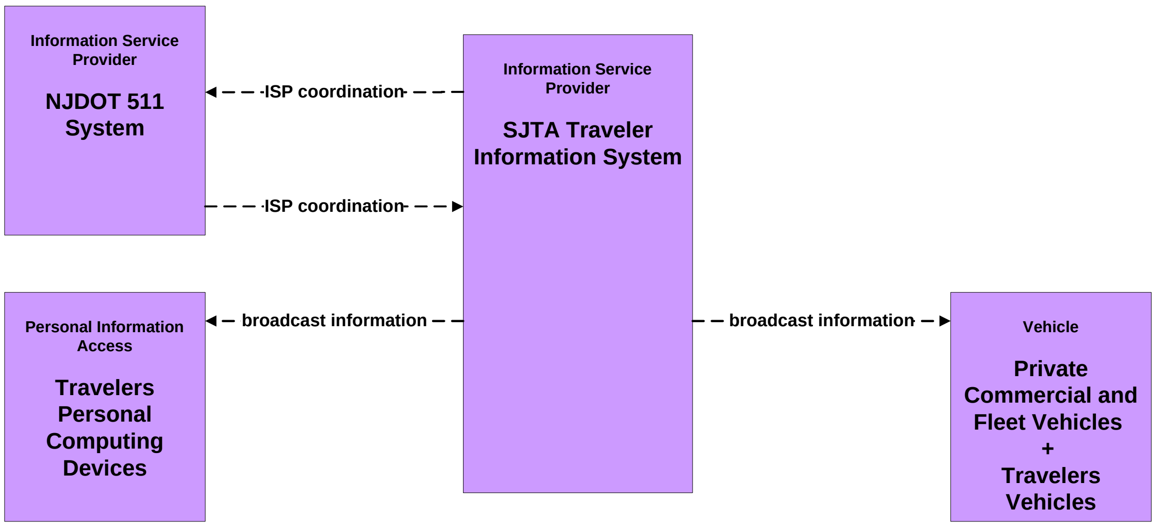
Institutional Agreements

The following agencies agree to share information.

NJDOT

NJTA

ATIS1 - Broadcast Traveler Information
SJTA



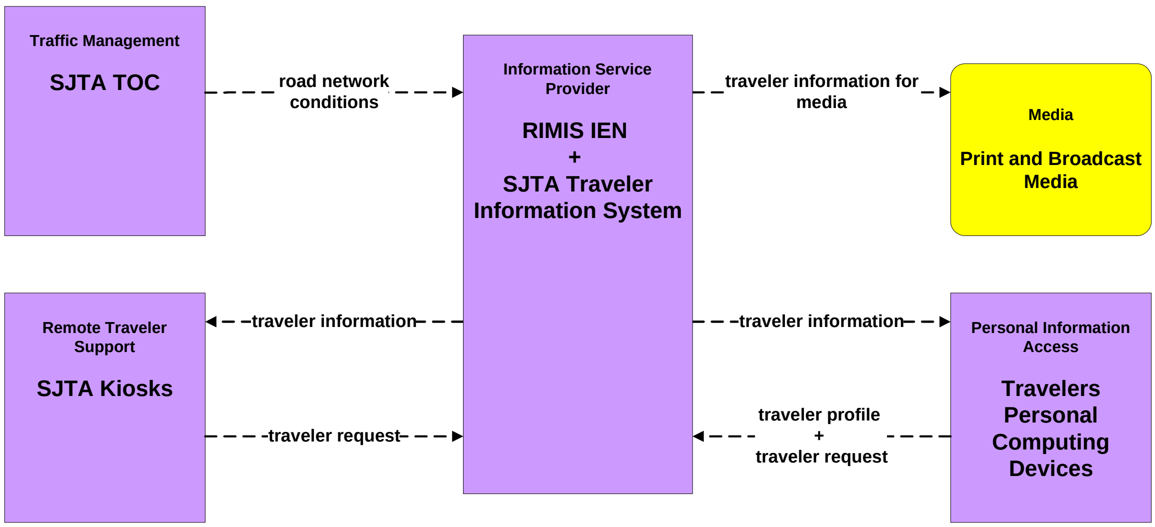
Operational Concept
This system facilitates the transmittal of broadcast information to traveler's vehicles.

Institutional Agreements
The following agencies agree to share information.

NJDOT

SJTA

ATIS2 - Interactive Traveler Information
South Jersey Transportation Authority



Operational Concept

This system facilitates the dissemination of road network information to travelers.

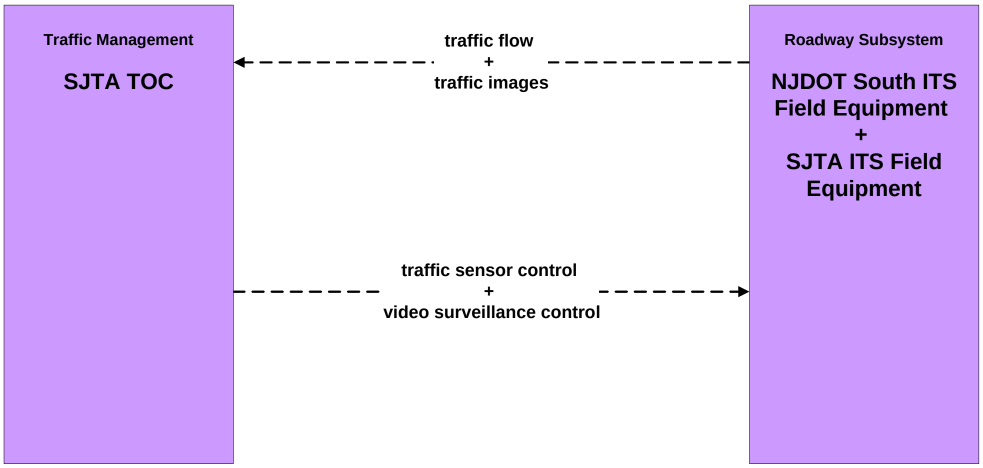
Institutional Agreements

The following agencies agree to share data:

SJTA

RIMIS

ATMS01 - Network Surveillance
South Jersey Transportation Authority



Operational Concept

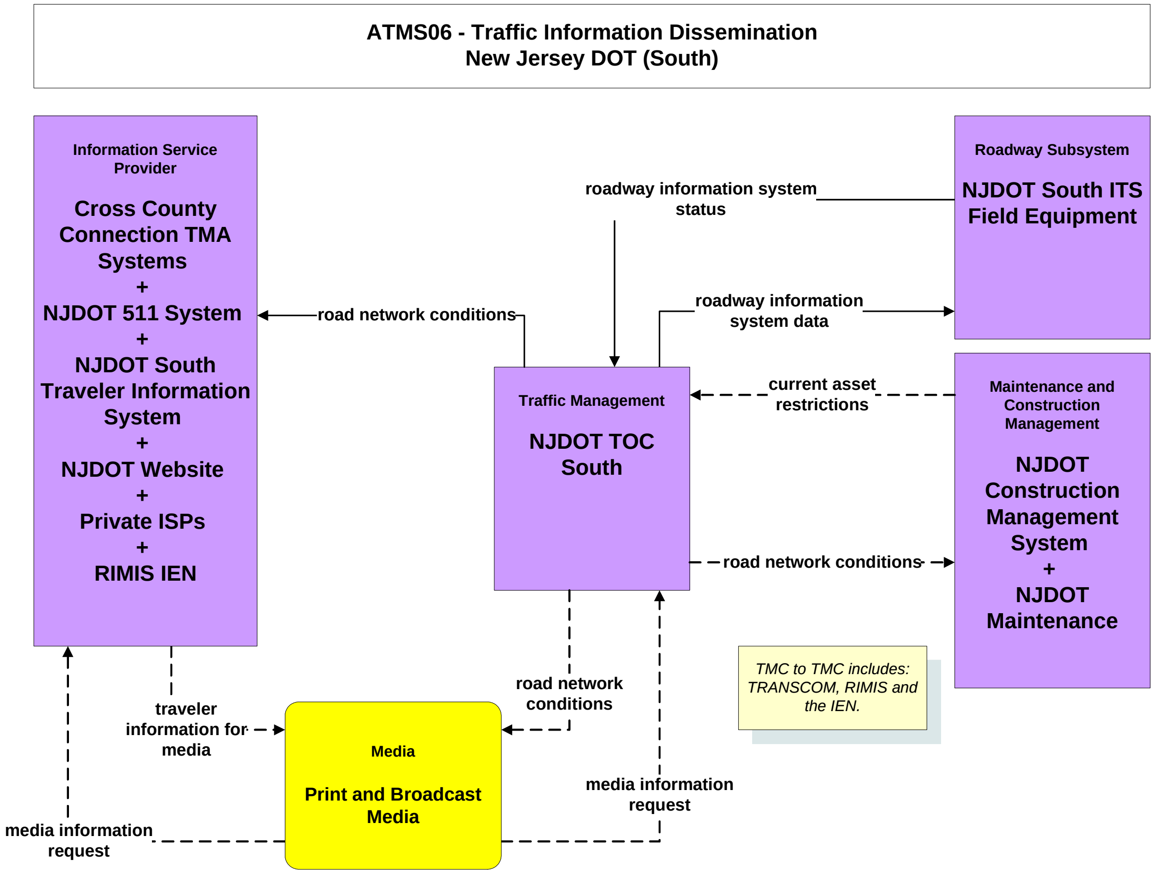
Traffic data is transmitted between NJDOT & SJTA field equipment and the SJTA TOC.

Institutional Agreements

The following agencies agree to share information:

NJDOT

SJTA



Operational Concept

This system facilitates the dissemination of road network information between agencies and to travelers.

Institutional Agreements

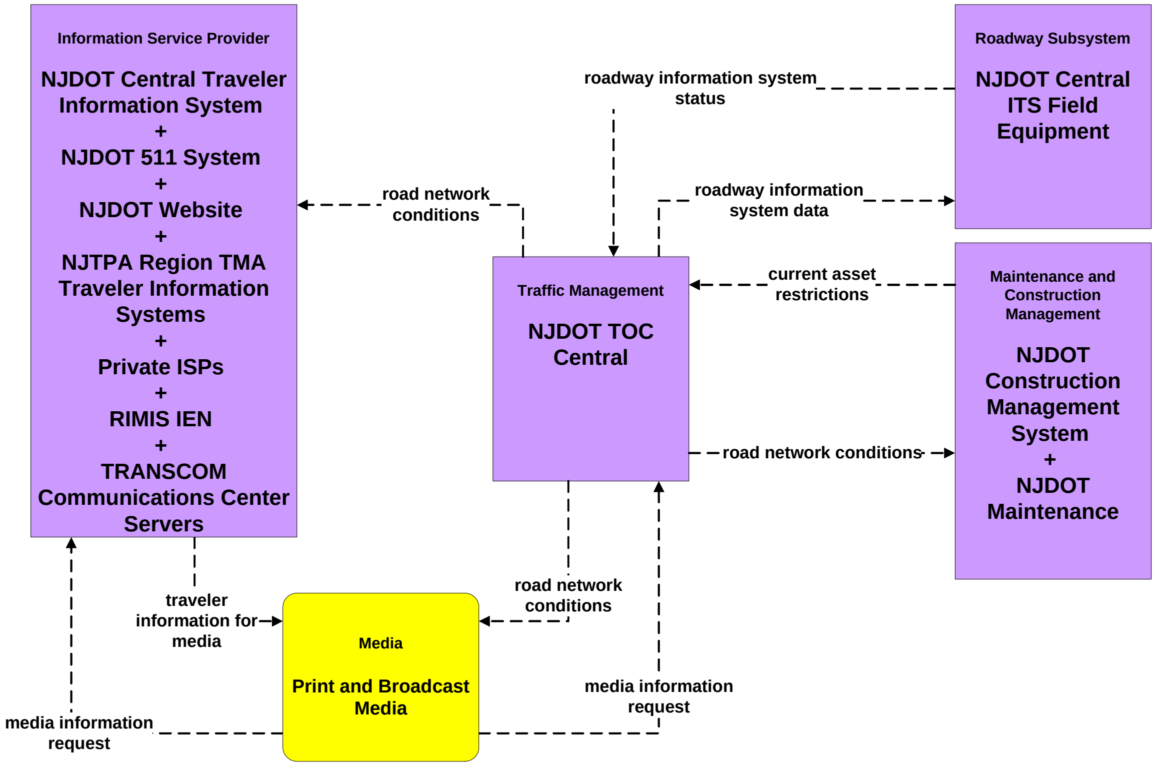
The following agencies agree to share information:

Cross County Connection TMA

NJDOT

RIMIS

ATMS06 - Traffic Information Dissemination
New Jersey DOT (Central)



Operational Concept
This system facilitates the dissemination of road network information between agencies and to travelers.

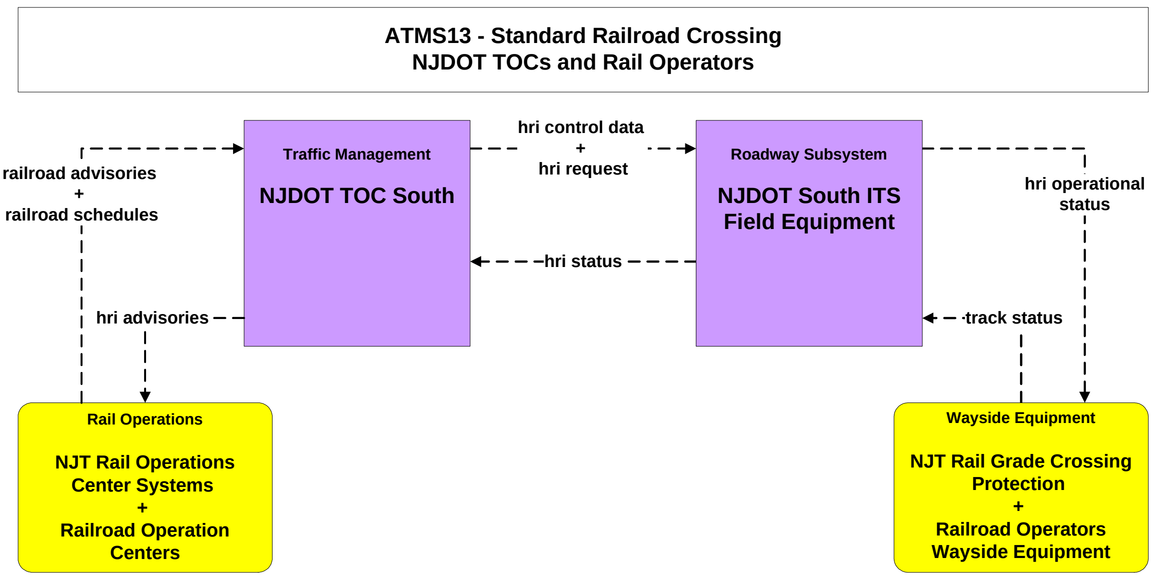
Institutional Agreements
The following agencies agree to share information:

Cross County Connection TMA

NJDOT

TRANSCOM

RIMIS



Operational Concept

Railroad crossing information is transmitted between NJDOT and NJ TRANSIT.

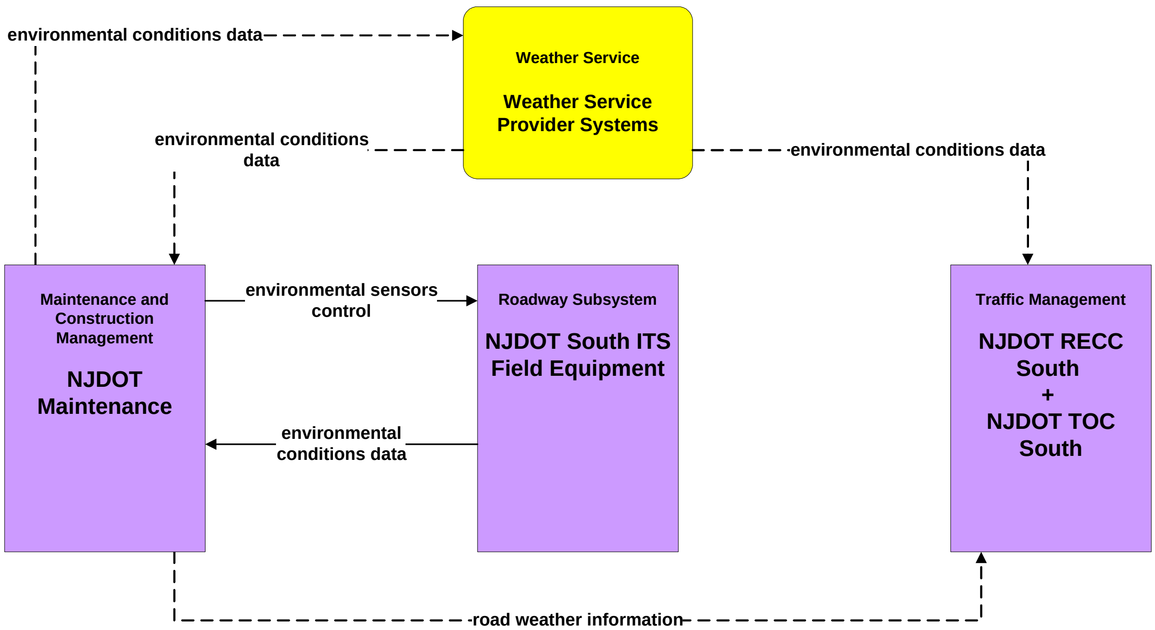
Institutional Agreements

The following agencies agree to share information:

NJDOT

NJ TRANSIT

MC03 - Road Weather Data Collection
New Jersey DOT - South

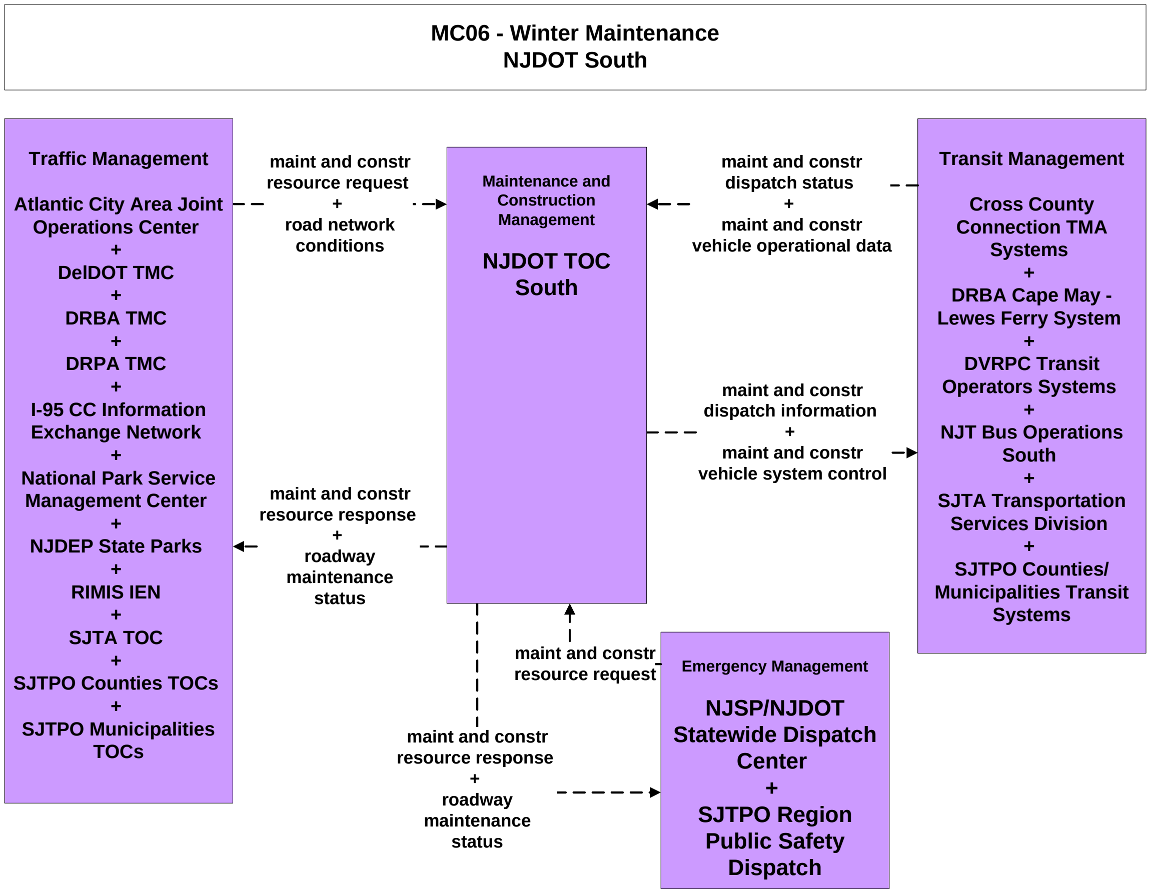


Operational Concept

Road weather data is collected and disseminated.

Institutional Agreements

None required. All ITS elements are under the same institutional entity.



Operational Concept

This system facilitates the transfer of winter maintenance information and road network information.

Institutional Agreements

The following agencies agree to share information:

Atlantic City Joint Operations Center

DelDOT

DRBA

DRPA

I-95 CC

NPS

NJDEP

RIMIS

SJTA

SJTPO Counties/Municipalities TOCs

NJDOT

SJTPO Region Public Safety Dispatch

Cross County Connection TMA

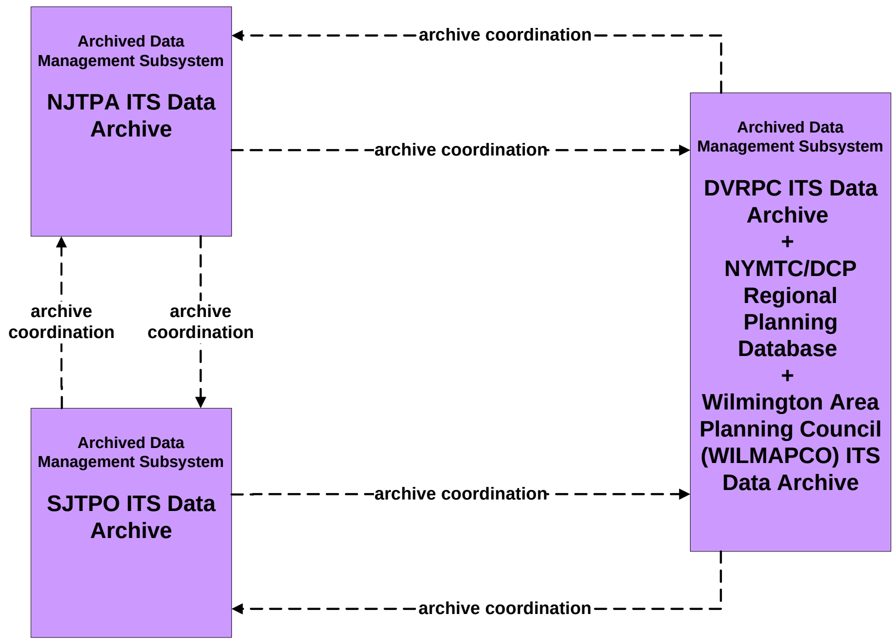
DVRPC Transit Operators

NJ TRANSIT

SJTA Transportation Services Division

SJTPO Counties/Municipalities Transit Systems

AD3 - ITS Virtual Data Warehouse
ITS Data Archives Coordination



Operational Concept

Archive coordination is carried out amongst several agencies.

Institutional Agreements

The following agencies agree to share information:

NJTPA

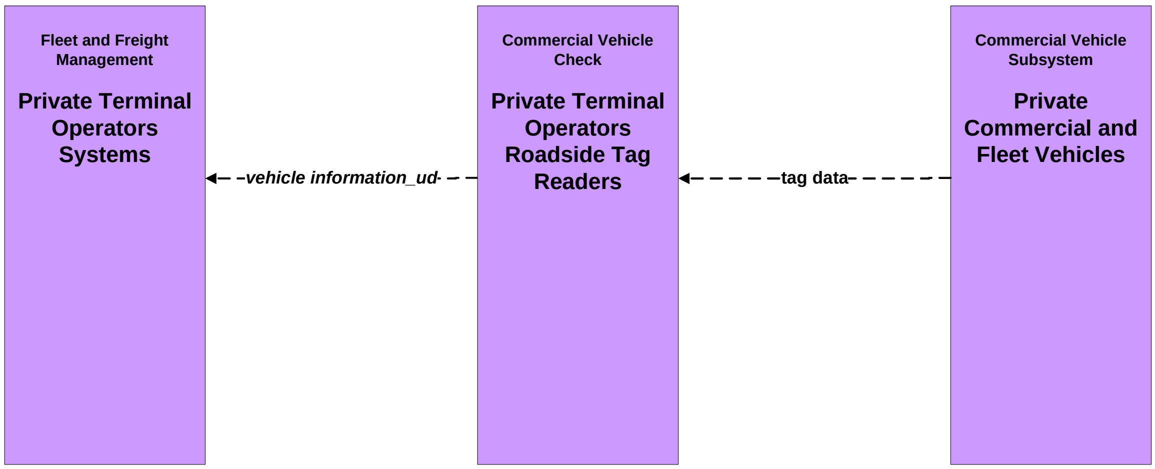
SJTPO

DVRPC

NYMTC

WILMAPCO

CVO01 - Fleet Administration
Private Terminal Operators



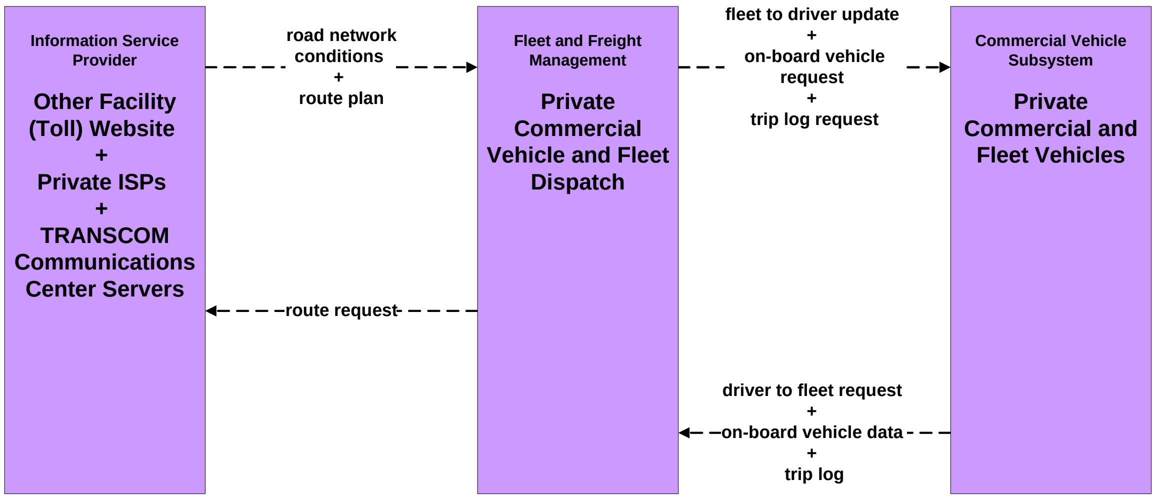
Operational Concept

This system facilitates the management of private fleet vehicles through the use of vehicle tags and roadside tag readers.

Institutional Agreements

None required. All ITS elements are under the same institutional entity.

CVO01 - Fleet Administration
Private Commercial Vehicle and Fleet (Other)



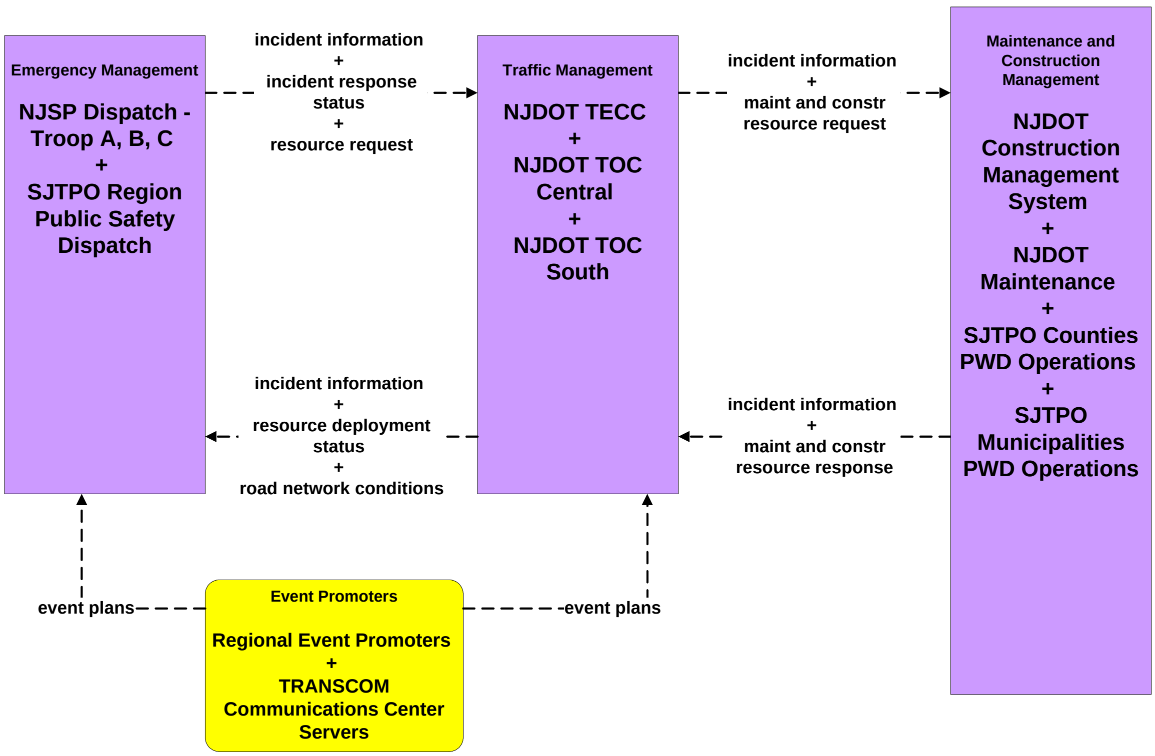
Operational Concept

This system facilitates communication between private operators and their fleets.

Institutional Agreements

None required. All ITS elements are under the same institutional entity.

ATMS08 - Incident Management
New Jersey DOT – SJTPO Region



Operational Concept

This system facilitates the dissemination of incident and response information.

Institutional Agreements

The following agencies agree to share data:

NJSP

SJTPO Region Public Safety Dispatch

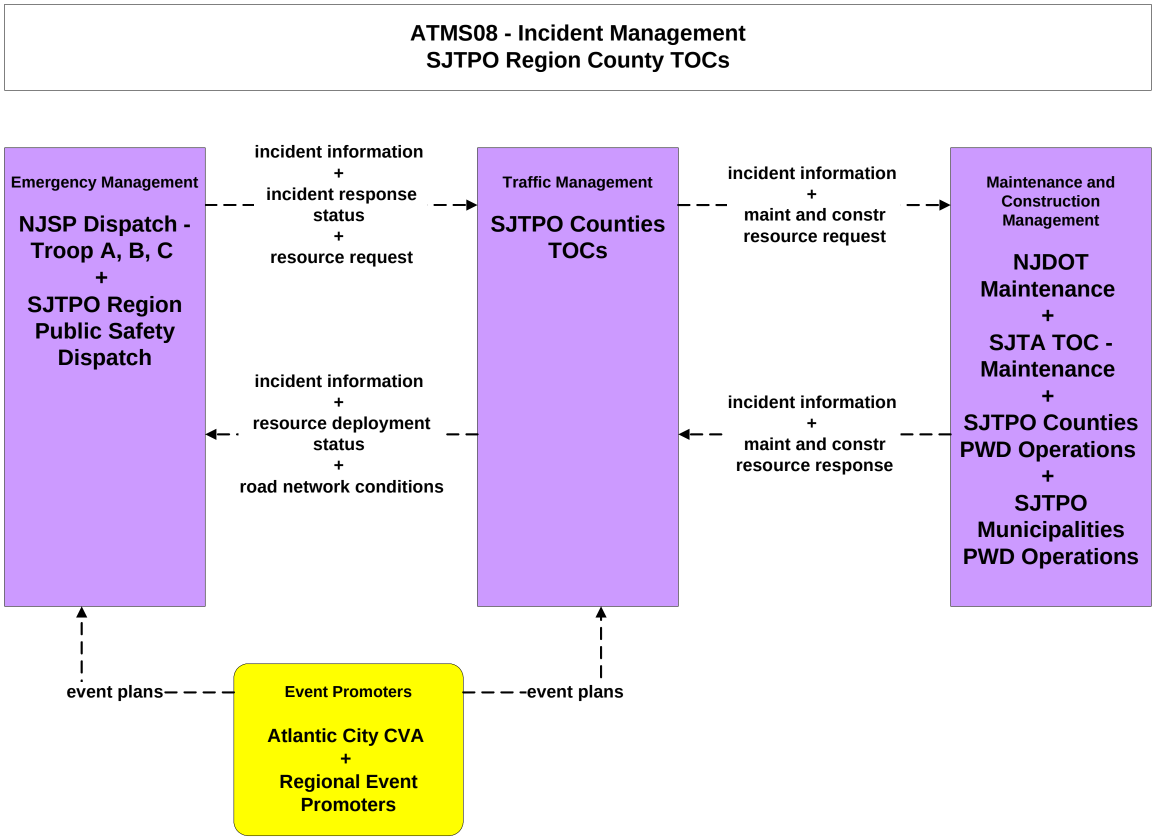
NJDOT

SJTPO Counties/Municipalities

Regional Event Promoters

TRANSCOM

SJTA



Operational Concept

This system facilitates the dissemination of incident and response information.

Institutional Agreements

The following agencies agree to share data:

NJSP

SJTPO Region Public Safety Dispatch

NJDOT

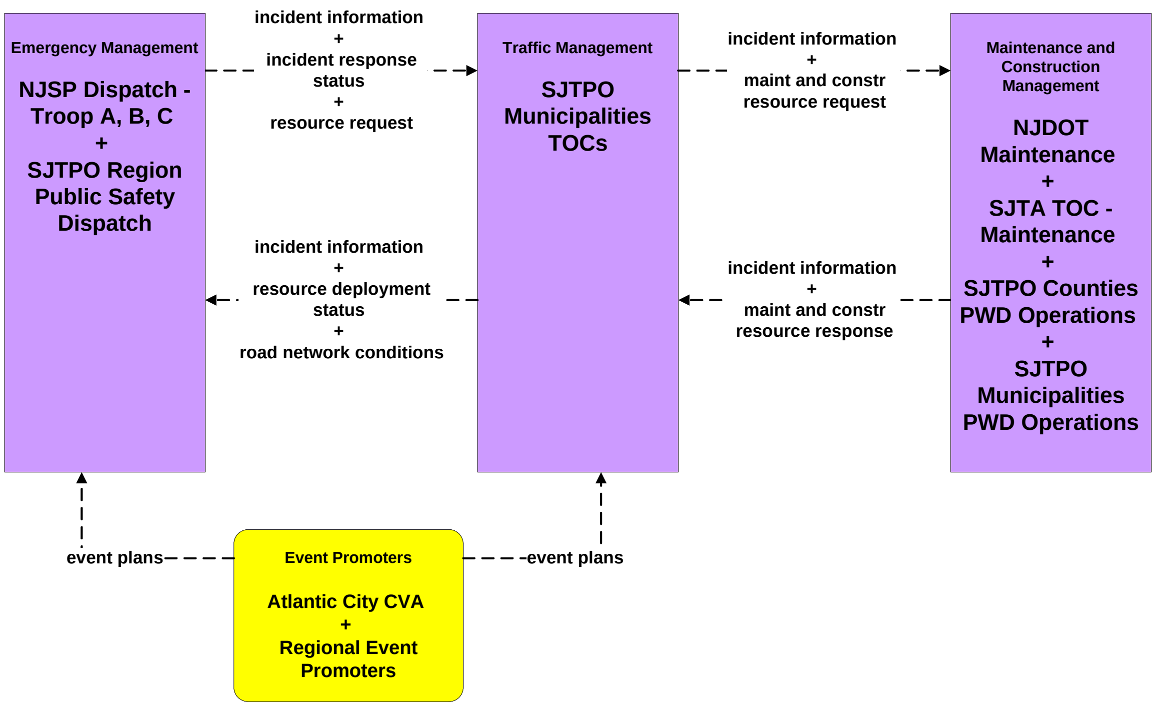
SJTPO Counties/Municipalities

Regional Event Promoters

Atlantic City CVA

SJTA

ATMS08 - Incident Management
SJTPO Region Municipal TOCs



Operational Concept
This system facilitates the dissemination of incident and response information.

Institutional Agreements
The following agencies agree to share data:

NJSP

SJTPO Region Public Safety Dispatch

NJDOT

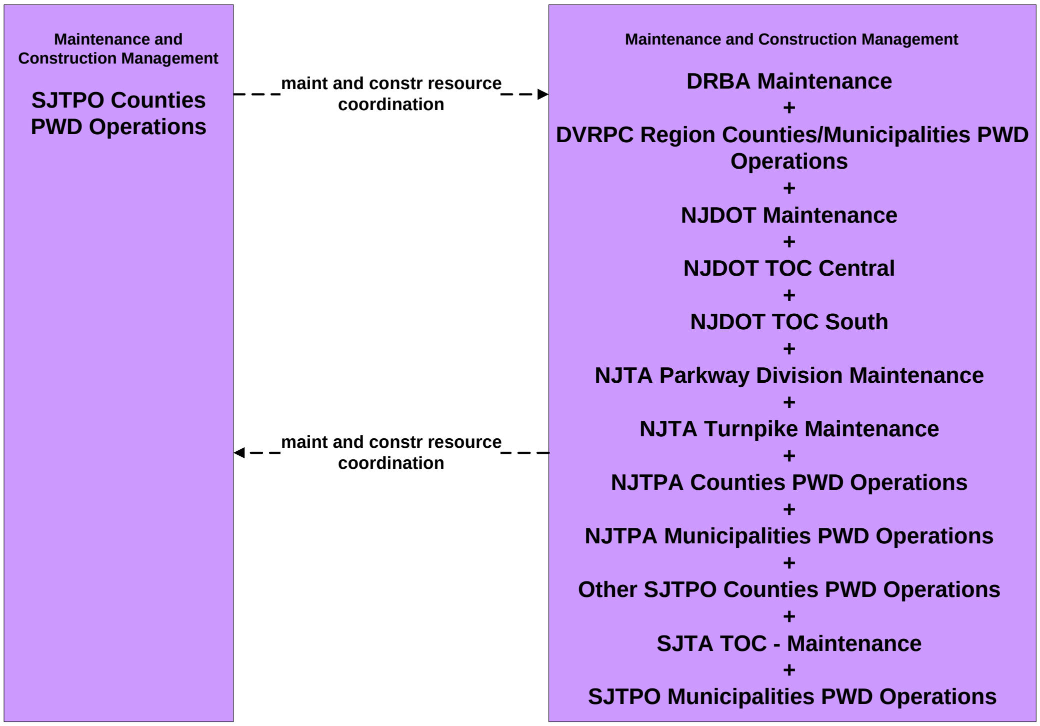
SJTPO Counties/Municipalities

Regional Event Promoters

Atlantic City CVA

SJTA

ATMS08 - Incident Management
SJTPO Counties PWD Operations (MCM – MCM)



Operational Concept

This system facilitates the dissemination of maintenance and construction resource information.

Institutional Agreements

The following agencies agree to share data:

NJDOT

NJTA – Parkway

NJTA – Turnpike

DRBA

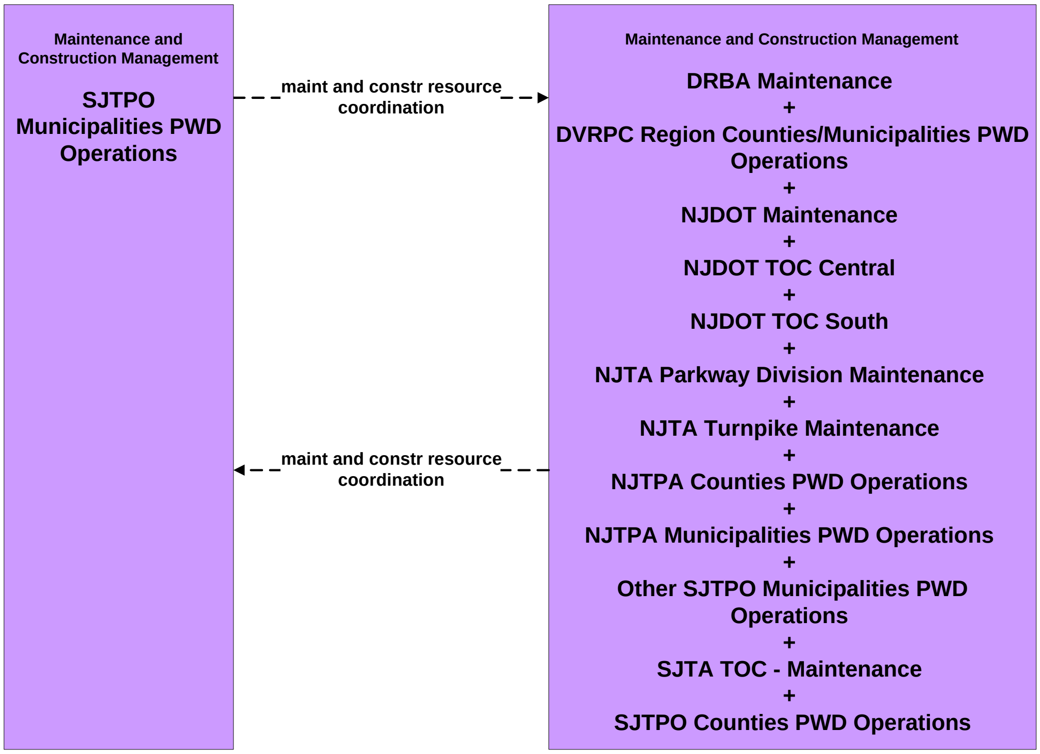
SJTPO Counties/Municipalities

DVRPC Counties/Municipalities

NJTPA Counties/Municipalities

SJTA

ATMS08 - Incident Management
SJTPO Municipalities PWD Operations (MCM – MCM)



Operational Concept

This system facilitates the dissemination of maintenance and construction resource information.

Institutional Agreements

The following agencies agree to share data:

NJDOT

NJTA – Parkway

NJTA – Turnpike

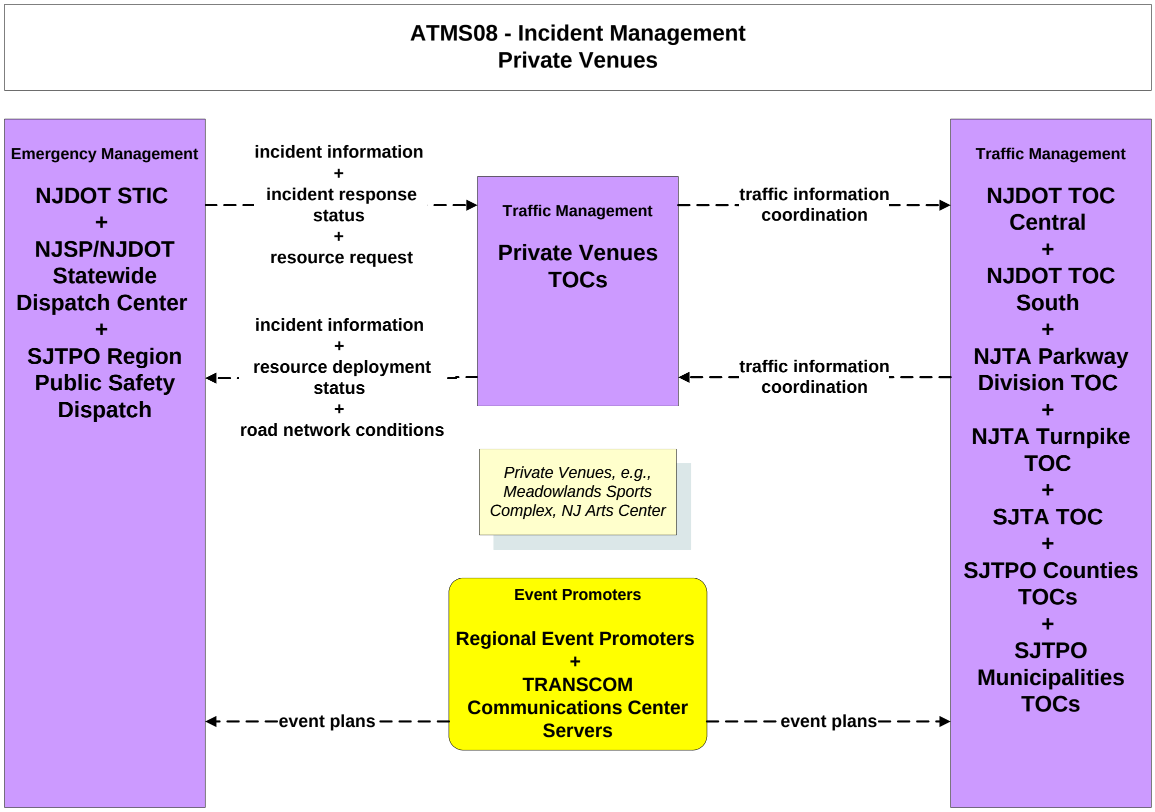
DRBA

SJTPO Counties/Municipalities

DVRPC Counties/Municipalities

NJTPA Counties/Municipalities

SJTA



Operational Concept

This system facilitates the dissemination of incident, response, and event information

Institutional Agreements

The following agencies agree to share data:

NJSP

SJTPO Region Public Safety Dispatch

NJDOT

SJTPO Counties/Municipalities

SJTA

Regional Event Promoters

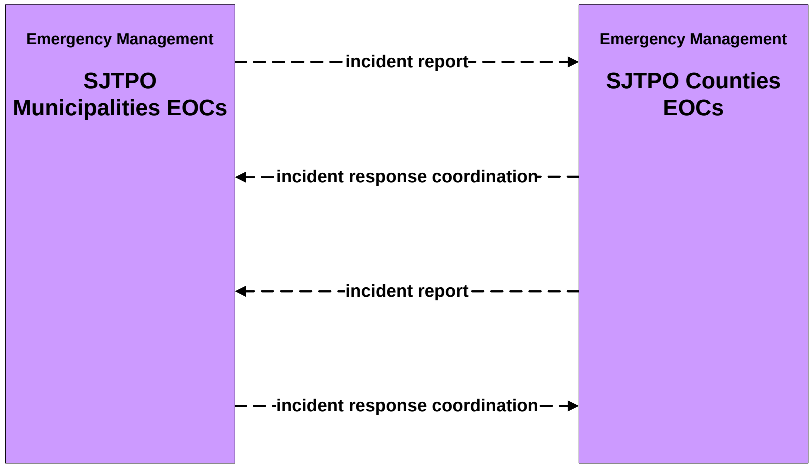
TRANSCOM

NJTA – Parkway

NJTA – Turnpike

Private Venues TOCs

EM01 - Emergency Call-Taking and Dispatch
Municipal EOCs



Operational Concept

Incident response and coordination information is transferred amongst SJTPO counties and municipalities

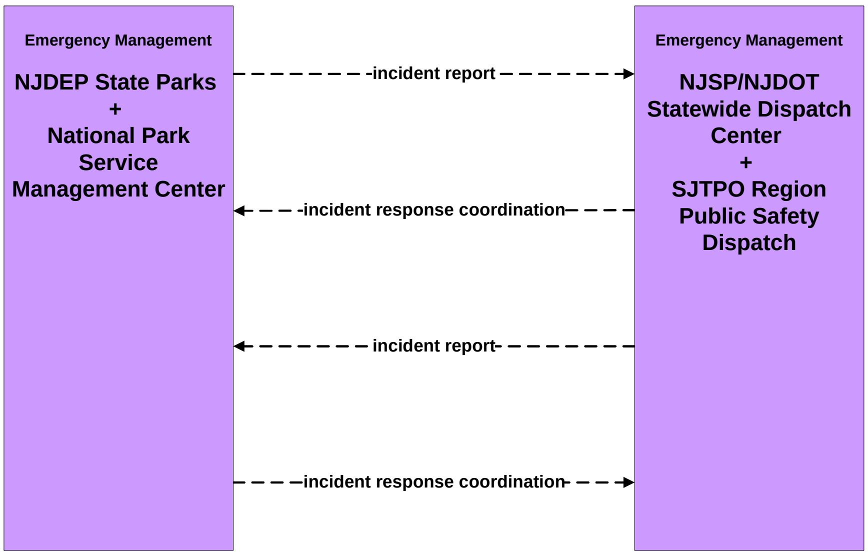
Institutional Agreements

The following agencies agree to share information:

SJTPO Counties

SJTPO Municipalities

EM01 - Emergency Response Coordination
National and State Parks and Local Public Safety



Operational Concept

Incident response and coordination information is communicated amongst NJDEP, NPS and public safety dispatch centers.

Institutional Agreements

The following agencies agree to share information:

NJDEP

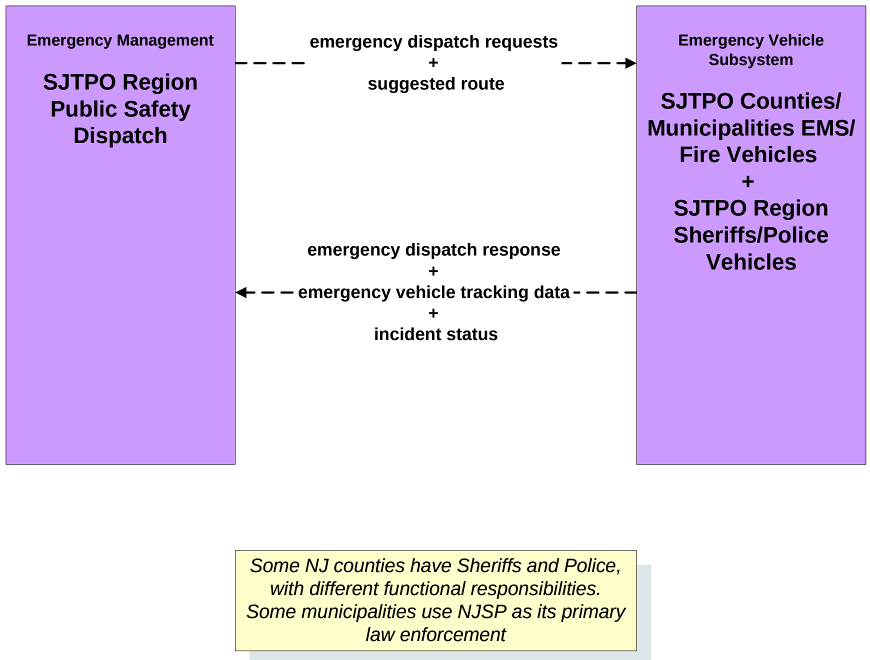
NPS

NJSP

NJDOT

SJTPO Region Public Safety Dispatch

EM02 - Emergency Routing
SJTPO Region Emergency Vehicles



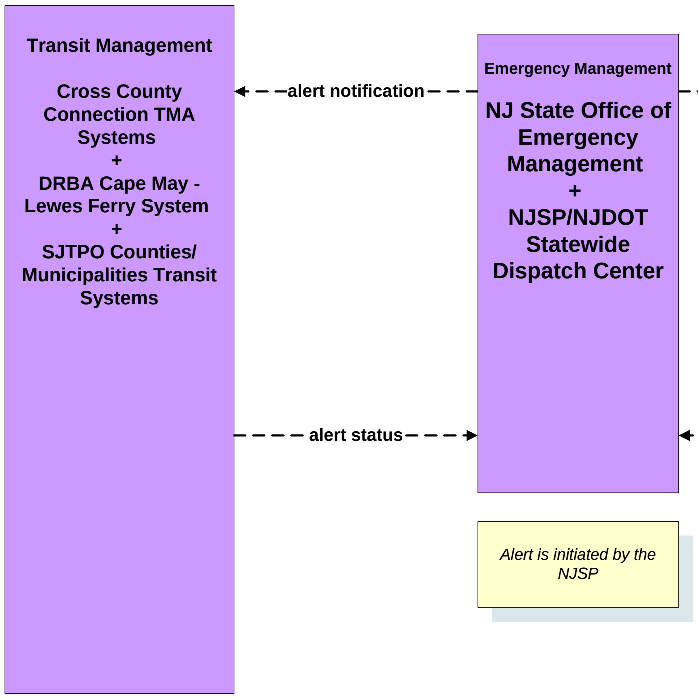
Operational Concept
Emergency dispatch and response information is communicated between public safety dispatch centers and public safety vehicles.

Institutional Agreements
The following agencies agree to share information:

SJTPO Region Public Safety Dispatch

SJTPO Counties/Municipalities

EM06 - Wide-Area Alert
SJTPO Regional Alerts including Amber Alerts



Operational Concept
Wide area alert information is disseminated amongst various agencies.

Institutional Agreements
The following agencies agree to share information:

Atlantic City Joint Operations Center

DelDOT

DRBA

DRPA

RIMIS

SJTA

SJTPO Counties/Municipalities TOCs

NJSP

NJDOT

Cross County Connection TMA

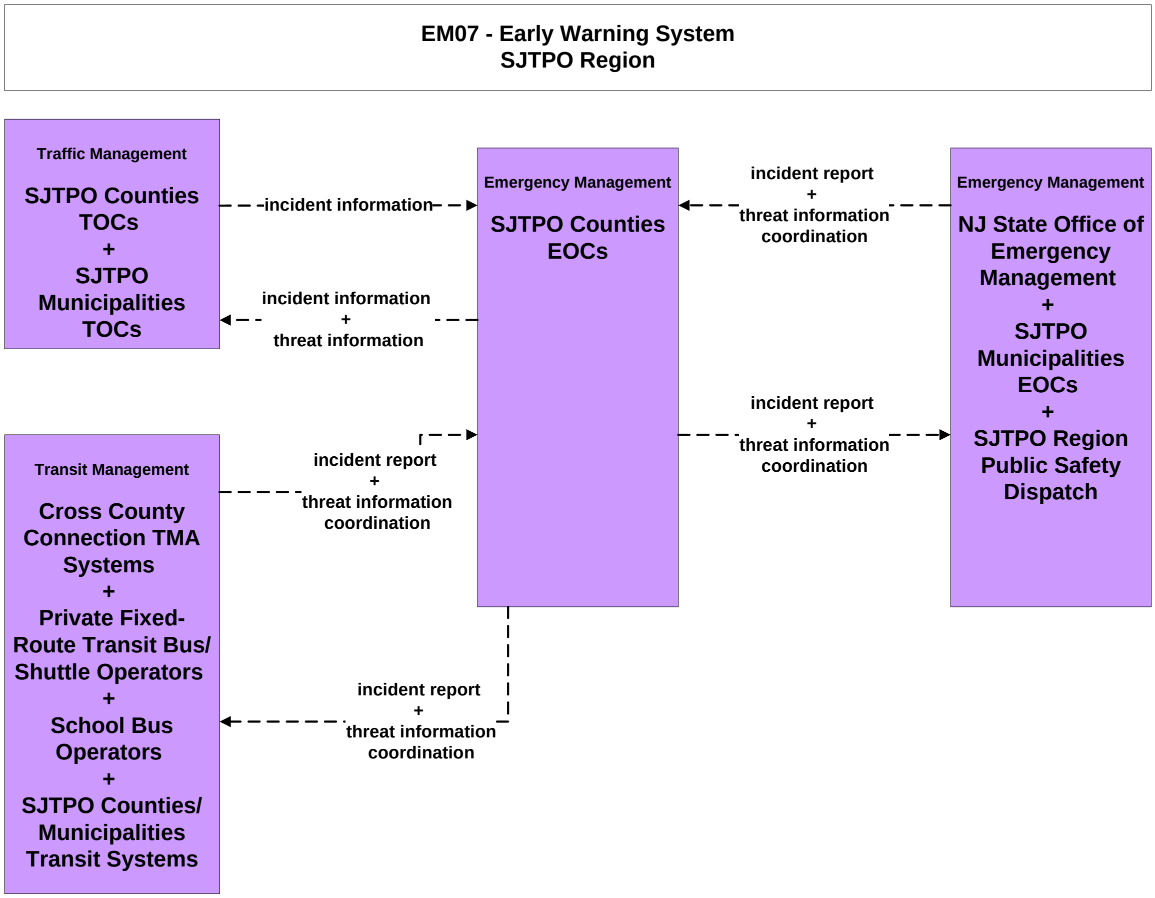
DVRPC Transit Operators

NJ State OEM

NJ TRANSIT

SJTA

SJTPO Counties/Municipalities Transit Systems



Operational Concept

This system facilitates the dissemination of incident report and coordination information.

Institutional Agreements

The following agencies agree to share information:

SJTPO Counties/Municipalities TOCs & EOCs

SJTPO Public Safety Dispatch

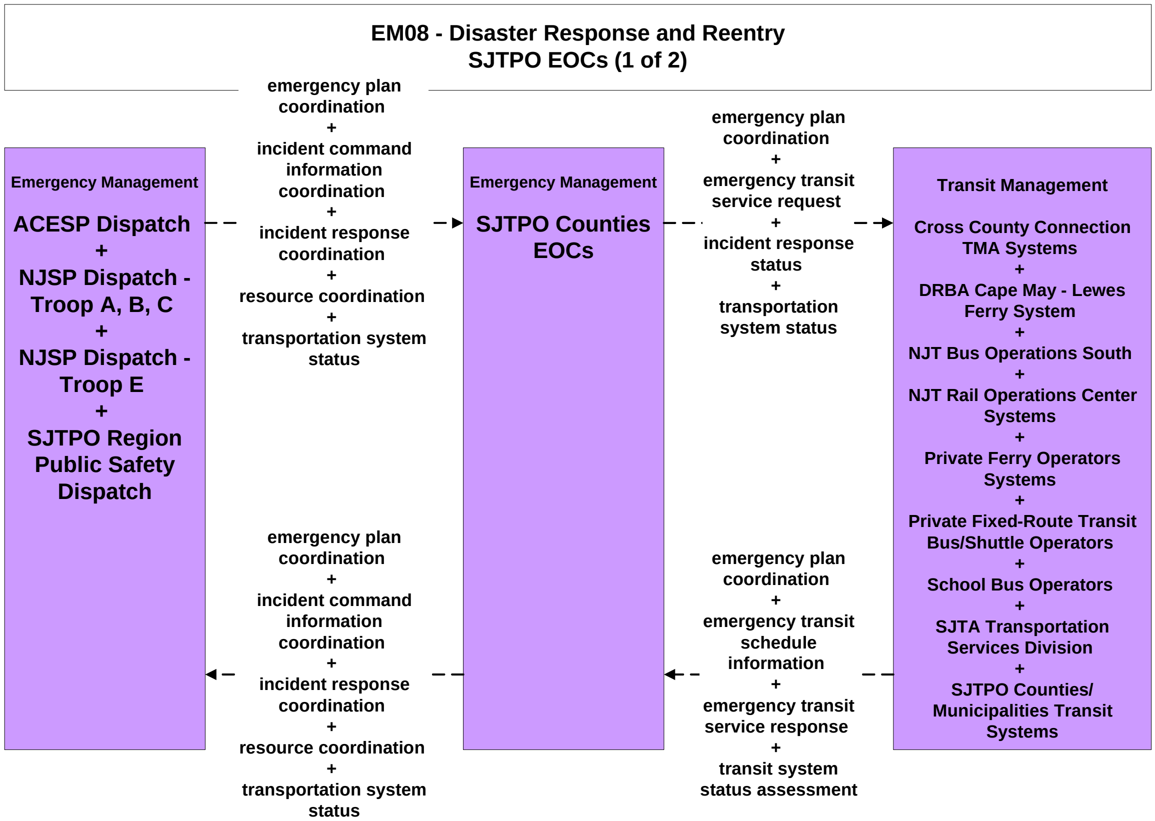
Cross County Connection TMA

SJTPO Counties/Municipalities Transit Systems

Private Fleet Operators

School Bus Operators

NJ State OEM



Operational Concept

This system facilitates the emergency/disaster response and coordination.

Institutional Agreements

The following agencies agree to share information:

SJTPO Counties/Municipalities EOCs

SJTPO Public Safety Dispatch

Cross County Connection TMA

SJTPO Counties/Municipalities Transit Systems

School Bus Operators

DRBA

NJ TRANSIT

Private Ferry Operators

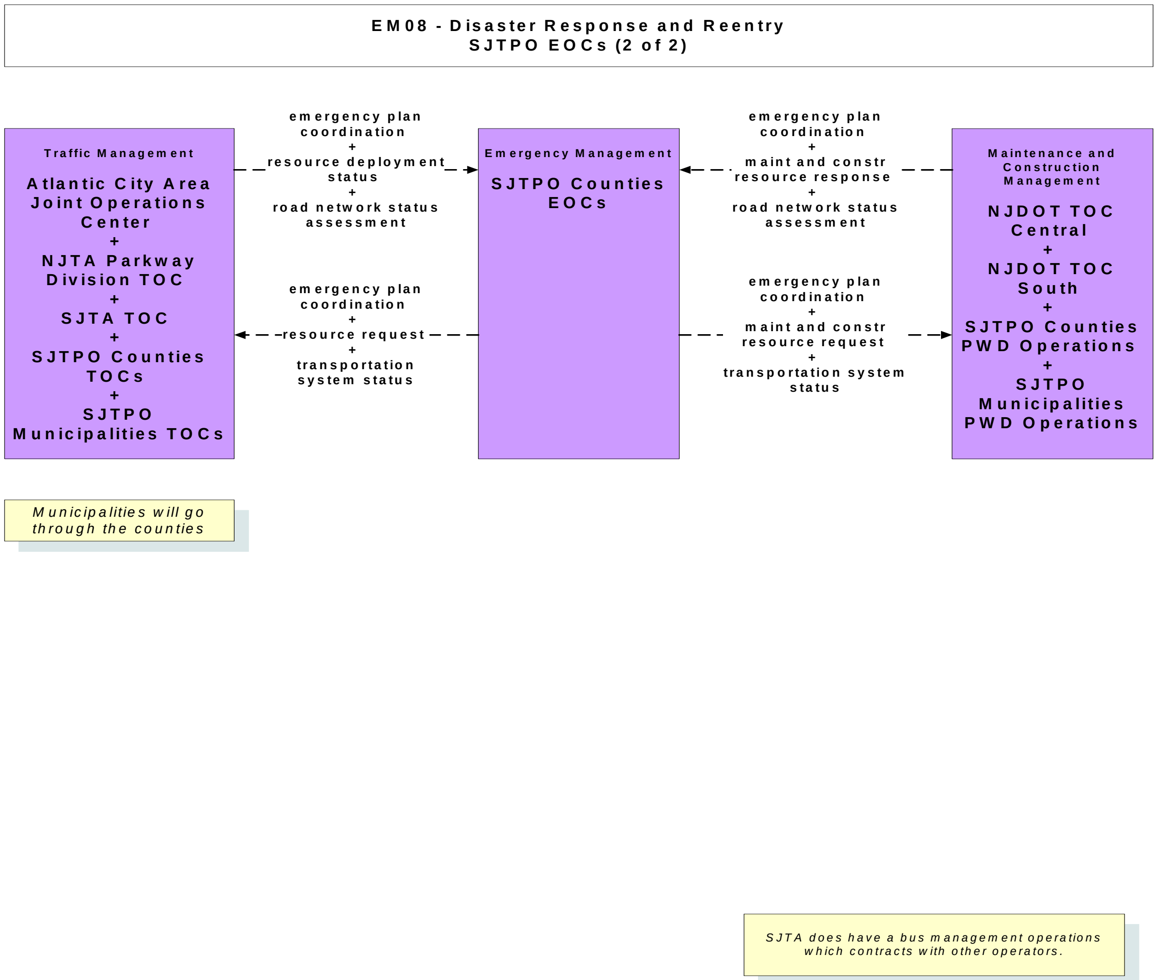
Private Fixed-Route Transit Operators

School Bus Operators

SJTA

ACESP

NJSP



Operational Concept

This system facilitates the emergency/disaster response and coordination.

Institutional Agreements

The following agencies agree to share information:

SJTPO Counties/Municipalities TOCs & EOCs

SJTPO Public Safety Dispatch

SJTPO Counties/Municipalities

SJTA

Atlantic City Area Joint Operations Center

NJSP

NJTA – Parkway

NJDOT

8 Functional Requirements

8.1 Introduction

An ITS Architecture is a functional architecture. The information exchanged between ITS elements in the architecture is driven by functions resident in each of the elements defined in the architecture. The functions describe the tasks or activities performed by the ITS elements and "what" is done with the information received by the element. To define projects that implement various portions of the ITS Architecture, functional requirements must be derived from the functions to translate the functional descriptions into designs to be built.

To illustrate functions and functional requirements, the ITS element NJDOT STIC is used as an example. In the Southern region, the NJDOT STIC is mapped to the Traffic Management subsystem in the National ITS Architecture. A functional area for the NJDOT STIC is TMC Traffic Information Dissemination. A description of this functional area and examples of requirements that support this functional area are shown below:

Functional Area: TMC Traffic Information Dissemination

> Controls dissemination of traffic-related data to other centers, the media, and travelers via the driver information systems (DMS, HAR) that it operates.

Requirement: 1 The center shall remotely control dynamic messages signs for dissemination of traffic and other information to drivers.

Requirement: 2 The center shall remotely control driver information systems that communicate directly from a center to the vehicle radio (such as Highway Advisory Radios) for dissemination of traffic and other information to drivers.

This document defines the functions and functional requirements for each ITS element in the SJTPO Regional ITS Architecture.

8.2 Process For Selecting Functional Requirements

The functional requirements identified for the SJTPO Regional ITS Architecture are based on stakeholder needs and ITS services planned for the Southern region. Numerous workshops were held to obtain a thorough understanding of the needs and services of the Southern region. The needs and services were translated into customized market packages that describe the desired transportation services for the Southern region. The customized market packages were used to create ITS projects that will address the goals and objectives for the Southern region.

Using Turbo Architecture™, functional requirements that support the ITS projects for the SJTPO region were selected. These functional requirements are listed in the Appendix 8.A. of this document.

The Appendix section displays the following information for each element:

- **Element.** Name of the system that will be performing the function
- **Entity.** Describes the National ITS Architecture subsystem to which the element is mapped
- **Functional Area.** Description of the function performed by the element
- **Requirement.** High-level functional requirement to be performed by the element supporting the functional area

8.3 How To Use The Functional Requirements

Functional requirements are an integral part of ITS project implementation. Figure 8-1 illustrates how stakeholders should use the functional requirements identified in their ITS architecture. As stated in the Integration Strategy document, the SJTPO Regional ITS Architecture will be used to identify ITS projects for the region. Through the planning process, funding is allocated to ITS projects. ITS projects that are funded for deployment must go through a project development or implementation process that seeks to systematically deploy ITS to reduce costly redesign risks. The ITS Architecture provides a bigger picture of how a project fits or interfaces with other elements in the region. The functional requirements derived from the ITS element functions in the ITS Architecture define what the project must do to satisfy its objectives and maximize integration opportunities. Functional requirements describe high-level activities and are not detailed design requirements. They guide the formulation of high-level requirements identified in the project implementation process. These requirements can be used as a tool to:

- reach a common understanding among stakeholders about what a project must do,
- initiate the definition of high-level requirements in the project implementation process,
- and define a project's scope.

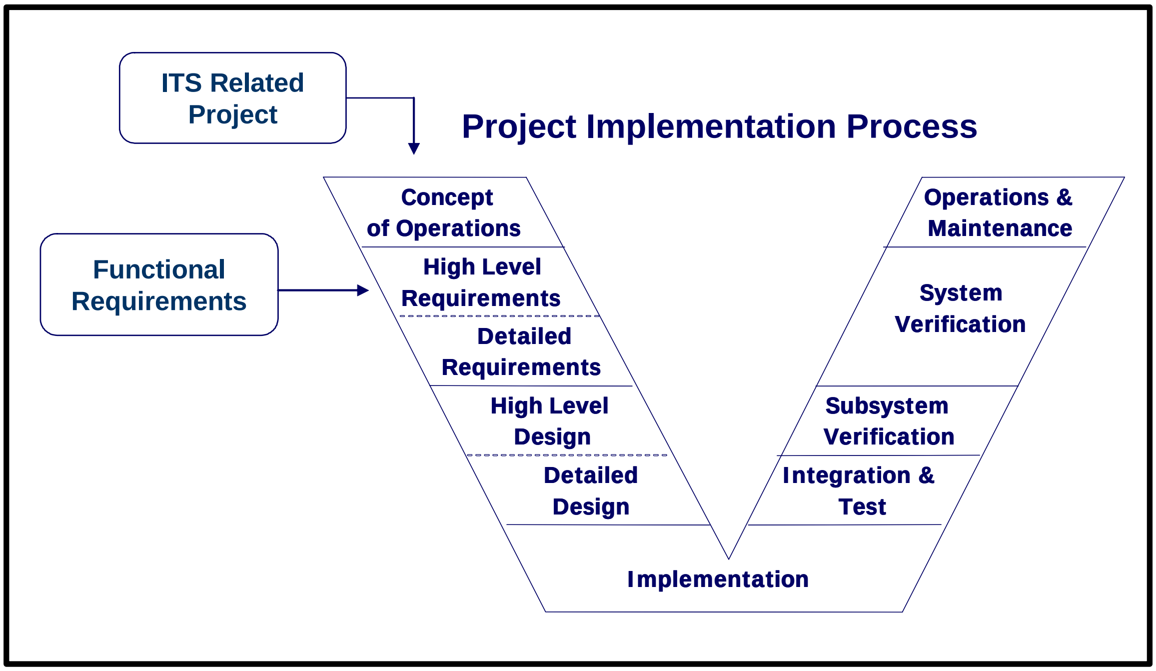


Figure 8-1. Functional Requirements Use

An example of a functional requirement in the ITS Architecture would be in the area of TMC Freeway Management. In this example, the TMC Freeway Management functional area is described and it is followed by a list of requirements that support that functional area as seen below.

Functional Area: TMC Freeway Management

Remotely controls ramp meters, mainline metering, and lane controls on freeways based on upstream and downstream traffic flow and ramp queue length algorithms. The center shall remotely control systems to manage use of the freeways, including ramp meters, mainline metering, and lane controls.

Requirement: 1 The center shall collect operational status from ramp meters, mainline metering, and lane controls and compare against the control information sent by the center.

Requirement: 2 The center shall collect fault data from ramp meters, mainline metering, and lane controls.

Requirement: 3 The center shall implement control strategies, under control of center personnel, on some or all of the freeway network devices (e.g. ramp meters, mainline metering, and lane controls), based on data from sensors monitoring traffic conditions upstream, downstream, and queue data on the ramps themselves.

Requirement: 4 The center shall implement control strategies, under control of center personnel, on some or all of the freeway network devices (e.g. ramp meters, mainline metering, and lane controls), based on data from sensors monitoring traffic conditions upstream, downstream, and queue data on the ramps themselves.

In Project Implementation Process, one of the most important steps is the definition of requirements. This process begins with the development of a Concept of Operations document that yields a broad view of the project's operational perspective from which requirements are derived. In the High-Level Requirements step, a set of requirements for the project are generated that provide a starting point for further refinement. This approach is indicative of the systems engineering process in that high level information is continually broken down or decomposed into more detailed or lower-level data. The ITS Architecture-generated Functional Requirements can be inserted as High-level Requirements that can serve as the starting point for this refinement process.

Stakeholders are encouraged to tailor their functional requirements to more closely match the desired operations of the systems in their region. Stakeholders should participate in the tailoring of functional requirements so that functions are accurately defined and stakeholders are motivated to support the requirements that will be levied on their systems.

Using the functional requirements as described in Figure 8-1 will aid stakeholders in understanding ITS projects planned for deployment and support integration efforts throughout the Southern region.

9 Interfaces and Interconnects

9.1 *Introduction*

This chapter focuses on system interconnects and interfaces. A system interconnect answers the question, "What ITS elements are connected?" A system interface answers the question, "What information and control exchanges (existing and planned) occur between ITS Elements?" Interconnects define the system connections required to implement ITS services within a region, ultimately through projects. Perhaps the most important interconnects to consider are those between ITS elements of different stakeholders as these delineate institutional boundaries that must be bridged, whether through formal or informal agreements, to accomplish system interconnectivity in projects.

This chapter is organized as follows:

- **Description.** Provides introductory and background information about this section, a definition for system interconnects and interfaces.
- **Importance.** Provides a brief explanation of the purpose and need for system interconnects and interfaces.
- **Documentation.** Provides a description of how system interconnects and interfaces are documented within the ITS Architecture and how to access, interpret, and use the information.

9.2 *Description*

System interfaces define high level information sharing requirements of systems. As shown in Section 6 of this report, market packages reflect the information sharing requirements of systems in graphical form through the depiction of architecture flows, sold or dashed arrows which indicate the type of information being exchanged and the direction of movement of the information.

9.2.1 Technical Approach

The consultant team first systematically identified the existing and future inventory of stakeholder elements. Next, the consultants identified user needs, generic ITS services, and developed customized market packages as identified by the stakeholders. This customization identified information exchange at the architecture flow level. Finally, a roll-up of all information exchange requirements at the architecture flow level for each subsystem level entity was reviewed with stakeholders.

System interfaces were refined through the process of editing of the customized market package diagrams. Where stakeholders defined a need for information or control exchange, an architecture flow was placed between system elements. Where no need was identified, the architecture flows were removed. And, where new local requirements were identified, outside of the scope of the National ITS Architecture, new architecture flows were created and documented.

9.2.2 Summary Statistics

The New Jersey ITS Architectures contain 2346 interconnects, separate connections between systems, and 9593 interfaces, equivalent to the number of architecture flows counted. An analysis of the architecture database reflects the following summary statistics.

Interconnect/Interface	Statewide	NJTPA	SJTPO	All
Interconnects	1001	902	847	2346
Interfaces	3973	3362	2923	9593

Table 9-1. Number of Interconnects and Interfaces by ITS Architecture

9.3 Importance

The focus of the ITS Architecture is on external interfaces between ITS elements. This focus on external interfaces acknowledges that usually the most difficult and time consuming barrier to deployment of interoperable ITS elements in a region or country is achieving the institutional agreement between stakeholders to exchange specific information between specific ITS elements. An objective of the New Jersey ITS Architectures is to specifically identify these information exchange requirements very early in the process of deployment, so that the time consuming process of achieving prerequisite institutional agreements can proceed as early as possible.

Moreover, identification of common interfaces of systems in a region provides opportunities for standardization of these interfaces resulting in improved interoperability of systems within the region.

9.4 Documentation

9.4.1 Turbo Architecture Documentation

Turbo Architecture is a useful tool for analysis of interconnects and system interfaces, and provides various reporting features, including:

- Interconnect Diagram
- Context Flow Diagram
- Interface Diagram
- Interconnects Screen
- Interfaces Screen

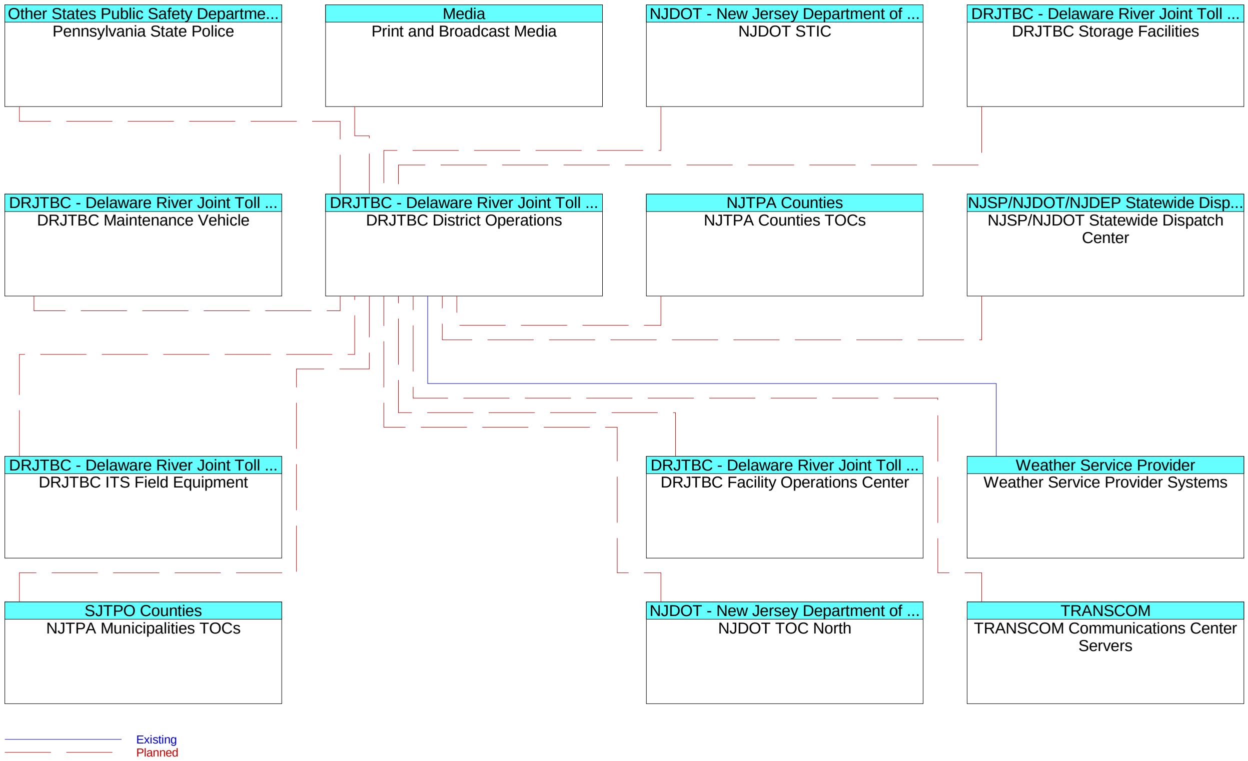


Figure 9-1. Sample Interconnect Diagram in Turbo Architecture

The Interconnect Diagram shows one ITS element in the center surrounded by the other ITS elements with which the ITS element is connected. An example is shown in the figure above.

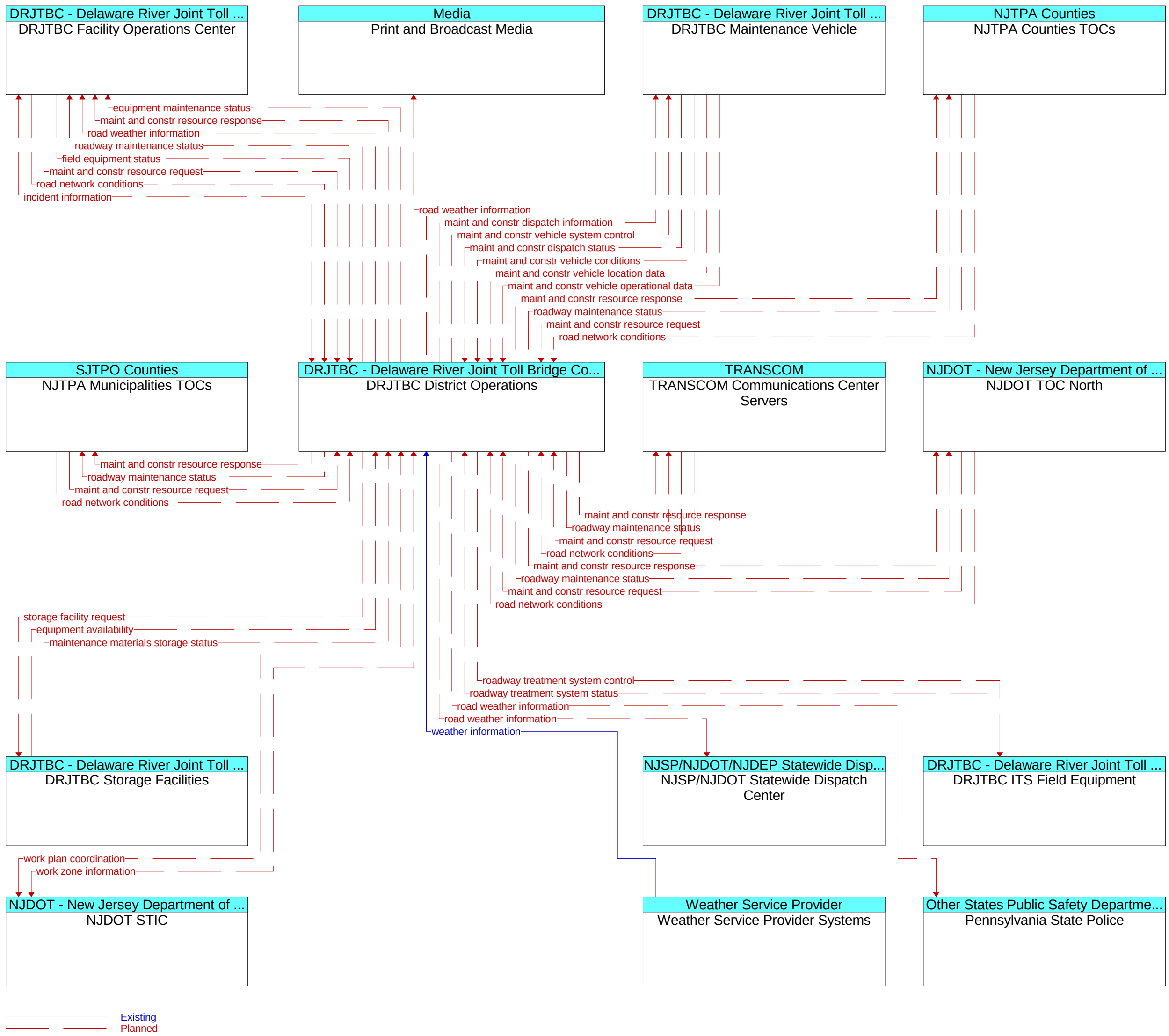


Figure 9-2. Sample Context Flow Diagram in Turbo Architecture

The Context Flow Diagram shows one ITS element in the center surrounded by the other ITS elements with which the ITS element is connected plus each architecture flow used in information and control exchanges. A sample Context Flow Diagram is shown in the figure above.

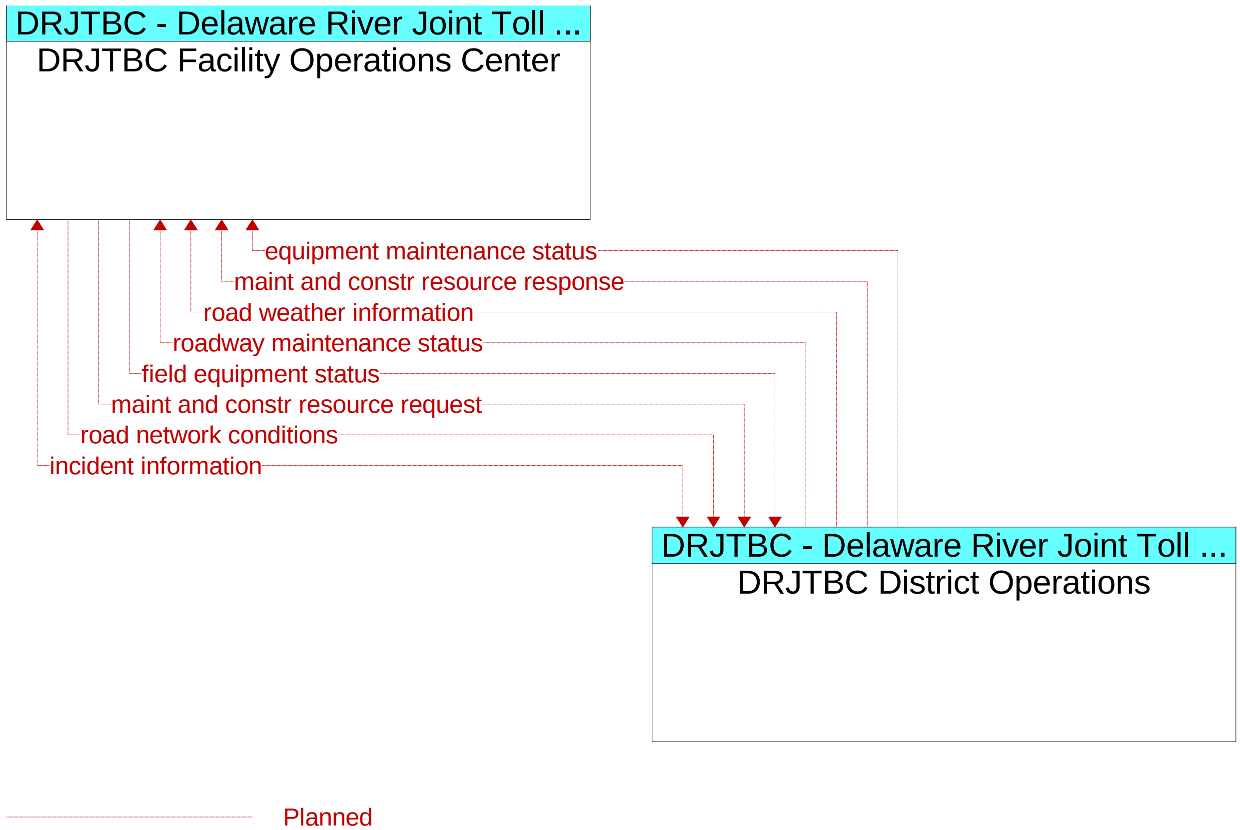


Figure 9-3 Sample Interface Diagram in Turbo Architecture

Depending on the number of elements shown, this diagram may look cluttered. The Turbo tool allows the user to zoom in for a more detailed view of the image on the screen. Likewise, on the web site, each diagram is stored in PDF format, which allows the user to zoom in.

The Interface Diagram shows 2 ITS elements plus each architecture flow used in information and control exchanges. An example Interface Diagram is shown in the figure above.

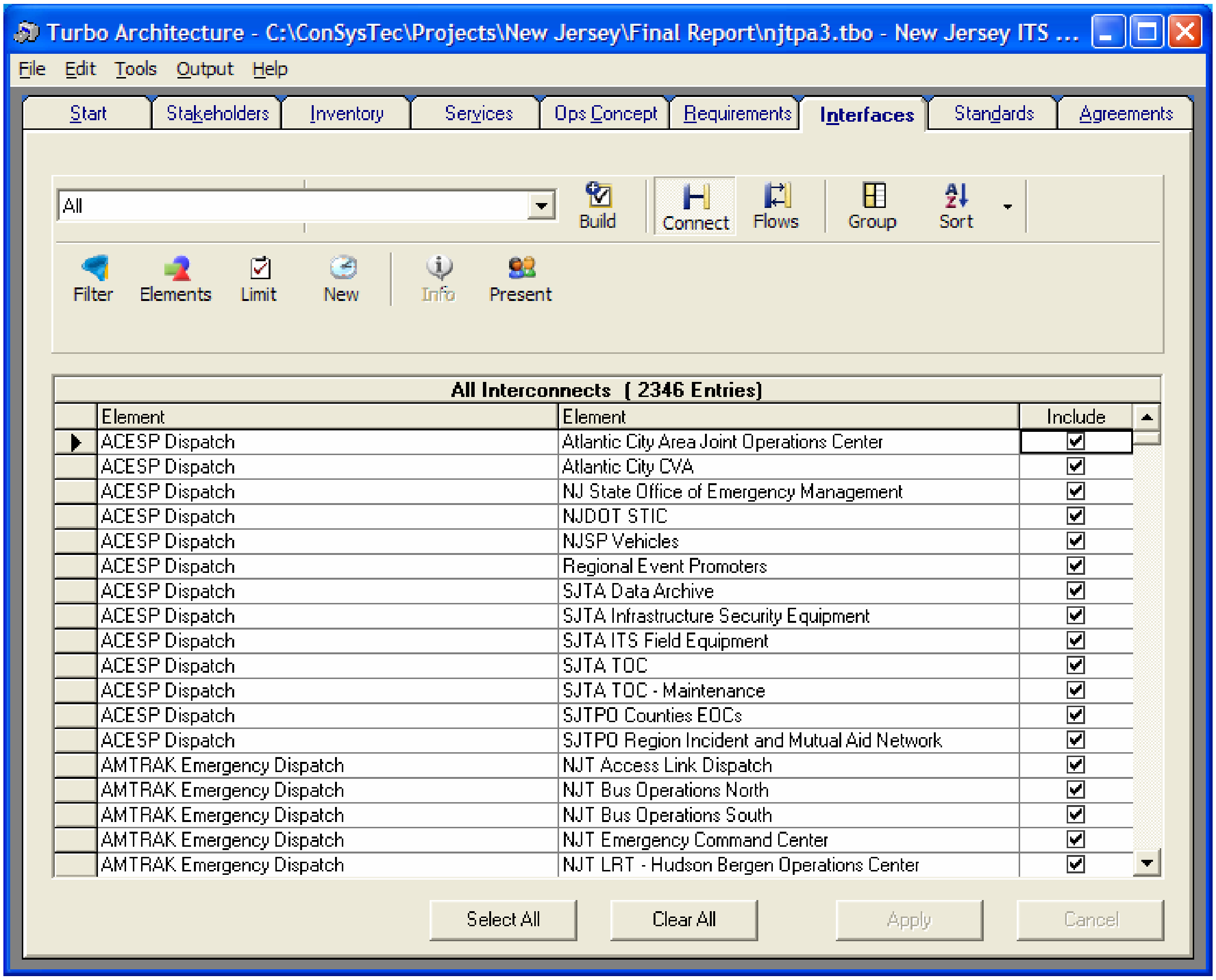


Figure 9-4. Sample System Interconnects Screen in Turbo Architecture

The Turbo Architecture Interconnects Screen shows in tabular form a list of all system interconnects sorting by first element and then interfacing element in alphabetical order. The list can also be sorted to only show the interconnects for a specific ITS element. An example is shown in the figure above.

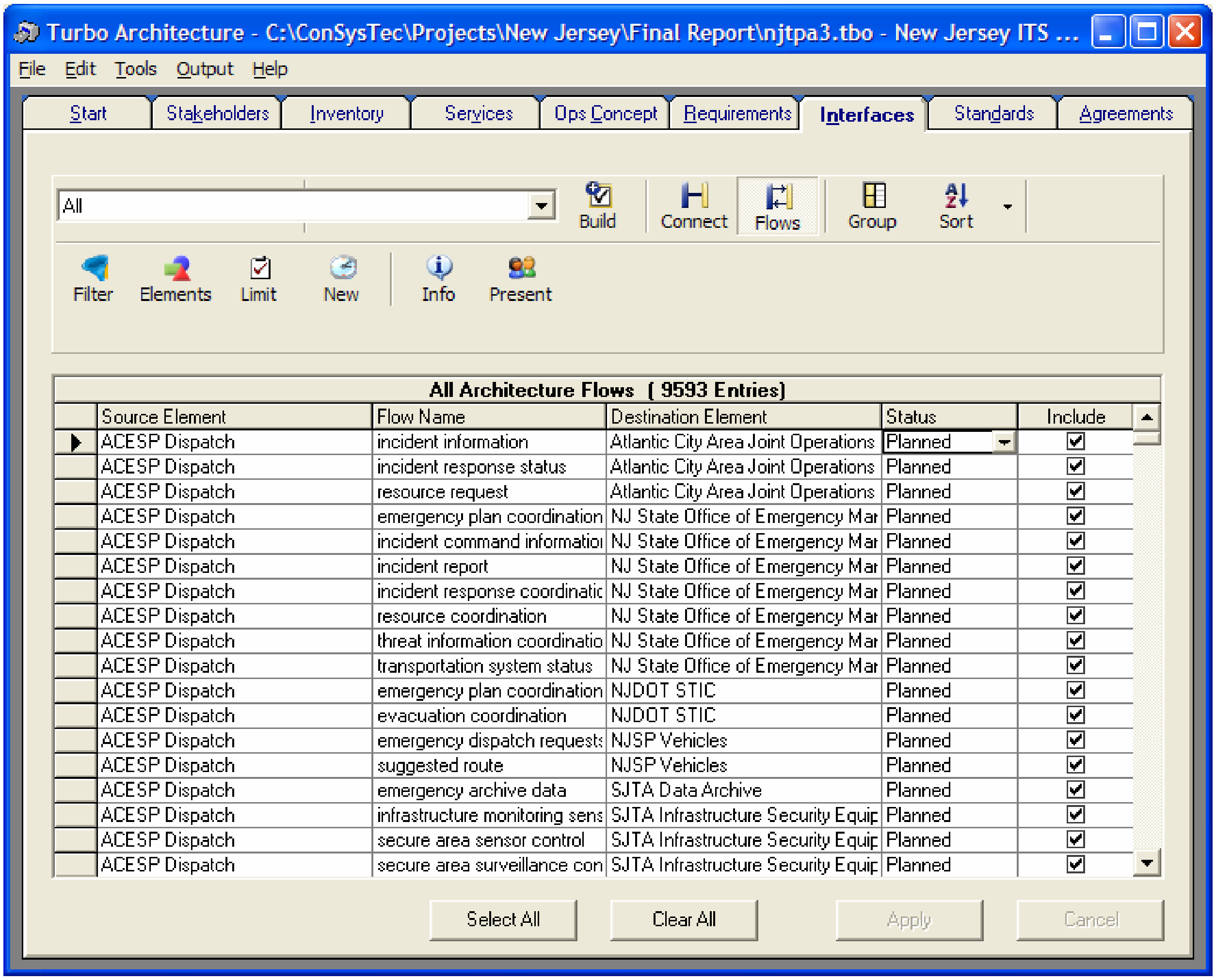


Figure 9-5. Sample System Interfaces Screen in Turbo Architecture

The Turbo Architecture Interfaces Screen shows in tabular form a list of all system interfaces sorting by first element and then interfacing element in alphabetical order, and flow from the first element to the interfacing element. Each entry also specifies whether the architecture flow is planned / future or existing. The list can also be sorted to only show the system interfaces for a specific ITS element. This is shown in the figure above.

9.4.2 Web Site Documentation

The primary method of documenting the system interfaces on the web site is through the customized market package diagrams. A discussion of market packages, and examples, is included in Section 6 of this report. A more detailed discussion of architecture flows in Section 7 of this report includes a discussion of the information exchanges between systems.

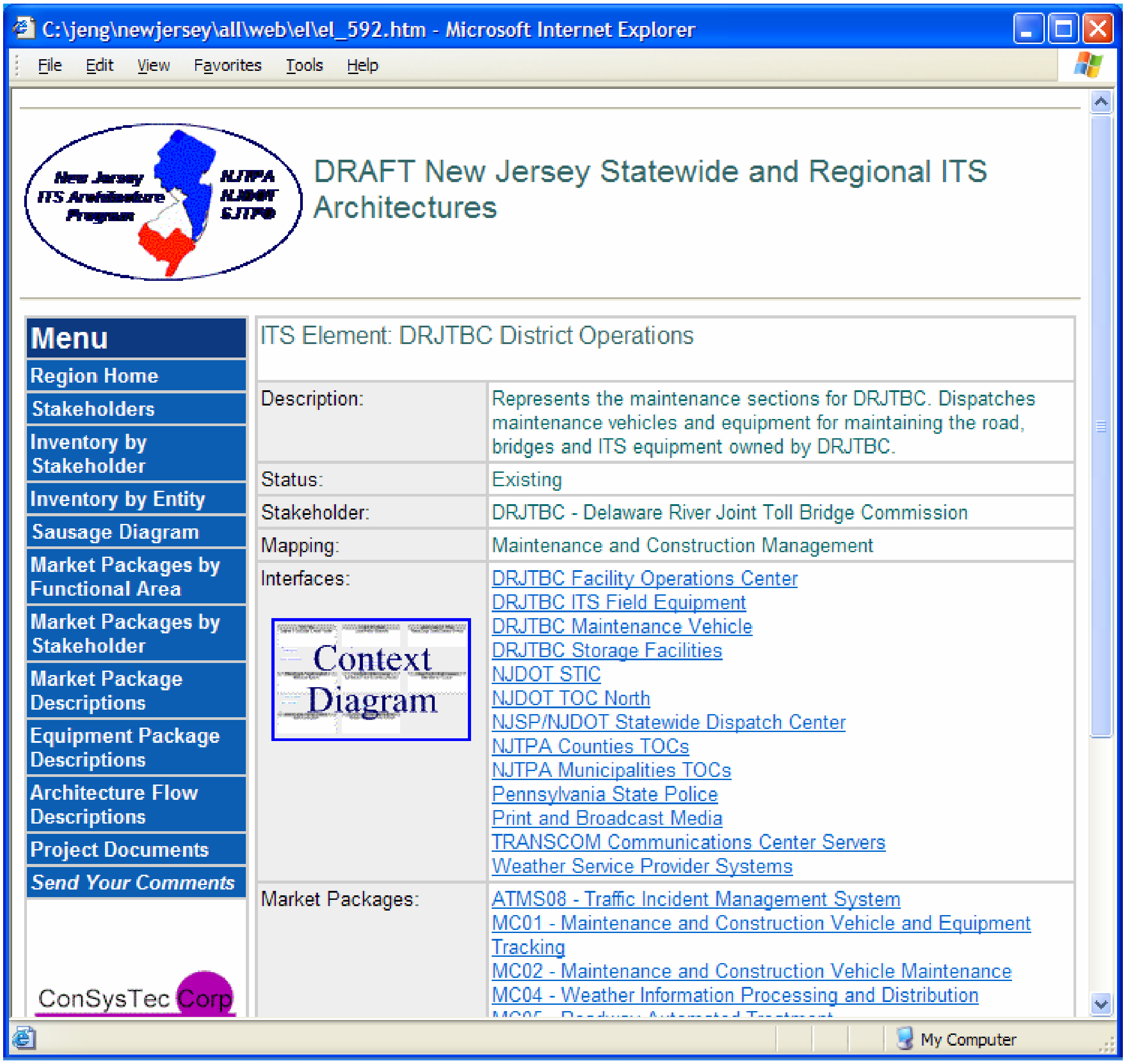


Figure 9-6. Sample Element Detail Page with Link to the Context Flow Diagram

Each element detail page also contains a link to the Context Flow Diagram, in PDF format.

A sample element detail page is shown in the figure above.

10 Information And Architecture Flows

10.1 Introduction

This chapter focuses on the ITS architecture flows used in the New Jersey ITS Architectures. Architecture flows represent the information and control exchanges between ITS elements.

This chapter is organized as follows:

- **Description**. Provides introductory and background information about this section, and a description of information and architecture flows.
- **Importance**. Provides a brief explanation of the purpose and need for information and architecture flows.
- **Documentation**. Provides a description of how information and architecture flows are documented within the ITS Architecture and how to access, interpret, and use the information.
- **Appendix 10.A.** Provides a list of each architecture flow and definition used in the New Jersey ITS Architectures.

10.2 Description

The attributes of architecture flows maintained in the ITS architecture include the following:

- Architecture flow name
- Description
- Whether the architecture flow is a National ITS Architecture architecture flow or user defined, one created to capture the specific local requirement of the New Jersey ITS Architectures.

10.2.1 Technical Approach

The consultant team first began with the default set of National ITS Architecture flows contained within the generic market package diagrams. Next, during the customized market package review with stakeholder, new architecture flows were added (user defined flows) as needed, and flows were removed that did not apply to stakeholder needs. The architecture flows (both default and user defined) are maintained using Turbo Architecture.

10.2.2 Summary Statistics

The New Jersey ITS Architectures contain 322 separate architecture flow definitions.

10.3 Importance

Architecture flows provide a definition of the information and control exchanges between ITS elements. In addition, each architecture flow has been mapped to the standards in the National ITS Standards Program, making it easy to identify which standards may be considered in developing projects based on the New Jersey ITS Architectures a straightforward process.

10.4 Documentation

10.4.1 Turbo Architecture Documentation

Turbo Architecture provides a means to add, edit, and delete user defined flows. Each user defined flow has the following attributes: name, description, and source and destination subsystem or terminator.

A sample Turbo Architecture screen used to edit the user defined flows is shown below. By convention user defined flows contain a *_ud* suffix.

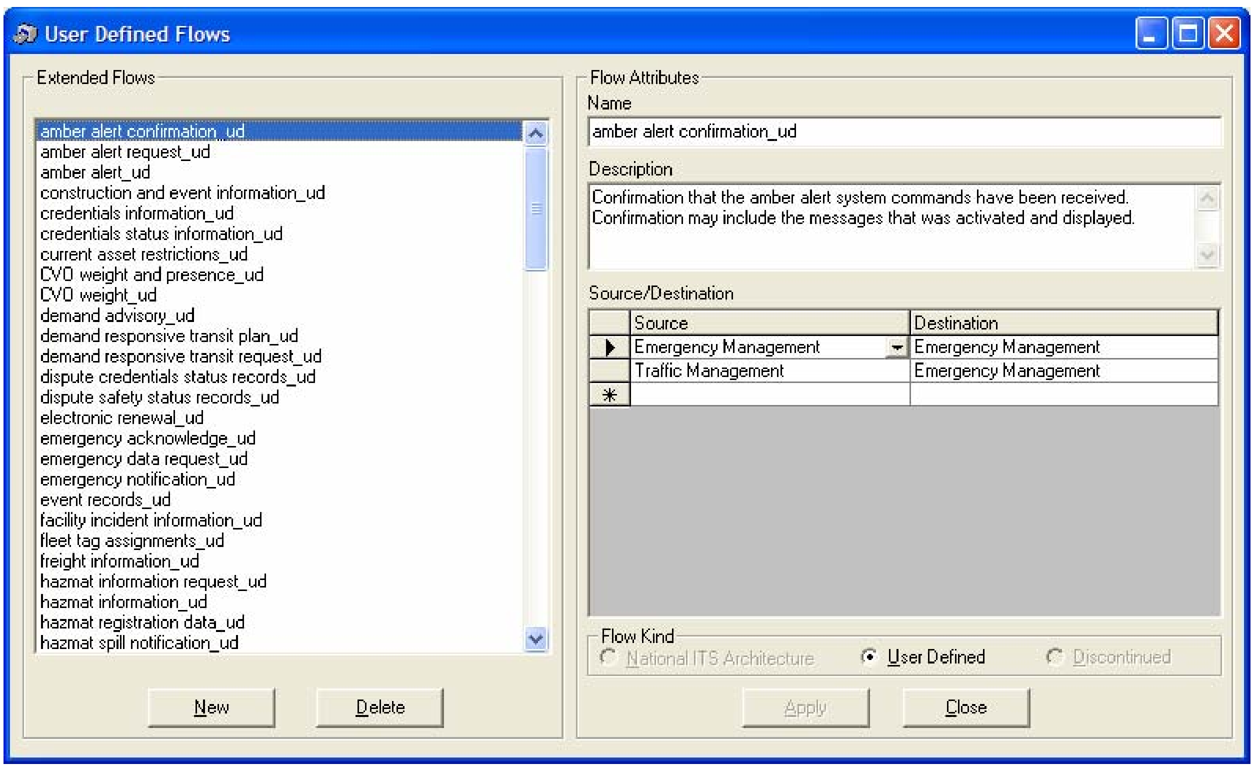


Figure 10-1. Sample Interconnect Diagram in Turbo Architecture

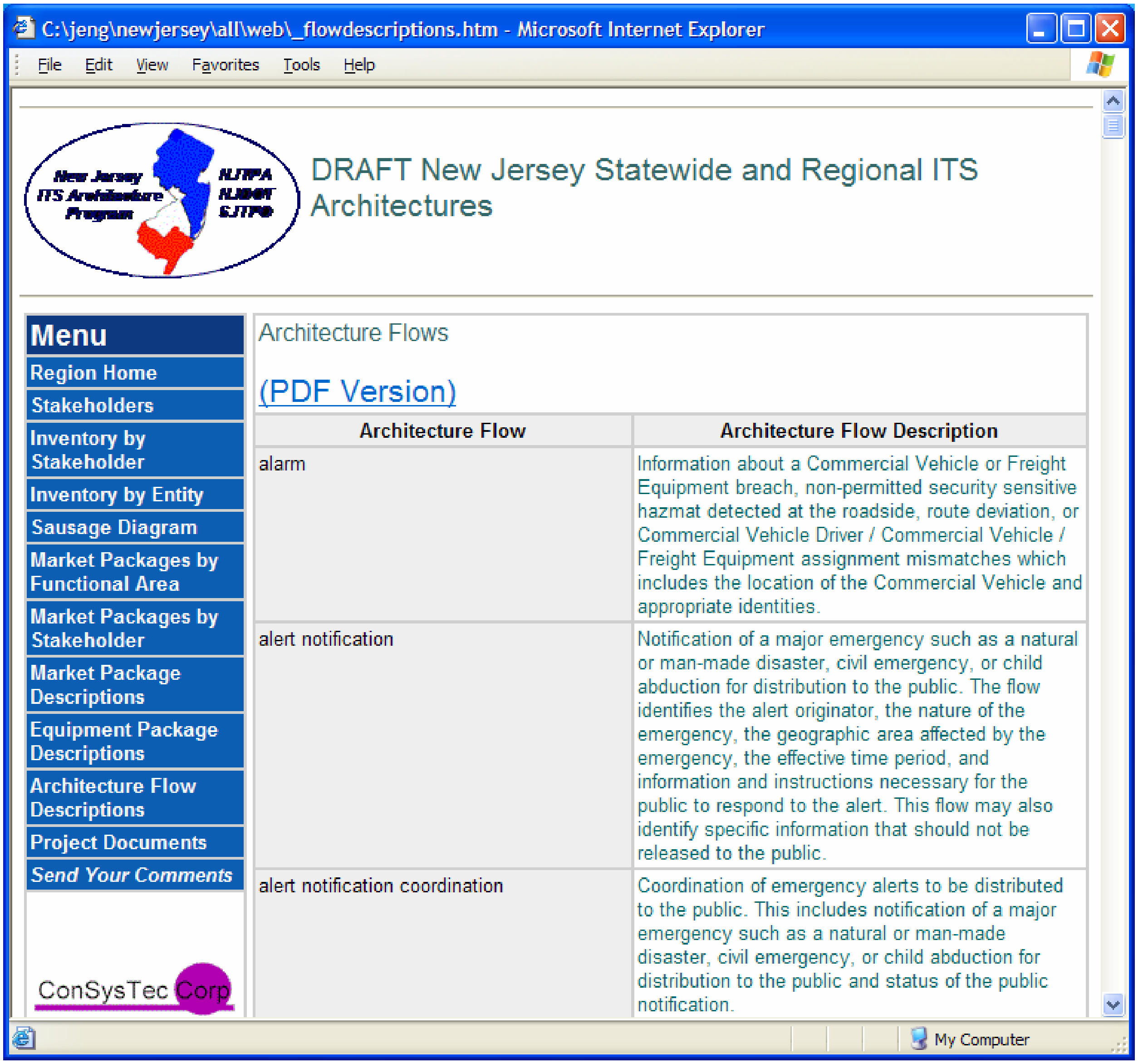


Figure 10-2. Sample Architecture Flow Definition Page from the Web Site

10.4.2 Web Site Documentation

The web site contains a menu button from which a user can review the definitions of all the architecture flows used in the ITS architecture. A sample architecture flow definition page is shown in the figure above.

11 Project Sequencing

11.1 Introduction

The incorporation of the ITS Architecture in the planning process will ultimately yield projects that are linked to the ITS Architecture. Through the deployment of projects produced from the planning process, the services supported in the ITS Architecture will be implemented and made a reality in the transportation system. Project implementation completes the evolution from transportation needs to services, to functional description in the ITS Architecture, to project identification in the planning process, and to project definition and deployment. The overarching goal of the ITS Architecture development process is that this evolution take place with the maximum amount of integration knowledge possible so as to efficiently and economically implement the systems required to serve the transportation community and users.

Key to this process or evolution is to understand what dependencies or relationships existing between systems and projects so that an order can be identified for deployment. Given the importance of integration for ITS, the dependencies of one system on another or one project on another, it is critical to view the entire transportation system at a high, functional level. The ITS Architecture provides this view point and makes possible the understanding of the relationships between the ITS systems in the region.

Project sequencing defines the order in which ITS projects should be implemented. A good sequence is based on a combination of transportation planning factors that are used to prioritize projects (e.g., identify early winners) and the project dependencies that show how successive ITS projects can build on one another.

In most cases, the first projects in the project sequence will already be programmed and will simply be extracted from existing transportation plans. Successive projects will then be added to the sequence based on the project dependencies and other planning factors.

11.2 Process For Selecting Projects

A three step process was used to select projects for the SJTPO Regional ITS Architecture:

- review of the SJTPO Regional ITS Architecture,
- review the Southern New Jersey Transportation Improvement Plan, and
- stakeholder feedback.

The SJTPO Regional ITS Architecture was created based on the needs for the region over the next 20 years. The ITS architecture identifies which systems operated by agencies in the SJTPO region should be interfaced to maximize integration opportunities throughout the region. Based on the existing and future needs of the SJTPO region, the first step of the process identified ITS projects to support stakeholder needs and the information represented in the SJTPO Regional ITS Architecture.

ITS projects provide services that meet the needs of the stakeholders in the region. In the ITS Architecture, these services are represented by market packages. Market packages identify the systems and information exchanges between those subsystems that facilitate the delivery of a service. To identify ITS projects from the ITS Architecture, market packages were examined and selected that best met the short, medium, and long term needs of the region. The market packages provided scope for each ITS project identified. In addition, the market packages provided insight into the hierarchy and dependencies between the identified ITS projects.

Once the ITS projects were identified, the second step in the process was to review the South Jersey Transportation Planning Organization’s Transportation Improvement Program (SJTPO TIP) Fiscal Year 2005 – 2007. The SJTPO TIP is a list of projects and programs scheduled to be implemented over a period of at least three years. Transportation projects must be included in the SJTPO TIP to receive most types of federal funding. The SJTPO TIP provides a mechanism for locally elected officials and agency staff to review the region's capital programming. It represents a consensus among MPO members and other major transportation interests in the region as to what improvements should have priority for available funds.

The ITS projects identified for the Southern region from the SJTPO ITS Architecture were compared to the SJTPO TIP to determine if the proposed ITS project had an existing funding source. If a TIP’s description was similar to the intent of an ITS project, then the TIP was identified as a potential funding source for the ITS project. If a TIP’s description was not similar to any of the proposed ITS projects, then the TIP was reviewed to determine if an additional ITS project was needed to support the TIP. At the conclusion of these first two steps, the initial list of ITS projects was established. The list was further refined to establish which projects were allocated to the short term (5 years), medium term (5 to 10 years), and long term (over 10 years). This provided a priority for the list of projects denoting a general order for project implementation.

The third step in the process, was to obtain stakeholder feedback on the proposed ITS projects and their prioritization. Obtaining stakeholder feedback was necessary for the following reasons:

- Ensure an ITS Project was consistent with stakeholder needs.
- Confirm estimated timeline or priority for ITS Project deployment.
- Understand the relationship and traceability between ITS projects and the SJTPO Regional ITS Architecture.

This part of the process was accomplished through a series of stakeholder workshops where the information was presented and input from the stakeholders was incorporated into the material. During the workshops comments were received from stakeholders regarding ITS project names, timeframes, and programmed projects.

The results of the workshops and project sequencing analysis are provided in Appendix 11.A. The Appendix contains the following information:

- **SJTPO TIP.** A listing of the transportation improvement projects for the South Jersey Transportation Planning Organization. The information included in the SJTPO TIP are:
    - **Project #.** Reference number for the TIP
    - **Project.** Name of the TIP
    - **Type.** Transportation functional area
    - **Description**. Narrative of the project described in the TIP
    - **Related Market Packages(s).** Name of a transportation service identified in the SJTPO Regional ITS Architecture that is related to projects identified in the TIP.
- Functional Area Projects
    - **Southern Transit Projects.** Transit related ITS projects proposed for the SJTPO region.
    - **Southern Parking Management Projects.** Parking management related ITS projects proposed for the SJTPO region.
    - **Southern ATIS and ATMS Projects.** Traveler information, traffic information, and maintenance and construction operations related ITS projects proposed for the SJTPO region.
    - **Southern Information Archive Projects.** Archive data management related ITS projects proposed for the SJTPO region.
    - **Southern CVO Projects.** Commercial vehicle operations related ITS projects proposed for the SJTPO region.
    - **Southern Public Safety Projects.** Emergency management, incident management, and disaster management related ITS projects proposed for the SJTPO region.
- The information included in each of the project functional areas are:
    - **Project Name.** Name of the proposed ITS project.
    - **Regionally Significant Project.** A √ indicates that a project will be implemented in a short timeframe (year 2005 – 2010) and is therefore regionally significant.

- **Market Package.** Maps the proposed ITS project to a transportation service identified in the National ITS Architecture and reflects traceability.
- **Market Package Diagram #.** Provides a reference for locating diagrams on the project website that displays the interfaces among systems that are planned for the proposed ITS project.
- **Timeframe (S/M/L).** Indicates the estimated timeframe for an ITS project to be deployed. The letter S refers to short-term, indicating projects planned for deployment between the years 2005 – 2010. The letter M refers to mid-term, indicating projects planned for deployment between the years 2010 – 2015. The letter L refers to long-term, indicating projects planned for deployment beyond the year 2015.
- **Programmed Projects.** Projects identified in the SJTPO TIP that are related to the proposed ITS project. If an entry is blank, then the current TIPs did not relate to the proposed ITS project.

11.3 How To Use The Projects

The Integration Strategy document states how the SJTPO Regional ITS Architecture should be used in the planning process. The recommended ITS project sequencing provided in the Appendix 11.A of this document should be used as an input for the Long Range Transportation Plan of the MPO and the Strategic/Long Range Plan for other planning organizations. The planning process allocates ITS projects funding in coordination with other transportation projects.

The Transportation Planning Process produces ITS projects that must go through a project development or implementation process that applies a systems engineering approach to reduce risk and costly redesign efforts. Figure 11-1 illustrates the planning process, how the ITS Architecture is incorporated and where the Project Sequencing resource fits into the process. As illustrated in the figure, the ITS Related Projects that come out of the ITS Architecture are from the Project Sequencing List. These projects are inputs into the Long Range Transportation Plan as well as the Strategic/Long Range Plans of other agencies outside the MPO process.

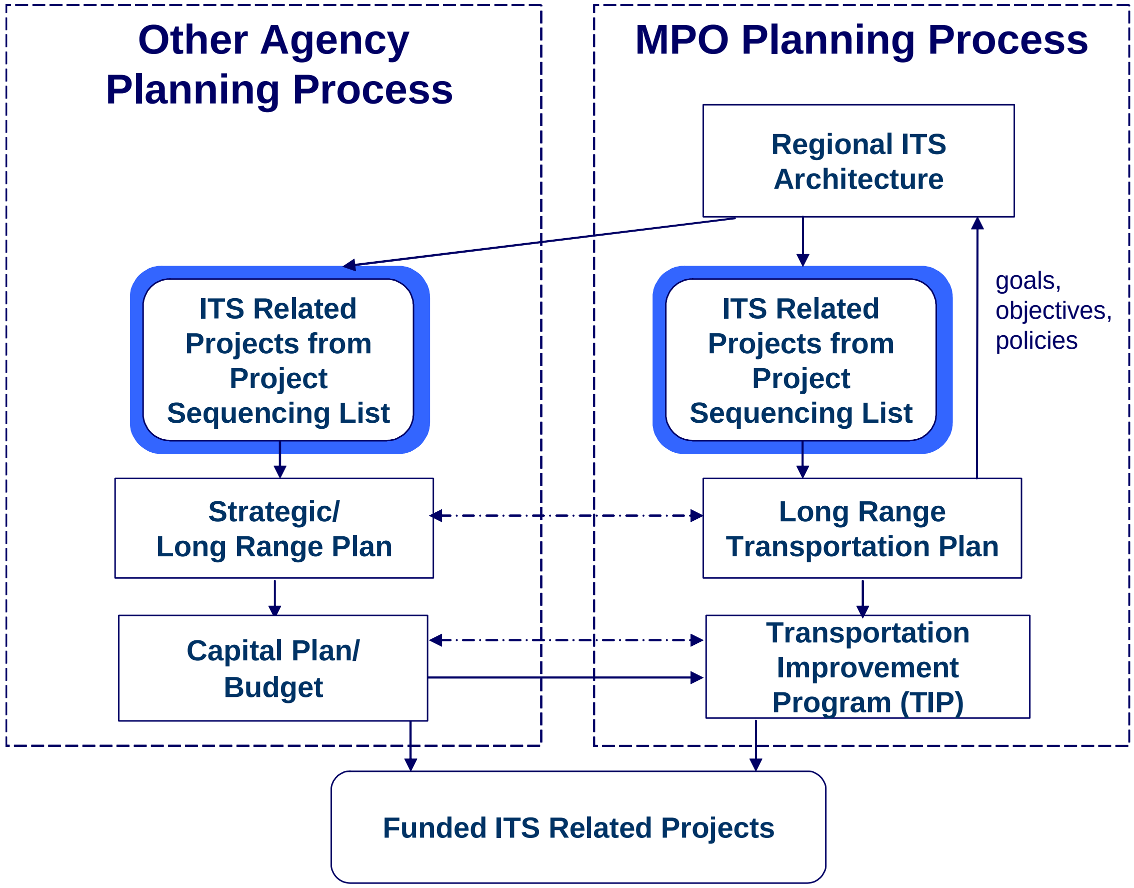


Figure 11-1 ITS Project Sequencing Use

As displayed in the Appendix 11.A, sequenced projects are divided in short/medium/long-term timeframes. These sequenced projects should be represented in the Long Range Plans. As these sequenced projects go through the planning process, the ones identified as short-term would be transitioned in the TIP and Capital Plan/Budget. Since the appendix defines a short-term project as being deployed in 1–5 years and the TIP and Capital Plan/Budget defines a project as being deployed in 1–3 years, stakeholders are required to further examine the short-term projects and determine which should be represented in the TIP and Capital Plan/Budget.

The key question stakeholders may ask is, now that I have a comprehensive list of ITS projects separated by timeframe for my region, how do I use the projects to achieve the goals expressed in the SJTPO Regional ITS Architecture? To answer this question, stakeholders should focus on the following concepts.

- **Why is this important.** Stakeholders should remember the reasons for going through the process of creating sequenced ITS Projects. Ultimately they want to deploy projects that support the needs expressed in their ITS Architecture.

- **Who's in Charge.** Stakeholders should consider identifying a person or group that is responsible for managing how ITS Projects get deployed. This person or group would be aware of the big picture by familiarizing themselves with all of the planned activities and ensure integration opportunities are maximized in project deployments.
- **Systematic Process.** Stakeholders should ensure that projects are managed in a systematic manner. For example, in the SJTPO Region there are two projects identified as short-term: SJTA Traveler Information System and SJTA TOC Surveillance and Traffic Management System. In order for the traveler information system project to experience a successful deployment, the surveillance and traffic management would need to be deployed first to ensure appropriate field devices are installed and supported by algorithms to convey useful traveler information to motorist.
- **Funding Allocation.** Stakeholders should ensure funding is allocated appropriately to support projects that have dependencies or synergies to be utilized. This is important if there are future projects that will depend on a short term or current project. The short term or current project must be funded appropriately to support the accommodation of known future project features or interfaces, thus avoiding redesign for future project accommodation.
- **Project List Management.** Stakeholders should prioritize projects within their common timeframes based on the aforementioned concepts. It is important for short-term projects to be reviewed by stakeholders prior to being transitioned into the TIP. A person or group designated as a list manager should be responsible for removing projects from the SJTPO region list once implemented. If a project is partially implemented due to unforeseen circumstances (e.g., limited funding received), then the list manager should update the project to reflect the remaining components that need to be implemented. The list manager shall also meet with stakeholders to determine how funding should be re-allocated.
- **Desired Outcome.** Stakeholders should remember the desired outcome which is to deploy projects to maximize integration opportunities throughout the SJTPO Region. Therefore, when projects are transitioned into the project development phase, stakeholders should always be aware of other project deployment activities (even if the other activities require a project to be deployed at a different time). This mindset will require stakeholders to be flexible in developing interfaces that will allow for future expansion based on overall regional needs.

Using the sequenced projects as described in Figure 11-1 and following the aforementioned concepts will aid stakeholders in understanding ITS projects planned for deployment and support integration efforts throughout the SJTPO region.

12 Integration Strategy

12.1 Introduction

The most important part of developing an ITS Architecture is establishing an approach to using it. An ITS Architecture provides guidance for planning ITS projects within a region. It also provides information that can be used in the initial stages of project definition and development.

This chapter presents the approach for integrating the ITS Architectures developed for the New Jersey Statewide, the NJTPA Region, and the SJTPO Region into the transportation planning process and leveraging the ITS Architectures in project definition. The approach facilitates and provides a mechanism for the projects identified in the Implementation Plan to be planned and deployed in an orderly and integrated fashion.

The overall objective of an ITS Architecture is to support the effective and efficient deployment of transportation/ITS projects that address the transportation needs of the region. The ITS Architecture focuses on the integration of systems to gain the maximum benefit of each system's information and capabilities across the transportation network. The Integration Strategy provides the process connection between the themes and needs identified in the ITS Strategic Plan and the ITS projects that are deployed within the regions and throughout New Jersey at the statewide level. The ITS Architecture defines "what" needs to be put in place to address the needs and requirements of the region. The transportation planning process will leverage the ITS Architecture as a roadmap to project sequencing and interdependency to achieve an integrated transportation system that addresses those strategic objectives.

12.2 Linking Transportation Needs With Projects

The primary objective of Intelligent Transportation Systems is integration. It is the integration of transportation systems to share information and coordinate activities that facilitates their benefits. The ITS Architectures in New Jersey illustrate the information to be exchanged between transportation systems to meet the transportation needs of the region. In New Jersey, overarching themes or objectives have been identified in an ITS Strategic Deployment Plan by the New Jersey Department of Transportation. The objectives provide an understanding of the needs in the state that deployment projects are to address.

The ITS Architectures link the objectives to the ITS projects that address them. The ITS Architectures were developed with these objectives in mind through the definition of ITS services or market packages.

The summarized objectives or needs as defined in the ITS Strategic Deployment Plan are:

- **Communication System.** An extensive, high speed system is necessary to support the sharing of transportation, incident, emergency, weather, security related, and other information.
- **Incident Management**. A system supports the sharing of recurring and non-recurring incident information with traffic management, public safety, maintenance agencies, etc. in order to quickly respond to situations and emergencies that can have statewide ramifications.
- **Instrumentation.** Instrumentation is necessary to support the planned infrastructure for transportation, weather, and security related equipment to aid decision makers in planning and operations. The instrumentation will serve as the eyes and ears of an operation center.
- **ITS Maintenance**. Maintenance is critical to support and maintain the various ITS equipment that are planned for deployment. If the ITS infrastructure are not properly maintained, the eyes and ears of operations will become blind and deaf to the system that is to be managed.
- **Real-time Transportation Information Dissemination.** This theme is necessary to provide motorists with transportation information that will aid in decision making for route and modal choices, particularly when traveling between the various jurisdictions.

By defining the ITS Architectures with services that address these objectives, projects can be defined through the planning process using the architectures that that address these needs through deployment. Table 12-1 provides a mapping of the objectives to the market packages identified in the ITS Architectures.

Strategic Plan Objectives	Market Packages that Support Objectives
Communications System	Many Market Packages are related to this objective
Incident Management	ATMS02 - Probe Surveillance
	ATMS03 - Surface Street Control
	ATMS04 - Freeway Control
	ATMS06 - Traffic Information Dissemination
	ATMS07 - Regional Traffic Control
	ATMS08 - Traffic Incident Management System
	ATMS21 - Roadway Closure Management
	EM01 - Emergency Call-Taking and Dispatch
	EM02 - Emergency Routing
	EM04 - Roadway Service Patrols

Strategic Plan Objectives	Market Packages that Support Objectives
	EM05 - Transportation Infrastructure Protection
	EM06 - Wide-Area Alert
	EM07 - Early Warning System
	EM08 - Disaster Response and Recovery
	EM09 - Evacuation and Reentry Management
	MC03 - Road Weather Data Collection
	MC04 - Weather Information Processing and Distribution
	MC06 - Winter Maintenance
	MC10 - Maintenance and Construction Activity Coordination
Instrumentation	ATMS01 - Network Surveillance
	EM05 - Transportation Infrastructure Protection
	MC03 - Road Weather Data Collection
	MC05 - Roadway Automated Treatment
ITS Maintenance	MC02 - Maintenance and Construction Vehicle Maintenance
	MC07 - Roadway Maintenance and Construction
Real-time transportation information dissemination	ATIS1 - Broadcast Traveler Information
	ATIS2 - Interactive Traveler Information
	ATMS06 - Traffic Information Dissemination
	ATMS08 - Traffic Incident Management System
	MC04 - Weather Information Processing and Distribution
	MC05 - Roadway Automated Treatment
	MC08 - Work Zone Management

Table 12-1. ITS Objectives Mapped to New Jersey ITS Architecture Market Packages

12.3 Using ITS Architecture in Planning

One of the most important outcomes of the New Jersey Statewide, NJTPA Regional, and SJTPO Regional ITS Architectures is that they will be used to plan and deploy ITS across the state and the regions involved. To do this, the ITS Architectures must be integrated into their respective planning processes. As a result of integrating the ITS Architectures into the planning processes, the architectures will link the objectives and needs of the regions with the ITS deployments in the field.

In transportation planning, the ITS Architectures can be used to support long-range planning, transportation improvement programming and strategic planning. As reviewed with stakeholders in the workshops, Figure 12-1 is a simple diagram of the transportation planning process. The elements of the process that the New Jersey ITS Architectures will support are highlighted.

In the State of New Jersey, metropolitan transportation planning is divided into three different regions. The transportation planning organizations responsible for the regions in the state are:

- Northern Region – North Jersey Transportation Planning Authority (NJTPA)
- Southern Region – South Jersey Transportation Planning Organization (SJTPO)
- Central Region – Delaware Valley Regional Planning Commission (DVRPC)

In addition, transportation planning is also performed at a Statewide level, and the organization responsible for this is the New Jersey Department of Transportation (NJDOT).

Although there are multiple organizations, the transportation planning processes for each are similar. Therefore, Figure 12-1 reflects a generic planning process that all organizations can identify with and base their more detailed process modifications on. The right-side of the figure (MPO Planning Process) refers to federally funded projects and the left-side (Other Agency Planning Process) refers to projects being funded through other means (e.g., local funding). All regions use both processes to fund their planning efforts. A primary goal of the planning process is to make quality, informed decisions on the investment of funds for regional transportation systems and services.

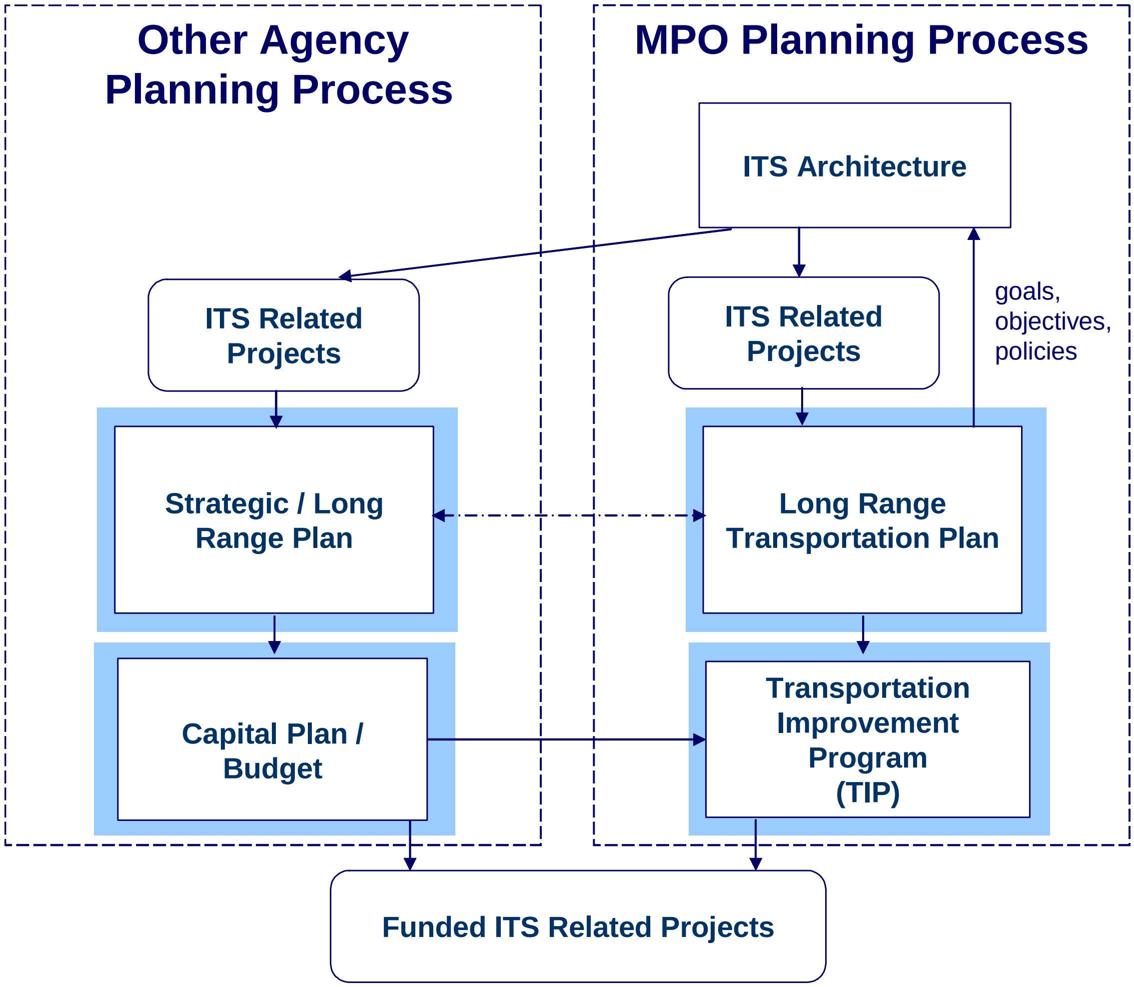


Figure 12-1. New Jersey ITS Architecture in the Transportation Planning Process

The regional outputs of the transportation planning process are two regional plans for both planning processes illustrated in Figure 12-1:

- The Long Range Transportation Plan (LRTP) is a long-range plan with a horizon of at least 20 years that must be updated every three years at a minimum. A Strategic/Long Range Plan is not required but is developed to determine the vision of an agency and how they will obtain the vision.
- The Transportation Improvement Program (TIP) is the short-term plan drawn from the LRTP that identifies specific transportation projects for a region. The TIP must be updated at least every two years. Projects must be included in the RTP and TIP in order to be eligible for federal funding. Regardless of funding source, ITS projects must be weighed against other transportation projects for inclusion in the TIP.

Outside of the MPO Planning Process there are other planning processes that need to be considered in planning ITS. These processes have similar components but do not handle federal funding and are not guided by the same rules as the MPO process.

- A Strategic/Long Range Plan is not required but is developed to determine the vision of an agency and how they will obtain the vision.
- If non-Federal funding resources are to be used, projects are included in a Capital Plan/Budget with short term timelines such as 1 to 3 years. ITS projects must be weighed against other transportation projects in the TIP.

The challenge for achieving integration across planned ITS projects in the regions is to know how they fit together and interact or depend on each other. The ITS Architectures can be leveraged to bridge the MPO processes to other agencies' planning processes which do not use federal funding. If all the processes are using the same reference point, the ITS Architectures, then project integration can start in the planning phases.

Here are some of the ways to use the ITS Architectures in the Long Range Planning Process:

- Use the Architecture to support the definition of the Long Range Plan goals and objectives. It provides the vision of ITS in the future as seen by regional stakeholders.
- The Architecture can be useful in understanding the complexities of the components necessary to realize the goals in the Long Range Plan and gain insight into potential project costs and dependencies.
- The Architecture focuses on interfaces between systems, giving planners an understanding of how the pieces or systems are glued together and, therefore, how the projects in the plan are related. This makes integration opportunities more obvious in this early planning phase.
- The Architecture can be useful in developing high-level project definitions, defining the scopes of projects, and forming regional operational concepts.

In the Transportation Improvement Program, the ITS Architecture assists the planner in defining projects with more detail in order to better scope them and establish project budget requirements. Some of the ways to use the ITS Architecture in the TIP process are:

- To define programmed projects in more detail. The Architecture can be used to better define the integration opportunities for each project.
- To more accurately estimate project budgets based an understanding of the elements and interfaces included in a project.

The tools of the ITS Architecture that are most applicable to the Long Range Planning Process and the Transportation Improvement Program are:

- **Operational Concept.** The operational concept developed in each ITS Architecture provides a narrative description of the roles and responsibilities of each system in the Architecture. It helps the planner understand the relationships and dependencies that exist between systems. When a project is defined and a high-level scope is determined, the operational concept provides more insight into the validity and comprehensiveness of the project definition. Deficiencies in the project definition can be addressed in a more direct manner with specific information of the issues involved. In the end, this provides a more thorough project definition in the long range plan and the TIP.
- **Market Packages.** Market packages offer service-oriented slices of the architecture that facilitate project definition with an understanding of integration opportunities. The market packages provide planners with insight into the elements to include in a project, making the project as comprehensive as possible. Planners should be cognizant of potential partners who can share development cost, material and/or labor, facilities, etc.
- **Interfaces / Information Flows.** Much like the operational concept, the interfaces or information flows within the ITS Architectures provide information about the relationships between systems in the region. The interface definitions in the architecture are more specific than in the operational concept in that information exchanges are broken down into individual units rather than more general descriptions. The planner can review the interfaces between systems in a project to determine if other systems are affected by a project.
- **Project Sequencing.** The project sequencing provided in the ITS Architectures gives insight into the timelines and dependencies of one project to the next. High priority or near term projects should be addressed first in the transportation plan.

Issues/Challenges

The most challenging issue to be addressed in the integration of the ITS Architecture in the planning process is the fact that there is more than one planning process. Coordination is important between the North Jersey Transportation Planning Authority, the South Jersey Transportation Planning Organization, the Delaware Valley Regional Planning Commission, and the New Jersey Department of Transportation for ITS projects in their respective plans. Integration opportunities should be taken advantage of within each of these regions as well as between them. This is the primary intent of the ITS Architecture compliance where Federal funding is involved.

The more difficult issue to address is coordination of ITS project planning between the Federally funded projects and the non-Federally funded projects. The non-Federally funded projects are generally not part of the Long Range Planning Process or the Transportation Improvement Program. The ITS Architecture contains systems and projects that bridge both Federally and non-Federally funded projects and systems. Coordinating all of these projects requires an understanding by all stakeholders of the ITS systems and potential of the entire region. The ITS Architectures provide a common reference point for all stakeholders to gain insight into the integration of the systems in the region.

Recommendations
It is recommended that the organizations responsible for the Long Range Plan and the Transportation Improvement Program, such as NJTPA, SJTPO, and NJDOT, designate an individual or group who is responsible for the application and monitoring of the ITS Architecture to their respective Transportation Planning Processes. The roles and responsibilities will include:

- Modification of the Transportation Planning Process to incorporate ITS Architecture checkpoints, review opportunities, and guidance to take advantage of the information contained in the ITS Architecture in the planning of ITS projects,
- Point of contact for ITS Architecture questions regarding its application in the planning process,
- Lead the evaluation of ITS projects for their compliance with the ITS Architecture,
- Outreach to stakeholders about how to use the ITS Architecture in the planning process,
- Provide feedback to the Maintenance Manager of the ITS Architecture on any ITS Architecture changes resulting from the planning of projects,
- Liaison between MPO and non-MPO planning organizations to share information about the projects in the various planning processes and coordinate integration opportunities.

These recommendations are provided at a level of detail high enough to provide flexibility in their implementation. Stakeholder feedback from the workshops indicated that the individual regions wished to determine the changes to their processes internally. It is important, given the common involvement of all the regions in many ITS projects that there not only be an understanding of an individual's region but that the planning processes of each region be understood and recognized by the other regions.

12.4 Using ITS Architecture in Project Definition

Projects that emerge from the planning process can benefit from the use of the ITS Architecture in their definition and development. Project implementation should follow the systems engineering process. The ITS Architecture is most effective in the early phases of the systems engineering process. Figure 12-2 shows the project implementation process for deploying ITS projects.

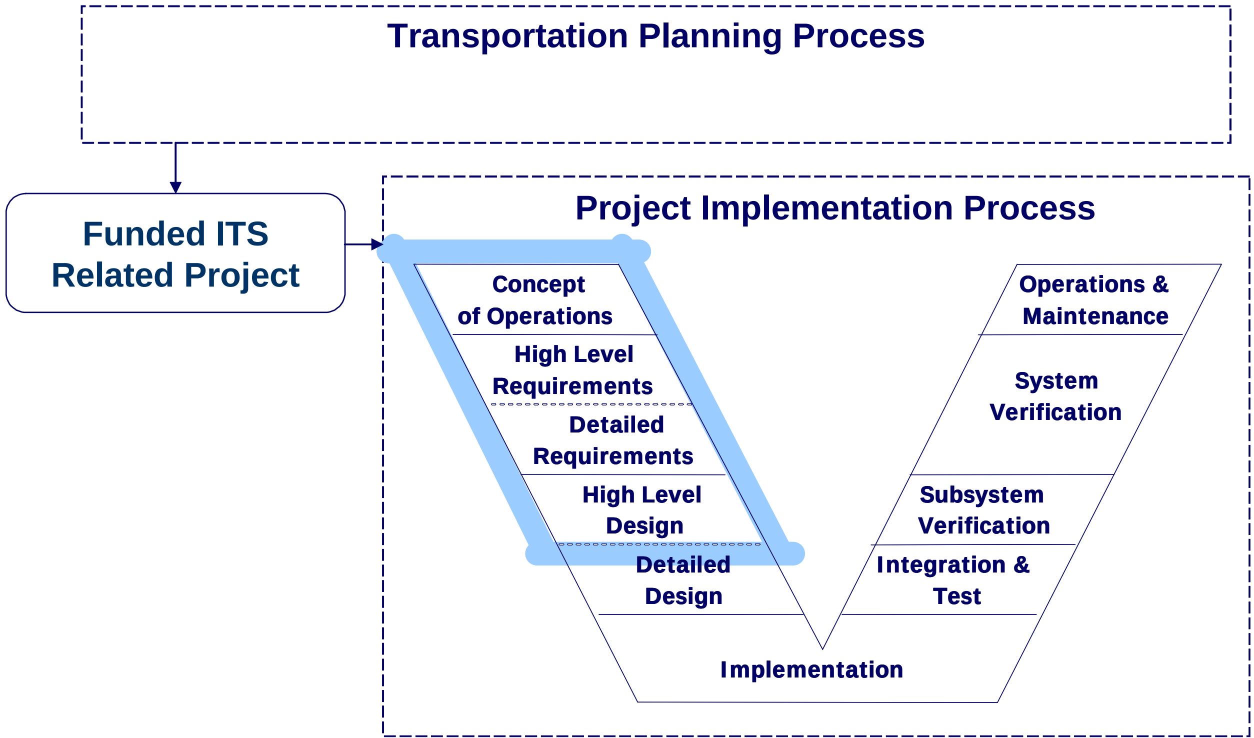


Figure 12-2. New Jersey ITS Architecture in the Project Implementation Process

The project implementation process shown in Figure 12-2 is a systems engineering process. It is a process that can be used to systematically deploy ITS that reduces risk. The Systems Engineering process is more than just steps in systems design and implementation; it is a life-cycle process. The process recognizes that many projects are deployed incrementally and expand over time. US DOT Rule 940 requires that the systems engineering process be used for ITS projects that are funded with federal funds.

As previously noted, the stakeholders in the workshops preferred to keep the processes at a high level to allow for the most flexibility for each region in developing their detailed approach. In the case of the New Jersey DOT, there are similarities between the systems engineering process defined in Figure 12-2 and the project development process followed at the department. NJDOT's project development process is as follows:

- Concept Development
- Scoping/Feasibility Assessment
- Preliminary Design
- Final Design
- Construction
    - Integration/Testing

  - System Verification
  - Subsystem Verification
- Operation and Maintenance

Table 12-2 shows the relationship the NJDOT project development process has to the FHWA system engineering process.

New Jersey Project Development Process	Relation	System Engineering Process
Concept Development	→	Concept of Operations
Scoping/Feasibility Assessment	→	High Level Requirements Detailed Requirements
Preliminary Design	→	High Level Design
Final Design	→	Detailed Design
Construction*		Implementation
Integration/Testing		Integration & Test
System Verification	→	Subsystem Verification
Subsystem Verification		System Verification
Operation and Maintenance	→	Operations & Maintenance

Note: * - Implementation step is not shown because the completion of construction a project is presumed to be implemented.

Table 12-2. New Jersey Project Development Process Relation to FHWA System Engineering Process

As shown by the highlights in Figure 12-2 and italics in Table 12-2, the New Jersey ITS Architectures can be used to support development of the concept of operations, requirements and high level design in the systems engineering process.

In deployment of an ITS related project, the New Jersey ITS Architecture should be used as the starting point for developing a project concept of operations. The concept of operations shows at a high level how the systems involved in a project operate in conjunction with the other systems of the region. The concept of operations for an ITS project should include this information and many more details specific to the project.

The market package diagrams tailored by the New Jersey stakeholders can also assist in definition of requirements for ITS systems involved in a specific project. The New Jersey ITS Architectures contain very high level functional requirements for all ITS systems in the State. These very high level requirements can be the beginning point for developing more detailed requirements.

The New Jersey ITS Architectures can support high level system design. The ITS architectures can be used by system designers to identify the ITS standards that are applicable for the interfaces included in each architecture.

Issues/Challenges

One of the challenges of using the ITS Architecture in the implementation of a project is educating stakeholders about the benefits and process. The systems engineering process is not a new process to many organizations. It may not be called the systems engineering process but their process may map to it very well as can be seen in Table 12-2 with the NJDOT process. Making these types of linkages between processes makes it easier to incorporate the ITS Architecture as a tool in the process.

Another challenge is engaging a broader stakeholder base on a project when the ITS Architecture indicates that possibility. This entire activity of seeking integration opportunities is more institutional than technical. There will be instances where getting more stakeholders involved in a project will increase its complexity or cross jurisdictional boundaries that may not have been considered in the initial scope. It is important to explore these integration opportunities so that, at the very least, they are accounted for and supported in the project design even though they may not be implemented with that specific project. The ultimate goal is to make ITS deployment as economical as possible.

Recommendations

It is recommended that the NJTPA, the SJTPO, and the NJDOT modify their project development/implementation processes to incorporate the use of ITS Architecture. The process modifications should be distributed to stakeholders so they are aware of the steps to follow and are aware that this process is a necessary part of any project receiving Federal funding.

It is also recommended that an individual or group be identified in the NJTPA, the SJTPO, and the NJDOT to review project submittals and evaluate compliance with the ITS Architecture. It is important to work with the FHWA Division Office Representative in establishing a review process given they will be involved in approval of the projects with Federal funding. The generation of a checklist would make the evaluation more structured and facilitate a consistent approach to each project.

13 Implementation Plan

13.1 Introduction

This Implementation Plan is submitted as part of the New Jersey ITS Architecture Project. The context of this document in relation to the rest of the Project is demonstrated in Figure 13-1. This figure shows how the Implementation Plan is built upon the information contained in the ITS Inventory, the development of Customized Market Packages, and the Definition of Projects. All of this information, including the Implementation Plan, fall under the ITS Architecture umbrella.

ITS Architecture	
Project Sequence (Priority, Project Description)	Implementation Plan (Cost, Benefits, Staffing)
Projects (made up of one or more Customized MP Diagram)	
Customized Market Package Diagrams (ITS Services, Interfaces and Interconnects)	
ITS Inventory	

Figure 13-1. Hierarchy of Information in the NJ ITS Architectures

There are four major topics that are addressed by the Implementation Plan. They include:

- Estimate costs for the Short Term projects identified in the Project Sequencing task
- Identify staffing costs
- Provide information for programming of projects
- Identify qualitative benefits that are expected from these projects.

In summary, the Implementation Plan identifies the funding and labor required to implement and operate the NJ ITS Architecture. It estimates the costs of the Short Term projects to include in the capital programs of the stakeholders, and it identifies the types of benefits that may be expected from specific projects.

13.2 Methodology

The primary source used for the unit cost and benefit information presented herein is the **2003 Update of the Intelligent Transportation Systems Benefits and Costs** by the USDOT (Publication Number FHWA-OP-03-075.) The data that serve as the basis for this publication are known as the National ITS Cost Database, and the National ITS Benefit Database.

13.2.1 Cost Assumptions

The following general assumptions were made in order to estimate the costs of projects:

- Construction Costs = baseline unit costs per "high end" National ITS Cost Database, include customization and integration. (Relative to the rest of the country, NJ is considered a high cost area.)
- Where a quantity of elements (e.g., field devices) is unknown, a range is assumed. The "high-end" and "low-end" costs listed in the tables are a result of this range.
- Annual Operations and Maintenance Costs = 8% annually of Construction costs, or per "high end" National ITS Cost Database for specific items (e.g., leased communications).

Several general assumptions were made for communication costs. It is important to note that these cost items should NOT be interpreted as technology selections; they only serve as "placeholders" to estimate costs. Some of the assumptions include:

- Center to Center data interconnects are estimated as a DS0 communication line
- It is assumed that Center to Center communications lines are unique to functional areas (i.e., APTS and ATMS systems do not share lines)
- Center to Vehicle data interconnects are estimated as a cellular or generic wireless communications item
- Center to Roadside interconnects maybe estimated as a "wireline to device" item, or other type communication
- Center to Device interconnects that explicitly identify video are estimated as a DS1 Communication line.

In some cases a proposed subsystem or interconnect may not have a related cost element in the database. For these cases, additional assumptions are made in order to assign a cost to the subsystem or interconnect. These assumptions are listed in the "Notes" section of the project-specific tables in Appendix 13.A.

In cases where a Center is being tasked by a project with new functionality, it is assumed that additional staffing is required. The specifics are found in the individual project tables in the Appendix 13.A.

The cost estimates herein are highly sensitive to the assumptions listed above and are considered order-of-magnitude estimates.

13.2.2 Types of Studies

In addition to the construction or implementation costs, there are additional work items and costs required in a public sector environment. These items are referred to as “types of studies” in the scope of work and include:

- Design = estimated at 10% of Construction costs
- Construction Support = estimated at 2% of Construction costs
- Construction Inspection = estimated at 10% of Construction costs

13.2.3 Benefit Types

Evaluation studies that have been done for other ITS projects are used as a guide to identify the types of benefits that can be expected by the NJ ITS Architecture projects. This Implementation Plan lists the types of expected benefits and references the evaluation studies that are relevant to each proposed project.

The taxonomy, or classification, of benefits is consistent with the **2003 Update of the Intelligent Transportation Systems Benefits and Costs**. The classification is done as follows:

- Program Area
    - Sub Area
        - Goal Area

The parsing of ITS into Subsystems, Interconnects, etc., as done in the National ITS Architecture is not an exact fit with the parsing of ITS into Program Areas and Sub Areas as done in the **Intelligent Transportation Systems Benefits and Costs**. Therefore, an effort has been to provide the most appropriate match.

13.3 SJTPO Results

The remainder of this Chapter will be submitted at a later date.

14 ITS Standards

14.1 Introduction

This chapter focuses on the applicable ITS standards for the New Jersey ITS Architectures. The architecture defines the functions (e.g., gather traffic information or request a route) that must be performed to implement transportation services, the systems where these functions reside (e.g., the roadside or the vehicle), the interfaces/information exchanges between systems, and the communication requirements for the moving of information from one system to another, whether wireline or wireless.

This chapter is organized into as follows:

- **Description.** Provides introductory and background information about this section and the topic of the national ITS standards.
- **Importance.** Provides a brief explanation of the purpose and need for the ITS standards.
- **Documentation.** Provides a description of how applicable ITS standards are documented within the ITS Architecture and how to access, interpret, and use the information.
- **Appendix 14.A.** Provides a list of applicable ITS standards for the New Jersey ITS Architectures.

14.2 Description

One objective of the New Jersey ITS Architectures is to identify applicable ITS interface standards. This objective supports the broader and related ITS objectives of achieving interoperability between ITS deployments and reducing the cost of ITS deployments.

14.2.1 Technical Approach

Using the Turbo Architecture software, which contains a mapping of the National ITS Architecture architecture flows to ITS standards, the ConSysTec architecture team developed a list of applicable candidate ITS standards. This list, summarized across all three of the New Jersey ITS Architectures, is shown in Appendix 14.A.

14.3 Importance

The New Jersey ITS Architectures identify the requirements for the ITS standards needed to support regional interoperability, as well as product standards needed to support economy of scale considerations in deployment. The result is a New Jersey statewide and regional plan for transportation management system integration, from which technical ITS project specifications can be shaped.

The concept of interoperability between systems falls largely into two areas: Center-to-Center System Interoperability and Center-to-Field System Interoperability. In general, center-to-center interoperability refers to interoperability between center-based systems, including both information and command-control exchanges. Center-to-field interoperability involves interoperability not only of information exchanges, and command and control between center and field systems, but also interoperability between different manufacturers' equipment, including electrical and mechanical specifications. The ITS architecture will identify candidate standards for use in projects.

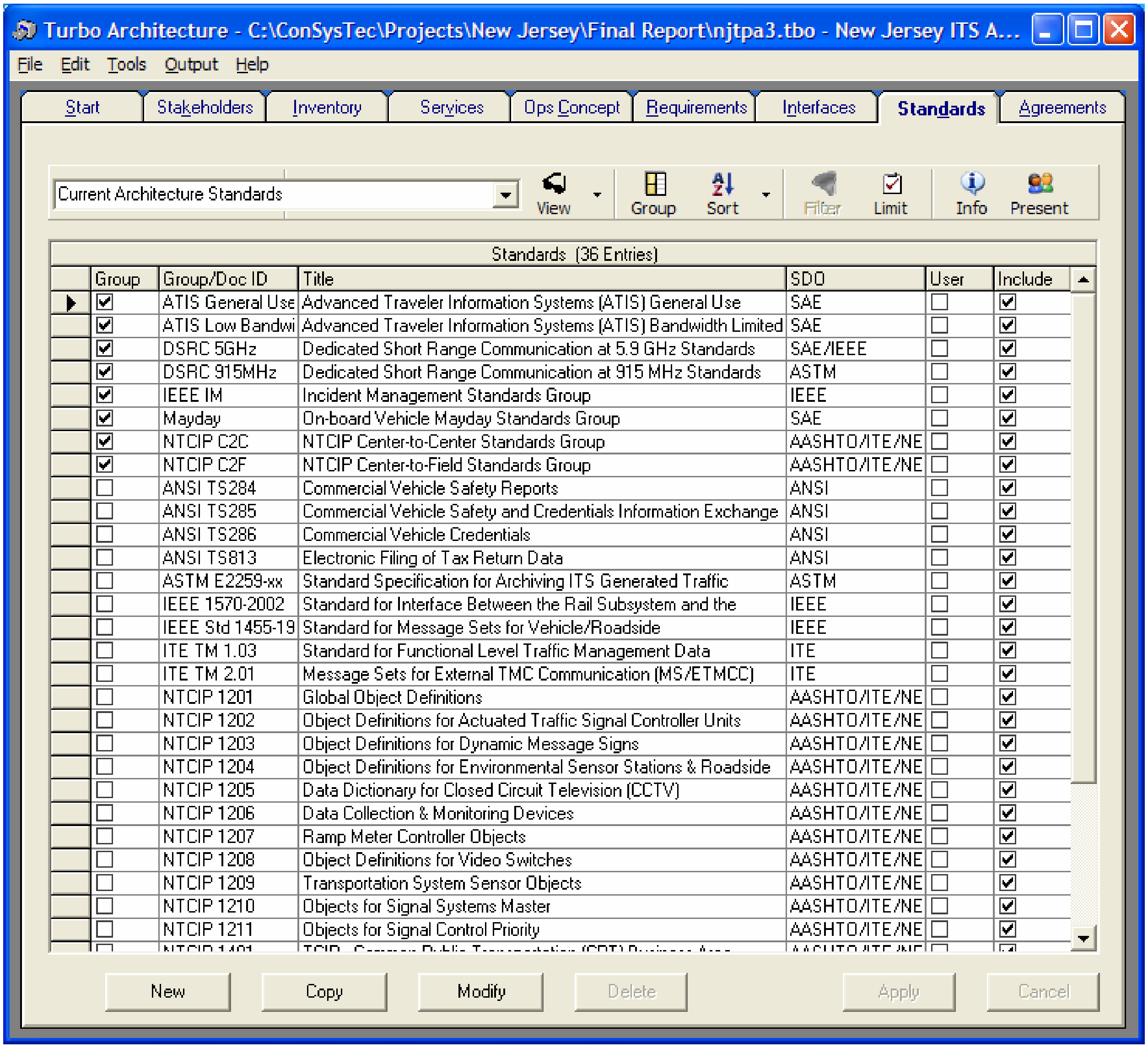
While the objective of an ITS architecture is to document the current and future information sharing relationships between existing and planned ITS elements, the objective of the standards is to guide the specification and deployment of the external interfaces of identified architecture elements (i.e. the interfaces between specific centers, field equipment, vehicles and traveler equipment).

14.4 Documentation

14.4.1 Turbo Architecture Documentation

Turbo Architecture provides a means to add, edit, and delete candidate standards -- the default list of applicable ITS standards was generated from a mapping of the ITS architecture flows to the ITS standards, something which is supported by Turbo Architecture.

A sample Turbo Architecture screen used to maintain the list of applicable ITS standards is shown below.



Group	Group/Doc ID	Title	SDO	User	Include
☑	ATIS General Use	Advanced Traveler Information Systems (ATIS) General Use	SAE	☐	☑
☑	ATIS Low Bandwi	Advanced Traveler Information Systems (ATIS) Bandwidth Limited	SAE	☐	☑
☑	DSRC 5GHz	Dedicated Short Range Communication at 5.9 GHz Standards	SAE/IEEE	☐	☑
☑	DSRC 915MHz	Dedicated Short Range Communication at 915 MHz Standards	ASTM	☐	☑
☑	IEEE IM	Incident Management Standards Group	IEEE	☐	☑
☑	Mayday	On-board Vehicle Mayday Standards Group	SAE	☐	☑
☑	NTCIP C2C	NTCIP Center-to-Center Standards Group	AASHTO/ITE/NE	☐	☑
☑	NTCIP C2F	NTCIP Center-to-Field Standards Group	AASHTO/ITE/NE	☐	☑
☐	ANSI TS284	Commercial Vehicle Safety Reports	ANSI	☐	☑
☐	ANSI TS285	Commercial Vehicle Safety and Credentials Information Exchange	ANSI	☐	☑
☐	ANSI TS286	Commercial Vehicle Credentials	ANSI	☐	☑
☐	ANSI TS813	Electronic Filing of Tax Return Data	ANSI	☐	☑
☐	ASTM E2259-xx	Standard Specification for Archiving ITS Generated Traffic	ASTM	☐	☑
☐	IEEE 1570-2002	Standard for Interface Between the Rail Subsystem and the	IEEE	☐	☑
☐	IEEE Std 1455-19	Standard for Message Sets for Vehicle/Roadside	IEEE	☐	☑
☐	ITE TM 1.03	Standard for Functional Level Traffic Management Data	ITE	☐	☑
☐	ITE TM 2.01	Message Sets for External TMC Communication (MS/ETMCC)	ITE	☐	☑
☐	NTCIP 1201	Global Object Definitions	AASHTO/ITE/NE	☐	☑
☐	NTCIP 1202	Object Definitions for Actuated Traffic Signal Controller Units	AASHTO/ITE/NE	☐	☑
☐	NTCIP 1203	Object Definitions for Dynamic Message Signs	AASHTO/ITE/NE	☐	☑
☐	NTCIP 1204	Object Definitions for Environmental Sensor Stations & Roadside	AASHTO/ITE/NE	☐	☑
☐	NTCIP 1205	Data Dictionary for Closed Circuit Television (CCTV)	AASHTO/ITE/NE	☐	☑
☐	NTCIP 1206	Data Collection & Monitoring Devices	AASHTO/ITE/NE	☐	☑
☐	NTCIP 1207	Ramp Meter Controller Objects	AASHTO/ITE/NE	☐	☑
☐	NTCIP 1208	Object Definitions for Video Switches	AASHTO/ITE/NE	☐	☑
☐	NTCIP 1209	Transportation System Sensor Objects	AASHTO/ITE/NE	☐	☑
☐	NTCIP 1210	Objects for Signal Systems Master	AASHTO/ITE/NE	☐	☑
☐	NTCIP 1211	Objects for Signal Control Priority	AASHTO/ITE/NE	☐	☑

Figure 14-1. Sample Applicable ITS Standards in Turbo Architecture

14.4.2 Web Site Documentation

The web site provides information derived from the National ITS Architecture mapping of architecture flows to standards. From the ITS Element Detail Page, a user may click to view a specific interface (which contains a list of the information and control exchange between the two elements). These web pages are shown in the figures below.

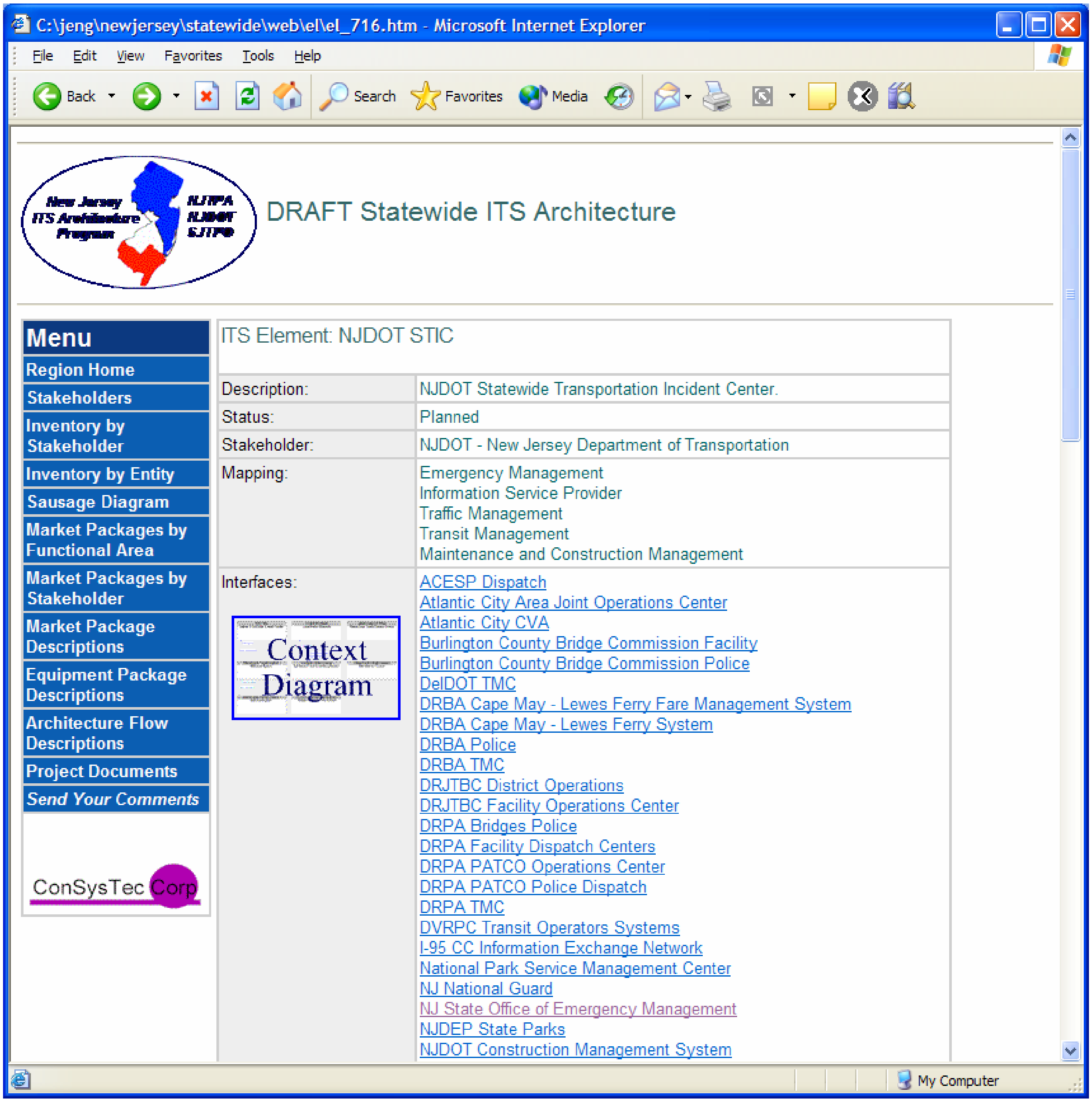


Figure 14-2. ITS Element Detail Page from the Web Site

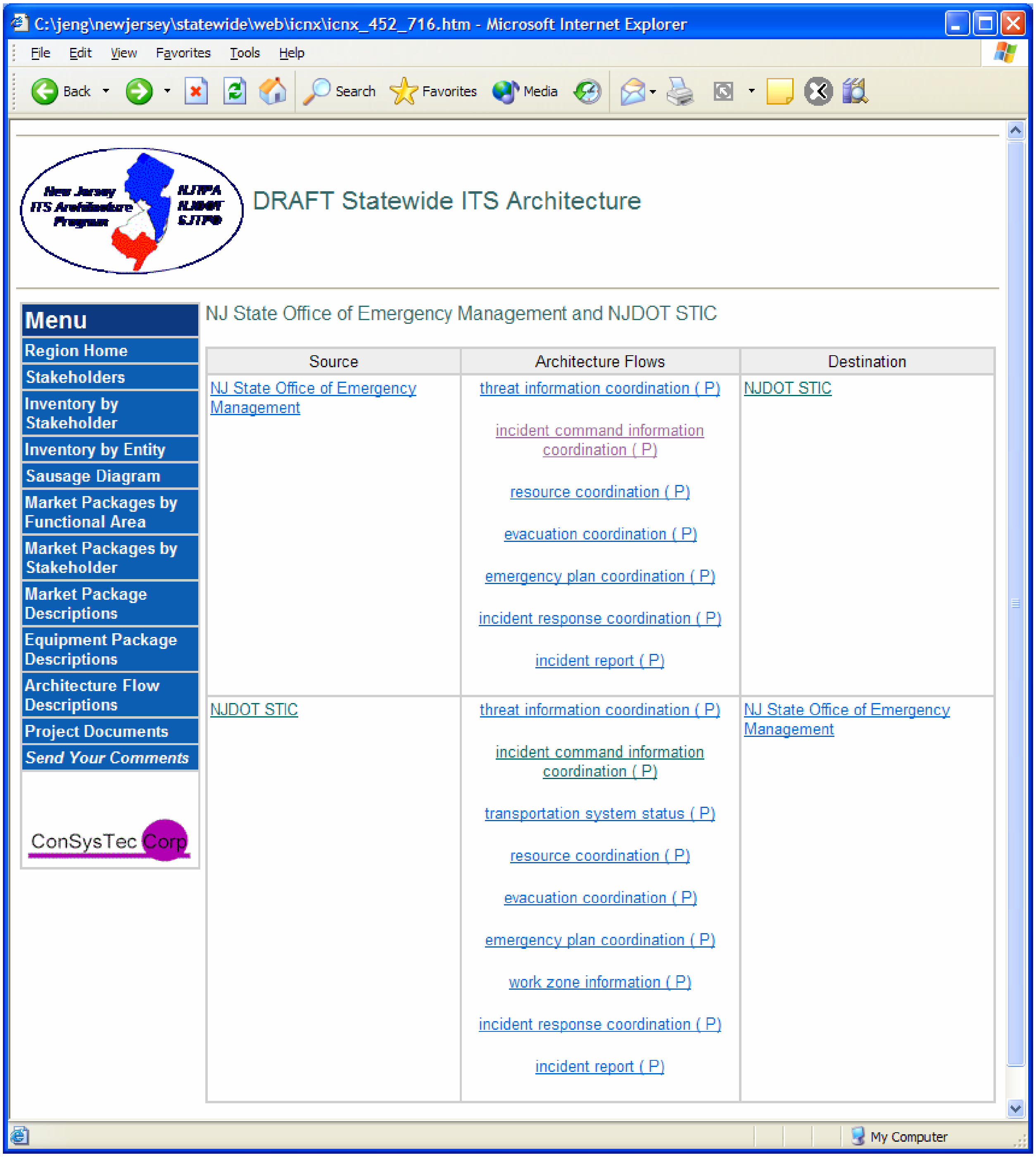
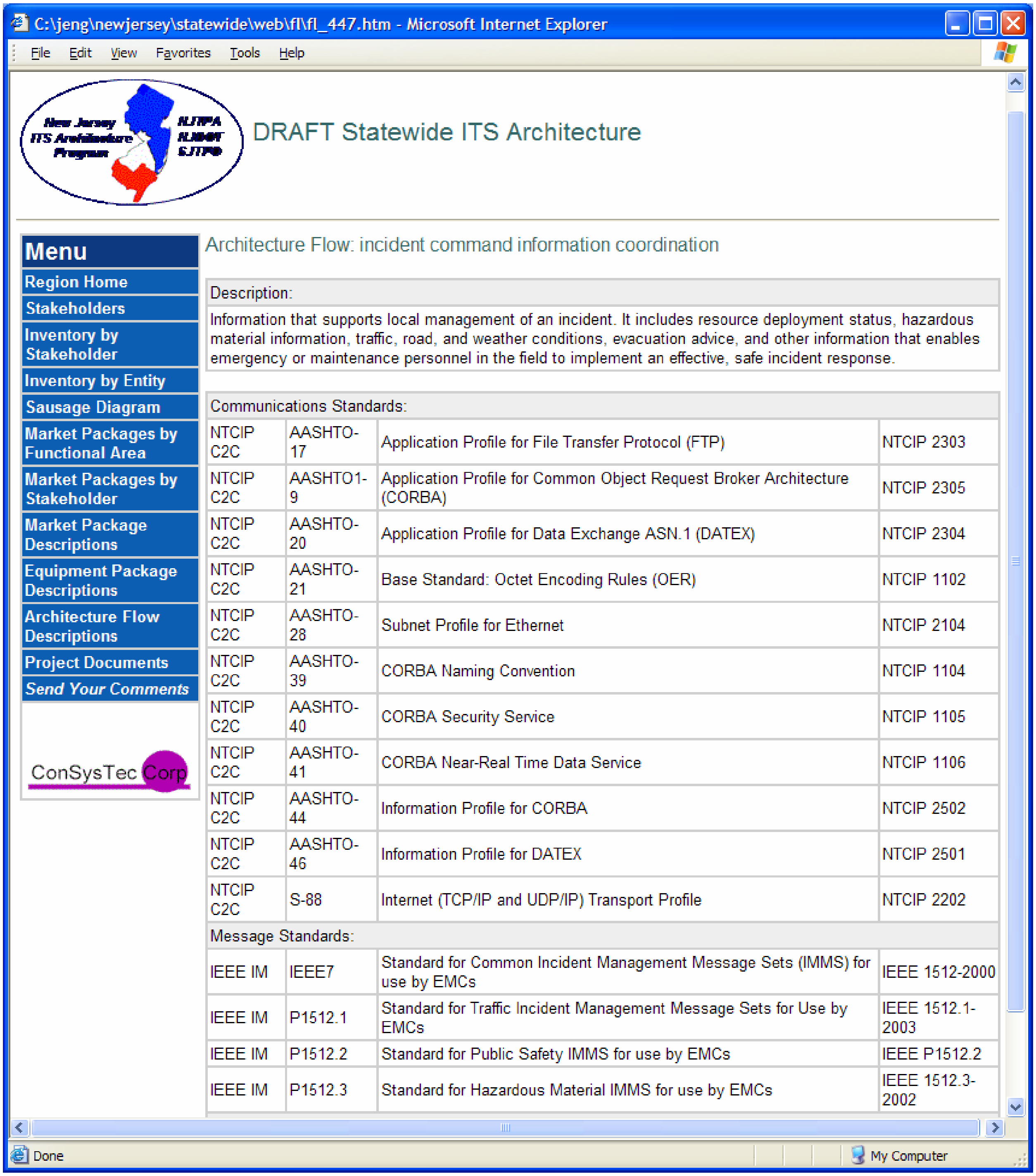


Figure 14-3. ITS Element Interconnection Page from the Web Site



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File Edit View Favorites Tools Help

DRAFT Statewide ITS Architecture

Menu
Region Home
Stakeholders
Inventory by Stakeholder
Inventory by Entity
Sausage Diagram
Market Packages by Functional Area
Market Packages by Stakeholder
Market Package Descriptions
Equipment Package Descriptions
Architecture Flow Descriptions
Project Documents
Send Your Comments

Architecture Flow: incident command information coordination

Description:

Information that supports local management of an incident. It includes resource deployment status, hazardous material information, traffic, road, and weather conditions, evacuation advice, and other information that enables emergency or maintenance personnel in the field to implement an effective, safe incident response.

Communications Standards:			
NTCIP C2C	AASHTO-17	Application Profile for File Transfer Protocol (FTP)	NTCIP 2303
NTCIP C2C	AASHTO1-9	Application Profile for Common Object Request Broker Architecture (CORBA)	NTCIP 2305
NTCIP C2C	AASHTO-20	Application Profile for Data Exchange ASN.1 (DATEX)	NTCIP 2304
NTCIP C2C	AASHTO-21	Base Standard: Octet Encoding Rules (OER)	NTCIP 1102
NTCIP C2C	AASHTO-28	Subnet Profile for Ethernet	NTCIP 2104
NTCIP C2C	AASHTO-39	CORBA Naming Convention	NTCIP 1104
NTCIP C2C	AASHTO-40	CORBA Security Service	NTCIP 1105
NTCIP C2C	AASHTO-41	CORBA Near-Real Time Data Service	NTCIP 1106
NTCIP C2C	AASHTO-44	Information Profile for CORBA	NTCIP 2502
NTCIP C2C	AASHTO-46	Information Profile for DATEX	NTCIP 2501
NTCIP C2C	S-88	Internet (TCP/IP and UDP/IP) Transport Profile	NTCIP 2202
Message Standards:			
IEEE IM	IEEE7	Standard for Common Incident Management Message Sets (IMMS) for use by EMCs	IEEE 1512-2000
IEEE IM	P1512.1	Standard for Traffic Incident Management Message Sets for Use by EMCs	IEEE 1512.1-2003
IEEE IM	P1512.2	Standard for Public Safety IMMS for use by EMCs	IEEE P1512.2
IEEE IM	P1512.3	Standard for Hazardous Material IMMS for use by EMCs	IEEE 1512.3-2002

Done My Computer

Figure 14-4. Sample Architecture Flow-Specific ITS Standards Page from the Web Site

From the ITS Element Interconnect Page, a user can click on a flow and view more detail, including specific information related to the ITS standards that may apply to the specification and implementation of the architecture flow in a project. This is shown in the figure above.